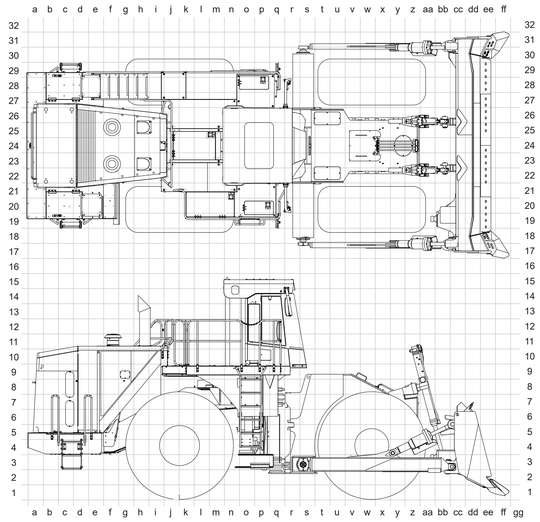
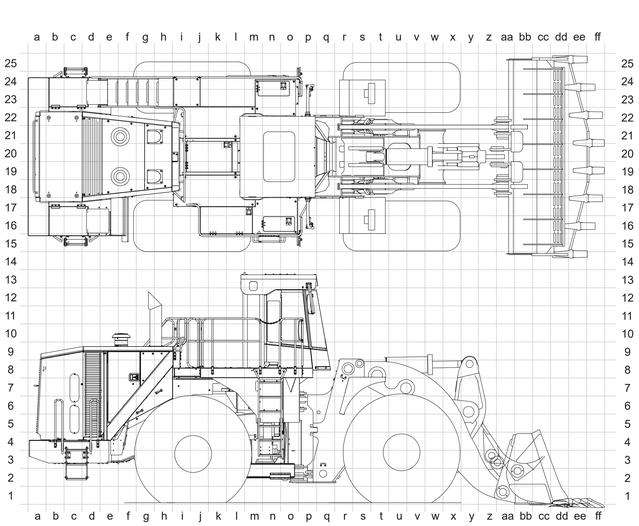
Connector Location		
Connector Number	Schematic Location	Machine Location
CONN 1	I-14	E-4, E-20
CONN 2	H-14	E-6, E-22
CONN 3	H-14	I-7, I-18
CONN 4 TDC Probe	E-14	F-7, F-20
CONN 5	D-14	E-7, E-20
CONN 6	C-13, F-13	E-7, E-21
CONN 7	F-13	E-7, E-20
CONN 8	F-13	G-7, G-19
CONN 9	G-13	F-7, F-20
CONN 10	H-13	J-6, J-20
CONN 11	I-13	I-6, I-21
CONN 12	F-12	M-6, M-22
CONN 13	C-12	F-7, F-18
CONN 14	B-12	F-5, F-19
CONN 15	A-12	F-5, F-19
CONN 16	D-11	K-6, K-17
CONN 17	E-11	K-7, K-19
CONN 18	F-11	M-6, M-22
CONN 19	H-10	M-6, M-19
CONN 20	G-9	N-7, N-18
CONN 21 Aux Start Receptacle	I-9	E-5, E-22
CONN 22	I-8	D-6, D-18
CONN 23	I-8	J-8, J-18
CONN 24	A-8	K-6, K-16
CONN 25	F-7	J-8, J-17
CONN 26	F-5	K-6, K-17
CONN 27	F-4	K-8, K-17
CONN 28	I-6	N-8, N-22
CONN 29	I-4	N-8, N-22
CONN 30	I-3	N-8, N-22
CONN 31	C-3, G-3	O-6, O-20 P-7, P-24
CONN 32	I-2	S-7, S-23
CONN 33	E-2	S-7, S-17
CONN 34	C-2	Z-6, Z-26
CONN 35	C-2	Z-9, Z-26
CONN 36	F-1, B-2	O-6, O-19 T-7, T-23
CONN 37	B-2	Z-6, Z-22
CONN 38	A-2	Z-9, Z-22
CONN 39	H-1	Y-6, Y-19
CONN 40	G-1	R-6, R-18
CONN 41	G-1	R-7, R-22
CONN 42	F-1	Q-7, Q-20

Component Location					
Component	Schematic Location	Machine Location	Component	Schematic Location	Machine Location
Alarm - Back Up	E-15	B-6, B-18	Sensor - Front Axle Oil Temperature	F-1	U-3, U-20
Alternator	I-13	E-6, E-19	Sensor - Fuel Pressure	F-14	E-8, E-21
Arc Supressor - (3)	B-2	W-6, W-24	Sensor - Fuel Temperature	F-14	E-8, E-21
Arc Supressor - (4)	C-2	W-6, W-24	Sensor - Impeller Clutch Pressure	N-13	K-5, K-20
Arc Supressor - A/C	E-12	F-5, F-19	Sensor - Implement Oil Temperature	D-12	N-7, N-17
Baterries	I-11	C-3, C-18, C-23	Sensor - Intake Air Pressure	D-14	F-7, F-20
Breaker - Engine Control	B-10	M-8, M-16	Sensor - Intake Manifold Air Temperature	E-14	F-7, F-20
Breaker - Key Switch	C-10	M-8, M-16	Sensor - Lift Cylinder Head End Pressure	G-1	Q-7, Q-19
Breaker - Main	B-10	M-8, M-17	Sensor - Lift Linkage Position	G-1	R-8, R-22
Breaker - Running Lamp	C-10	M-8, N-17	Sensor - Rear Axle Oil Temperature	E-12	J-3, J-20
Breaker - Starter Solenoid	B-10	M-8, M-17	Sensor - T/C Oil Outlet Temperature	H-12	K-6, K-20
Bus Bar	I-10	E-4, E-19	Sensor - T/C Output Speed	G-12	K-6, K-19
Control - Engine ECM	F-15	F-7, F-21	Sensor - Transmission Output Speed	G-10	N-4, N-21
Control - Gateway	C-8	K-8, K-16	Solenoid - A/C Compressor	E-12	E-5, E-19
Control - Power Train	A-6	K-8, K-16	Solenoid - Auto Lube	I-9	J-9, J-18
Diode - Blocking (1)	B-4	L-8, L-16	Solenoid - Demand Fan	E-11	K-6, K-21
Diode - Blocking (2)	B-4	L-8, L-16	Solenoid - Dual Tilt	B-2	W-6, W-24
Diode - Blocking (3)	B-4	L-8, L-16	Solenoid - Impeller Clutch	H-12	K-6, K-20
Fuse - Alternator	I-13	H-5, H-19	Solenoid - L.U.C.	G-12	K-6, K-20
Fuse Panel	D-9	M-8, M-16	Solenoid - Ride Control	F-1	Q-7, Q-20
Junction Block (1)	D-11	J-8, J-17	Solenoid - Start Aid	C-12	F-7, F-18
Junction Block (2)	D-11	J-8, J-17	Solenoids - Cylinder Head 1,3,5,7,9,11	G-15	Q-7, Q-19
Motor - Fuel Priming Pump	E-14	E-7, E-21	Solenoids - Cylinder Head 2,4,6,8,10,12	G-13	F-7, F-20
Motor - Starter	I-12	I-5, I-19	Solenoids - Transmission	H-11	L-6, L-20
Motor - Starter (Aux)	I-13	I-5, I-22	Switch - A/C Pressure	E-12	E-5, E-19
Relay - Backlight	C-4	L-8, L-16	Switch - Auto Lube Grease Level	H-9	J-9, J-18
Relay - Fender HID HAL	C-5	K-8, K-16	Switch - Brake Oil Pressure	D-12	O-7, O-18
Relay - Front Fender Flood	C-5	K-8, K-16	Switch - Bucket Positioner	G-1	Y-8, Y-19
Relay - Horn	C-4	L-8, L-16	Switch - Disconnect	I-10	E-4, E-24
Relay - HVAC Precleaner	C-4	L-8, L-16	Switch - Engine Service Lamp	I-15	E-5, E-22
Relay - Main	B-10	K-8, K-17	Switch - Fuel Differential Pressure	F-14	E-7, E-21
Relay - Primary Steering	C-10	L-8, L-17	Switch - Fuel Priming Pump	I-15	E-7, E-22
Relay - ROPS HID HAL	C-5	K-8, K-16	Switch - Ground Level Shutdown	I-15	E-4, E-24
Relay - Secondary Starter	C-10	L-8, L-17	Switch - Ground Level Stairway Lamp	I-15	E-4, E-24
Sender - Fuel Level	F-12	M-2, M-24	Switch - Lift Kickout	G-1	R-8, R-18
Sensor - Atmospheric Pressure	D-14	F-7, F-20	Switch - Park Brake	G-12	O-7, O-20
Sensor - Auto Lube Pressure	H-1	R-7, R-20	Switch - Park Brake Pressure	H-10	O-7, O-20
Sensor - Camshaft Speed Timing	E-14	E-7, E-21	Switch - Primary Steering Pressure	F-12	M-6, M-22
Sensor - Coolant Temperature	E-14	E-7, E-19	Switch - Steering Oil Temperature	F-12	N-6, N-22
Sensor - Crankshaft Speed Timing	E-14	E-5, E-18	Switch - Transmission Oil Filter Bypass	H-9	K-8, K-20
Sensor - Engine Oil Pressure	D-14	E-7, E-20			





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36 Page, (Dimensions: 48 inches x 35 inches)

Schematic

844H Wheel Dozer and 990H Wheel Loader Electrical System

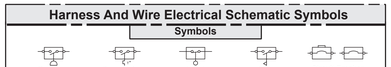
BTW1-UP
BWX1-UP

Volume 1 of 2: Chassis and Engine Wiring

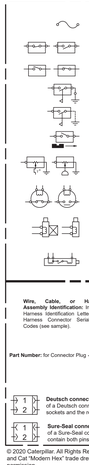
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Harness And Wire Electrical Schematic Symbols

Symbols



Symbols and Definitions



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Switch (Normally Open): A switch that will close at a specified point (temp, press, etc.). The circle indicates that the component has screw terminals and a wire can be disconnected from it.

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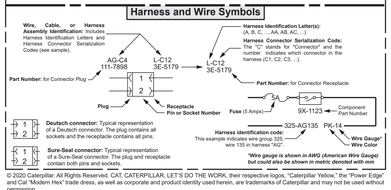
Sender: A component that is used with a temperature or pressure gauge. The sender measures the temperature or pressure. Its resistance changes to give an indication to the gauge of the temperature or pressure.

Relay (Magnetic Switch): A relay is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close the switch part of the relay.

Solenoid: A solenoid is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close a valve or move a piece of metal that can do work.

Magnetic Latch Solenoid: A magnetic latch solenoid is an electrical component that is activated by electricity and held latched by a permanent magnet. It has two coils (latch and unlatch) that make electromagnet when current flows through them. It also has an internal switch that places the latch coil circuit open at the time the coil latches.

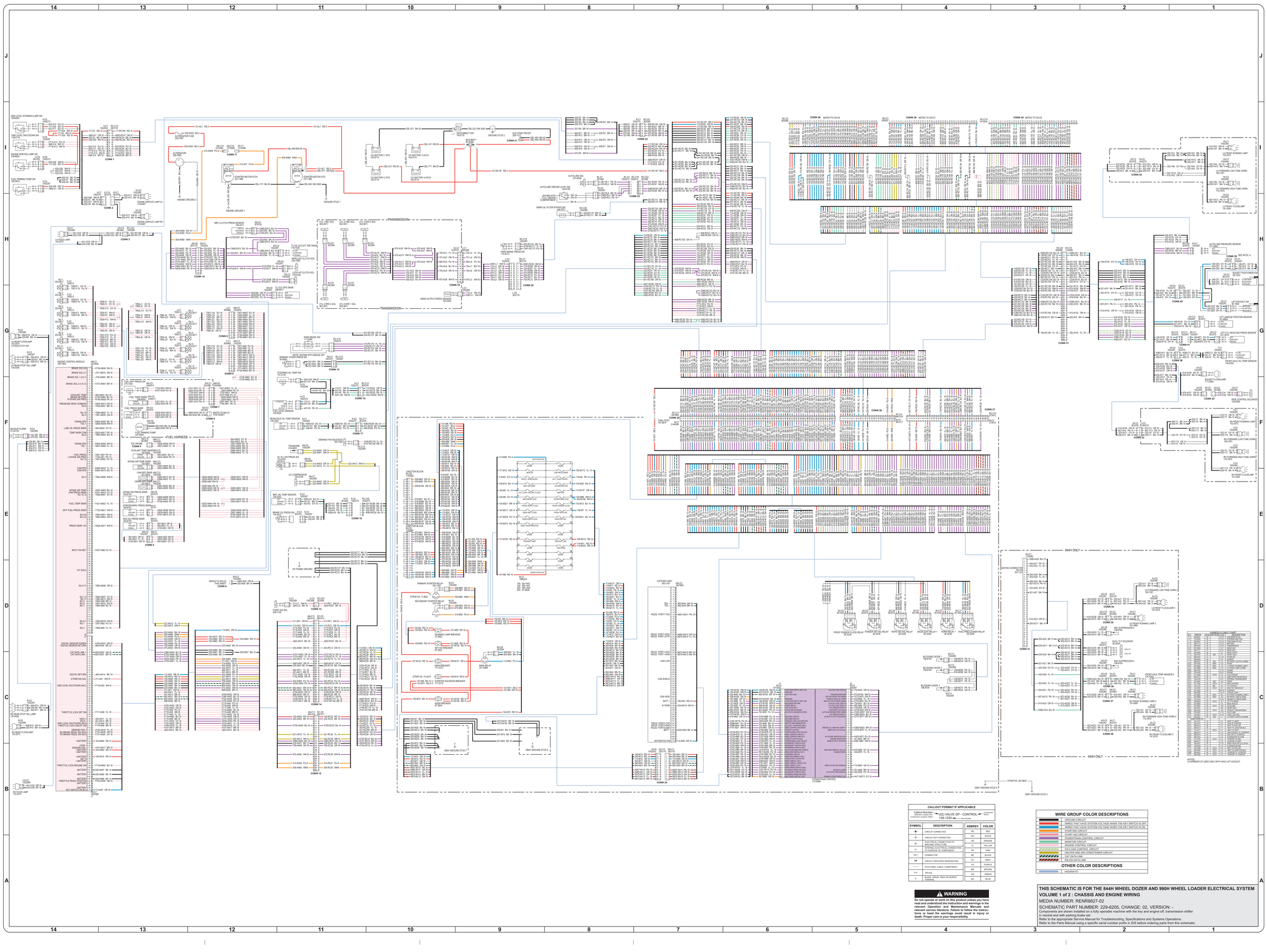
Harness and Wire Symbols



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36 Page, (Dimensions: 48 inches x 35 inches)

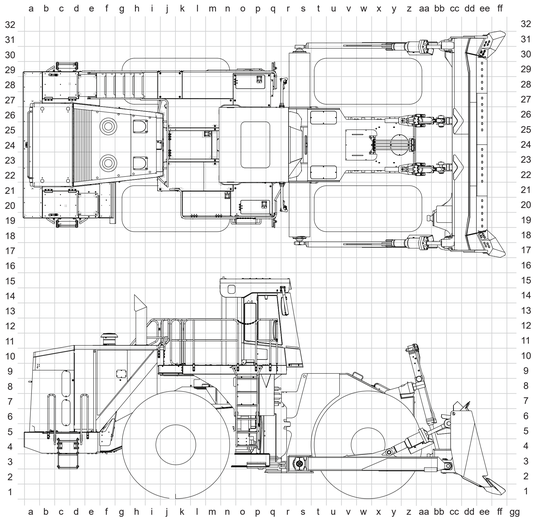


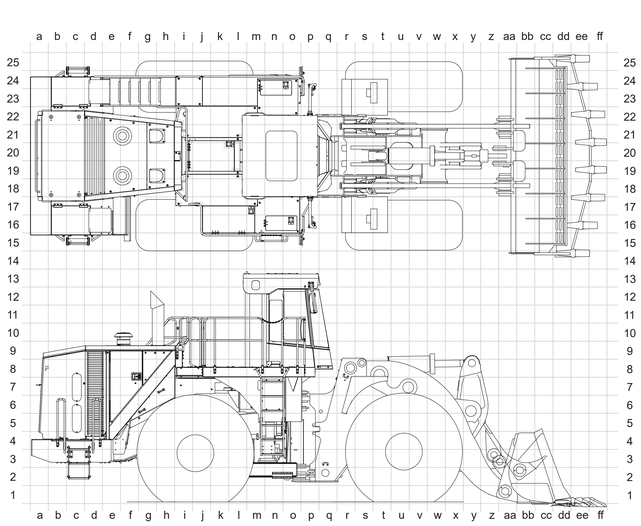
844H Component Locations					
Component	Schematic Location	Machine Location	Component	Schematic Location	Machine Location
Actuator - Water Valve	F-15	N-10, N-22	Switch - Auto Lube Manual	F-13	P-11, P-22
Alarm - Action	H-3	R-11, R-24	Switch - Beacon	I-12	P-11, P-22
Camera - Rear View	A-14	A-5, A-16	Switch - Blower	H-10	P-11, P-22
Control - Dimmer	F-3	R-11, R-23	Switch - Dual Tilt	G-7	P-11, P-22
Control - Operator Monitor	E-3	R-11, R-25	Switch - Dual Wiper Motor	I-10	P-11, P-22
Control - STIC	F-4	Q-11, Q-25	Switch - Front Fixed Lamp	E-13	P-11, P-22
Control - WLPCS	C-4	Q-11, Q-23	Switch - Front HID Flood Lamp	D-13	P-11, P-22
Converter - 12/24 DC	I-4	N-14, N-24	Switch - Front Inter. Wiper	H-10	P-11, P-22
Diode - Implement Control	G-5	P-11, P-23	Switch - Horn	G-7	Q-11, Q-24
Gage - Quad	H-3	R-11, R-24	Switch - Implement Lockout	G-5	P-11, P-22
Keypad - WLPCS	F-10	R-11, R-23	Switch - Key	G-10	P-11, P-22
Monitor - Rear Vision	A-12	R-11, R-23	Switch - Operator Mode Select	H-12	P-11, P-22
Motor - Air Pre-Cleaner	F-1	R-13, R-22	Switch - Payload Store	F-7	P-11, P-22
Motor - Blower	E-15	M-10, M-24	Switch - Quick Shift	G-12	P-11, P-22
Motor - Front Washer	I-14	S-10, S-24	Switch - RH Dash Lamp	I-5	P-11, P-22
Motor - Front Wiper	D-2	S-10, S-24	Switch - RH Service Brake Pedal	G-3	P-11, P-22
Motor - LH Washer	I-14	R-14, R-26	Switch - Rear Flood Lamp	D-13	P-11, P-22
Motor - LH Wiper	F-1	R-13, R-26	Switch - Rear Wiper	I-10	P-11, P-22
Motor - Rear Washer	I-14	M-11, M-24	Switch - Reduced Rim Pull	H-8	P-11, P-22
Motor - Rear Wiper	I-13	M-11, M-24	Switch - Ride Control	G-12	P-11, P-22
Motor - RH Washer	I-14	R-14, R-22	Switch - Running Lamp	E-13	P-11, P-22
Motor - RH Wiper	F-1	R-13, R-22	Switch - Stairway Access Lamp	C-13	P-11, P-22
Radio - Product Link	I-2	Q-11, Q-22	Switch - Steering Lock	F-4	P-11, P-22
Relay - Single Tilt	G-7	P-11, P-23	Switch - Stop Lamp	F-3	P-11, P-22
Resistor - Water Valve Actuator	F-15	M-10, M-23	Switch - Thermostat	E-15	P-11, P-22
Resistor - Blower Motor	E-15	M-10, M-23	Switch - Throttle Lock On/Off	G-3	P-11, P-22
Sensor - L.H. Brake Pedal	G-3	Q-9, Q-25	Switch - Throttle Lock Resume	F-5	P-11, P-22
Sensor - Throttle Position	D-3	Q-9, Q-25	Switch - Throttle Lock Set	F-5	P-11, P-22
Solenoid - Lockout	G-5	P-11, P-23	Switch - T/C Lockup	H-12	P-11, P-22
Speedometer/Tachometer	I-3	R-11, R-24	Switch - Water Valve Temperature Select	C-13	P-11, P-22
Switch - A/C Blower	H-10	P-11, P-22			

844H Connector Locations		
Connector Number	Schematic Location	Machine Location
CONN 28	A-8	O-9, O-26
CONN 29	A-7	O-9, O-26
CONN 30	A-6	O-9, O-26
CONN 43	H-15	N-15, N-22
CONN 44	G-14	M-11, M-25
CONN 45	G-14	M-11, M-25
CONN 46	A-13 / D-3	R-11, R-23
CONN 47	I-13	N-11, N-23
CONN 48	D-10	P-11, P-22
CONN 49	D-9	P-11, P-22
CONN 50	D-7	O-11, O-22
CONN 51 Service Tool Connector	I-9	P-11, P-23
CONN 52	E-7	P-11, P-24
CONN 53	E-7	P-11, P-24
CONN 54	H-6	O-10, O-22
CONN 55	D-5	O-11, O-22
CONN 56	F-5	P-11, P-25
CONN 57	H-5	O-10, O-22
CONN 58	G-4	O-11, O-22
CONN 59	G-4	O-11, O-22
CONN 60 PCS Customer Data Connector	C-2	O-11, Q-23
CONN 61	C-3	O-11, Q-23
CONN 62 Service Mode Plug	D-3	O-11, Q-23
CONN 63	F-3	O-11, Q-25
CONN 64	H-2	O-11, O-22
CONN 65	H-2	O-11, O-22
CONN 66	F-2	M-10, M-22

990H Component Locations					
Component	Schematic Location	Machine Location	Component	Schematic Location	Machine Location
Actuator - Water Valve	F-15	M-9, M-18	Switch - A/C Blower	H-10	O-9, O-18
Alarm - Action	H-3	P-9, P-20	Switch - Auto Lube Manual	F-13	O-9, O-18
Camera - Rear View	A-14	A-4, A-20	Switch - Beacon	I-12	O-9, O-18
Control - Dimmer	F-3	P-9, P-18	Switch - Blower	H-10	O-9, O-18
Control - Operator Monitor	E-3	Q-9, Q-20	Switch - Dual Wiper Motor	I-10	O-9, O-18
Control - STIC	F-4	O-10, O-21	Switch - Front Fixed Lamp	E-13	O-9, O-18
Control - WLPCS	C-4	P-9, P-19	Switch - Front HID Flood Lamp	D-13	O-9, O-18
Converter - 12/24 DC	I-4	M-12, M-20	Switch - Front Inter. Wiper	H-10	O-9, O-18
Diode - Implement Control	G-5	O-9, O-19	Switch - Horn	G-8	P-10, P-20
Gage - Quad	H-3	P-9, P-19	Switch - Key	G-10	O-9, O-18
Keypad - WLPCS	F-10	P-9, P-19	Switch - Operator Mode Select	H-12	O-9, O-18
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Motor - Air Pre-Cleaner	F-1	R-13, R-22	Switch - Quick Shift	G-12	O-9, O-18
Motor - Blower	E-15	L-8, L-20	Switch - RH Dash Lamp	I-5	O-9, O-18
Motor - Front Washer	I-14	Q-9, Q-20	Switch - RH Service Brake Pedal	G-3	O-9, O-18
Motor - Front Wiper	D-2	Q-9, Q-20	Switch - Rear Flood Lamp	D-13	O-9, O-18
Motor - LH Washer	I-14	Q-9, Q-21	Switch - Rear Wiper	I-10	O-9, O-18
Motor - LH Wiper	F-1	Q-9, Q-21	Switch - Reduced Rim Pull	H-8	O-9, O-18
Motor - Rear Washer	I-14	L-8, L-20	Switch - Reduced Rim Pull On/Off	G-7	O-9, O-18
Motor - Rear Wiper	I-13	L-9, L-20	Switch - Ride Control	G-12	O-9, O-18
Motor - RH Washer	I-14	Q-8, Q-18	Switch - Running Lamp	E-13	O-9, O-18
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Resistor - Blower Motor	E-15	M-9, M-18	Switch - Thermostat	E-15	O-9, O-18
Sensor - L.H. Brake Pedal	G-3	O-7, O-21	Switch - Throttle Lock On/Off	G-12	O-9, O-18
Sensor - Throttle Position	D-3	O-7, O-21	Switch - Throttle Lock Resume	G-7	O-9, O-18
Solenoid - Bucket Positioner Detent	G-8	O-9, O-19	Switch - Throttle Lock Set	G-7	O-9, O-18
Solenoid - Float Detent	G-8	O-9, O-19	Switch - T/C Lockup	H-12	O-9, O-18
Solenoid - Lift Kickout Detent	G-8	O-9, O-19	Switch - Water Valve Temperature Select	C-13	O-9, O-18
Speedometer/Tachometer	I-3	P-9, P-20			

990H Connector Locations		
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CONN 65	H-2	N-10, N-19
CONN 66	F-2	M-10, M-18





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36 Page, (Dimensions: 48 inches x 35 inches)

Schematic

844H Wheel Dozer and 990H Wheel Loader Electrical System

BTW1-UP
BWX1-UP

Volume 2 of 2: Cab Wiring

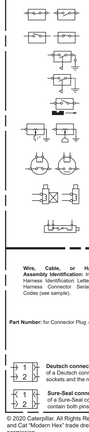
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Symbols



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Ground (Case): This indicates that the component does not have a wire connected to ground. It is grounded by being fastened to the machine.

Reed Switch: A switch whose contacts are controlled by a magnet. A magnet closes the contacts of a normally open reed switch; it opens the contacts of a normally closed reed switch.

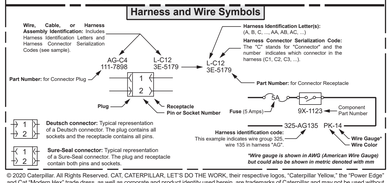
Sender: A component that is used with a temperature or pressure gauge. The sender measures the temperature or pressure. Its resistance changes to give an indication to the gauge of the temperature or pressure.

Relay (Magnetic Switch): A relay is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close the switch part of the relay.

Solenoid: A solenoid is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close a valve or move a piece of metal that can do work.

Magnetic Latch Solenoid: A magnetic latch solenoid is an electrical component that is activated by electricity and held latched by a permanent magnet. It has two coils (latch and unlatch) that make electromagnet when current flows through them. It also has an internal switch that places the latch coil circuit open at the time the coil latches.

Harness and Wire Symbols



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RENR8827-02 VOL 2 of 2

36 Page, (Dimensions: 48 inches x 35 inches)

WIRE GROUP COLOR DESCRIPTIONS

	GROUND CIRCUIT
	WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS OFF
	WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS ON
	VOLTAGE CONVERTER OUTPUT CIRCUIT
	STARTING CIRCUIT
	POWERTRAIN CONTROL CIRCUIT
	MONITOR CIRCUIT
	ENGINE CONTROL CIRCUIT
	PAYLOAD CONTROL CIRCUIT
	HEATER AND AIR CONDITIONER CIRCUIT
	WIPER WASHER CIRCUIT
	CAT DATA LINK
	RS-232 DATA LINK

OTHER COLOR DESCRIPTIONS

	HIGHWAYS

CALLOUT FORMAT IF APPLICABLE

Callout Number (Machine Location Tables) — (S2) VALVE GP - CONTROL — (Component Name)

Component Locations Tables — 138-1234 — (Part Number)

SYMBOL	DESCRIPTION
+	CIRCUIT CONNECTED
-||-	CIRCUIT NOT CONNECTED
⏚	ELECTRICAL CONNECTION TO MACHINE STRUCTURE
⏚	INTERNAL ELECTRICAL CONNECTION TO SURFACE OF COMPONENT
=ED=	CONNECTOR
1M	CIRCUIT GROUPING DESIGNATION
~ * ~	ATOH WIRE, CABLE, COMPONENT
5=0	SPLICE
⏚	BLADE, SPADE, RING OR SCREW TERMINAL

ABBREV	COLOR
WH	WHITE
OR	ORANGE
YL	YELLOW
PK	PINK
BK	BLACK
GY	GRAY
PU	PURPLE
BR	BROWN
GN	GREEN
BU	BLUE

WARNING

Do not operate or work on this product unless you have read and understood the instruction and warnings in the relevant Operation and Maintenance Manuals and Service Manuals. Failure to follow the instructions or heed the warnings could result in injury or death. Proper care is your responsibility.

THIS SCHEMATIC IS FOR THE 844H WHEEL DOZER AND 990H WHEEL LOADER ELECTRICAL SYSTEM

VOLUME 2 of 2 : CAB WIRING

MEDIA NUMBER: RENR8827-02

SCHEMATIC PART NUMBER: 229-6205, CHANGE: 02, VERSION: -

Components are shown installed on a fully operable machine with the key and engine off, transmission shifter in neutral and with parking brake set.

Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations.

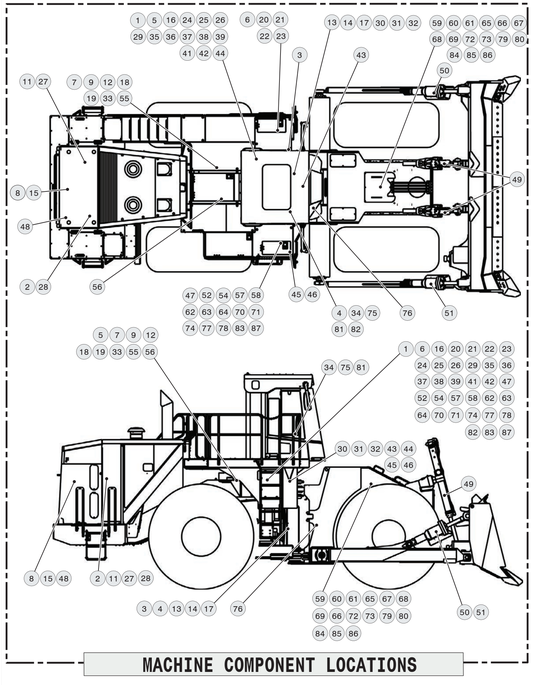
Refer to the Parts Manual using a specific serial number prefix in SIS before ordering parts from this schematic.

Component Locations

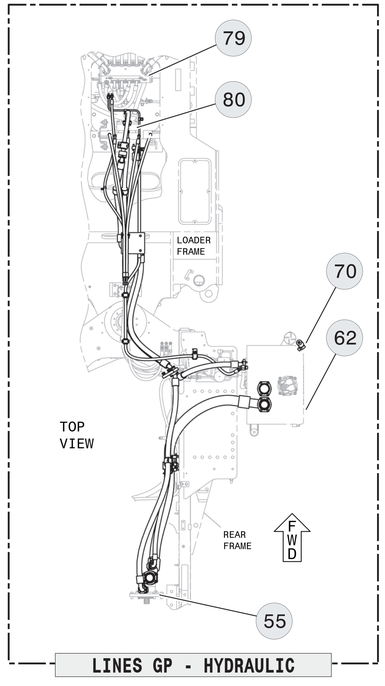
Description	Part Number	Machine Location	Schematic Location
Steering / Fan Drive Schematic			
Ball (Makeup Valve)	4B-9782	1	E-14
Core As - Hydraulic Oil Cooler (Hydraulic Fan, Steering)	191-4600	2	C-11
Cylinder Gp - Steering (LH)	6E-1244	3	G-14
(RH)	9T-9568	4	
Elbow	127-9015	5	C-10
Filter Element As - Oil (Hydraulic)	4T-3134	6	B-11
Filter Gp - Oil (Hydraulic Fan Pump Case Drain)	166-4647	7	B-11
(Hydraulic Fan Motor Case Drain)		8	C-11
(Steering Pump Case Drain)		9	B-12
Fitting As (Quick Disconnect) (Pressure Tap)	6V-3965	10	B-13
		11	C-11
		12	C-12
		13	D-12
		14	F-14
Motor Gp - Piston (Hydraulic Fan)	229-0100	15	D-11
Plug - Orifice (Cushion)	4T-4207	16	E-14
Pump Gp - Gear (Secondary Steering)	101-4007	17	D-12
Pump Gp - Piston (Hydraulic Fan, High Ambient Temperature)	235-0843	18	C-11
(Hydraulic Fan; Standard Ambient Temperature)	229-0099		
Pump Gp - Piston (Steering)	229-8604	19	C-12
Screen As (Hydraulic Tank)	9T-9227	20	B-11
Screen Gp	7J-2656	21	B-11
Tank & Filter Gp - Hydraulic (Steering, Hydraulic Fan)	6E-4683	22	B-12
Valve (Filter Bypass)	8J-1988	23	B-11
Valve (Primary Steering Pump Check)	6E-3780	24	E-12
Valve (Secondary Steering Pump Check)	7J-7423	25	F-12
Valve - Diverter (Secondary Steering)	2U-7345	26	F-12
Valve - Fluid Sampling (Steering, Hydraulic Fan Oil)	8C-3446	27	C-11
Valve Gp - Check	6E-1454	28	C-11
	104-7108	29	C-13
	176-9369	30	D-14
(Steering) (Pilot Cushion Override)	176-9371	31	D-14
(Steering Quad)	111-7775	32	D-15
Valve Gp - Demand Fan	191-8735	33	D-9
Valve Gp - Pilot (Stic Steering)	249-5615	34	B-15
Valve Gp - Pressure Reducing	6E-4286	35	D-13
Valve Gp - Relief (Pump Backup)	100-4335	36	E-13
(Secondary Steering)	6E-3986	37	E-12
(Steering Cylinder Crossover)	6E-3985	38	F-15
Valve Gp - Selector & Pressure Control (Primary & Secondary Steering Pilot Source Selector)	6E-5566	39	C-13
(Secondary Steering Warning)		40	
Valve Gp - Shuttle (Ball Resolver)	4T-1860	41	F-14
Valve Gp - Steering (With Secondary Steering)	6E-2923	42	F-13
Valve Gp - Steering Neutralizer	9T-7426	43	C-14
		44	C-15
Implements / Brake Supply Schematic			
Accumulator Gp - Brake (Charged)	219-2949	45	B-8
		46	C-8
Accumulator Gp - Pilot Oil (Charged)	226-0420	47	D-8
Core As - Oil Cooler	275-7895	48	B-5
Cylinder Gp - Lift	4Z-6424	49	C-2, D-2
Cylinder Gp - Tilt & Tip (LH)	6E-4835	50	E-1
(RH)	6E-4836	51	
Filter Element As - Oil (Hydraulic)	4T-3134	52	B-5
Fitting As (Quick Disconnect) (Pressure Tap)	6V-3965	53	C-4
		54	D-8
Pump Gp - Gear (Pilot, Brake)	230-0914	55	B-7
Pump Gp - Vane (Implement)	157-0956	56	B-4
Screen As (Hydraulic Tank)	9T-9227	57	B-5
	118-8693	58	B-5
Stem (Lift)	241-8833	59	E-5
(Shuttle Valve)	8J-7430	60	D-6
(Tift)	1U-0368	61	F-6
Tank & Filter Gp - Hydraulic (Implement, Brake)	237-4228	62	B-6
Tube As	9J-1985	63	B-5
Valve (Cooler Bypass)	6E-4451	64	B-5
Valve (Lift Unloading Load Check)	3G-1201	65	E-6
Valve (Load Check)	9T-3746	66	E-6
	9T-3747	67	F-6
Valve (Makeup)	6E-4343	68	E-5
Valve (Tilt Unloading Load Check)	9J-4794	69	E-6
Valve - Breaker Relief	220-0812	70	B-5
Valve - Fluid Sampling	8C-3446	71	C-8
Valve - Relief Poppet (Circuit Relief)	6J-2561	72	E-6
		73	F-6
Valve - Shuttle	6R-0442	74	C-7
Valve & Mtg Gp - Solenoid (Pilot On/Off)	152-2698	75	H-7
Valve Gp (Manual Blade Lower)	112-1817	76	C-3
Valve Gp - Check (Pilot Accumulator)	158-9956	77	D-7
Valve Gp - Combination (Brake Charging)	9T-9551	78	C-7
Valve Gp - Dual Tilt Control	225-2321	79	F-3
Valve Gp - Main Control (Dozer)	229-8722	80	E-7
Valve Gp - Pilot (Joystick, 3-Function)	229-8724	81	H-6
Valve Gp - Relief (Brake System Backup)	234-0351	82	B-7
Valve Gp - Relief (Pilot)	6E-6293	83	C-7
Valve Gp - Shuttle (Ball Resolver)	249-7805	84	C-2
	4T-4073	85	D-6
Valve Gp - Solenoid (Tilt, Tip Function) (Dual Tilt)	3E-9205	86	F-3
Valve Gp - Unloading	117-7761	87	C-7

Tap Locations
Pressure, Sampling, and Sensor

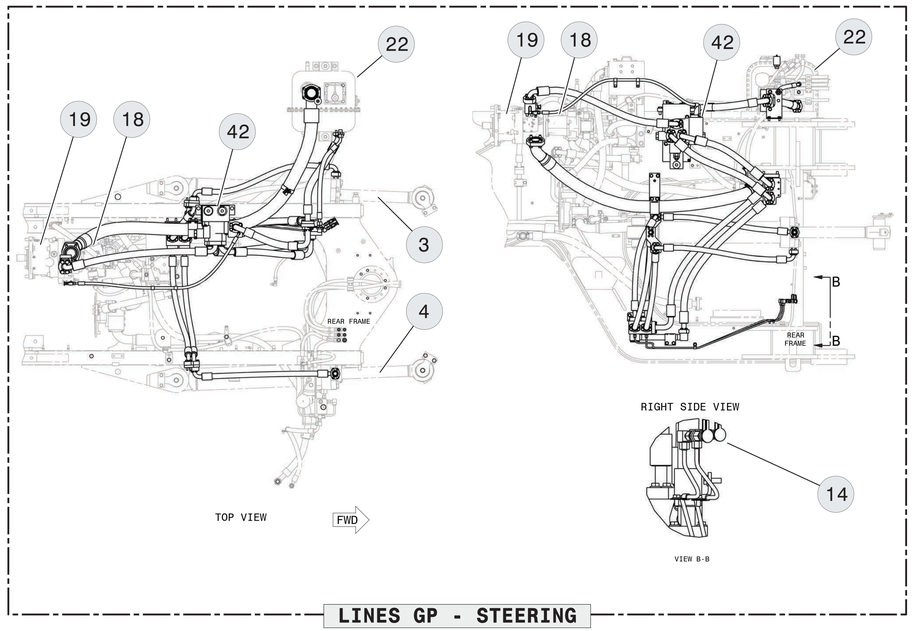
Tap Number	Description	Schematic Location
AA	Steer Pilot Supply Pressure Tap	B-13
BB	Steer Pump Cutoff	E-12
CC	Fan Pump Cutoff	C-11
DD	Fan Pump Discharge Pressure Tap	C-10
EE	Fan Pump Signal Pressure Tap	C-10
FF	Implement Relief - Lift Pressure Tap	C-4
GG	Implement Relief - Tilt Pressure Tap	C-4



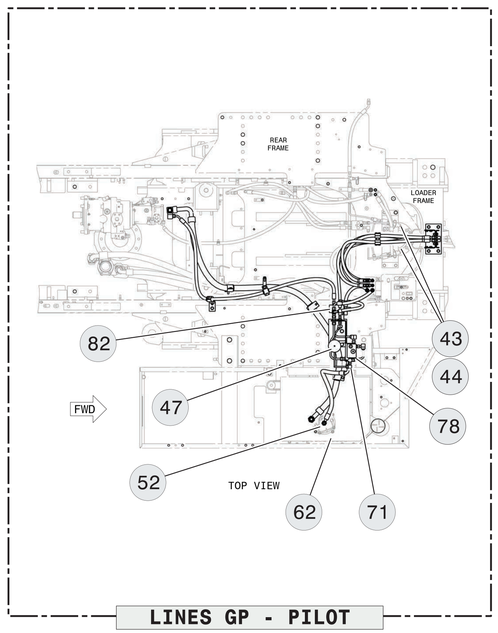
MACHINE COMPONENT LOCATIONS



LINES GP - HYDRAULIC



LINES GP - STEERING



LINES GP - PILOT

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RENR8838
March 2006

Schematic

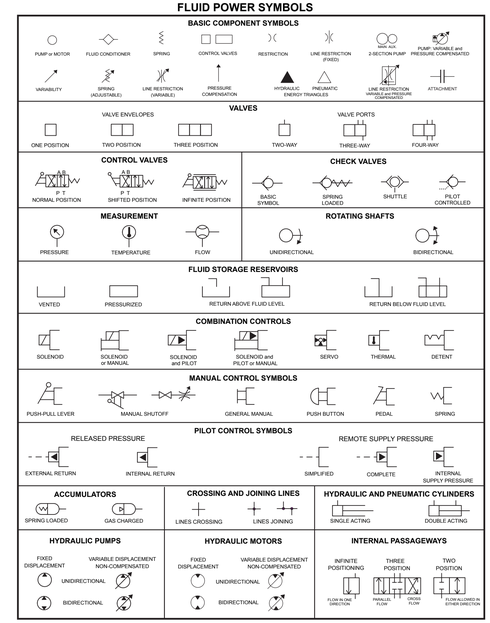
844H Wheel Dozer
Hydraulic System

BTW1-UP

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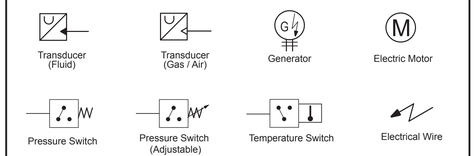
Printed in U.S.A.

FLUID POWER SYMBOLS



Electrical Symbols Table

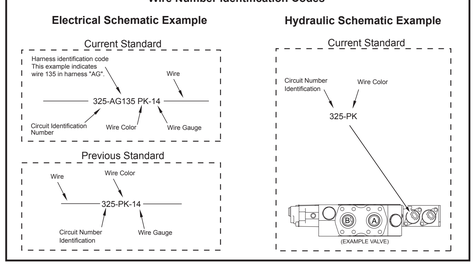
Hydraulic Symbols (Electrical)



Electrical Symbols (Electrical)

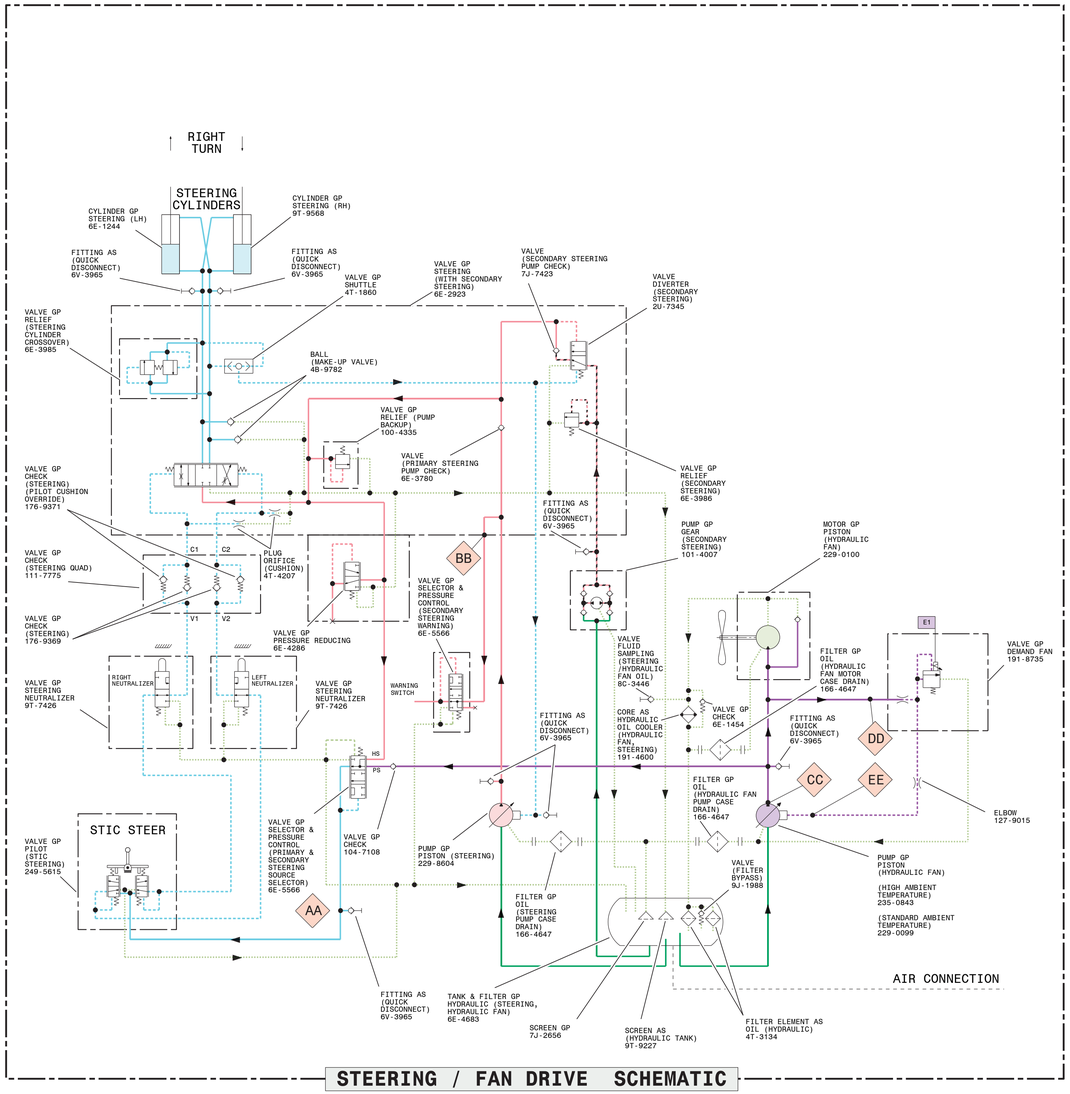


Wire Number Identification Codes

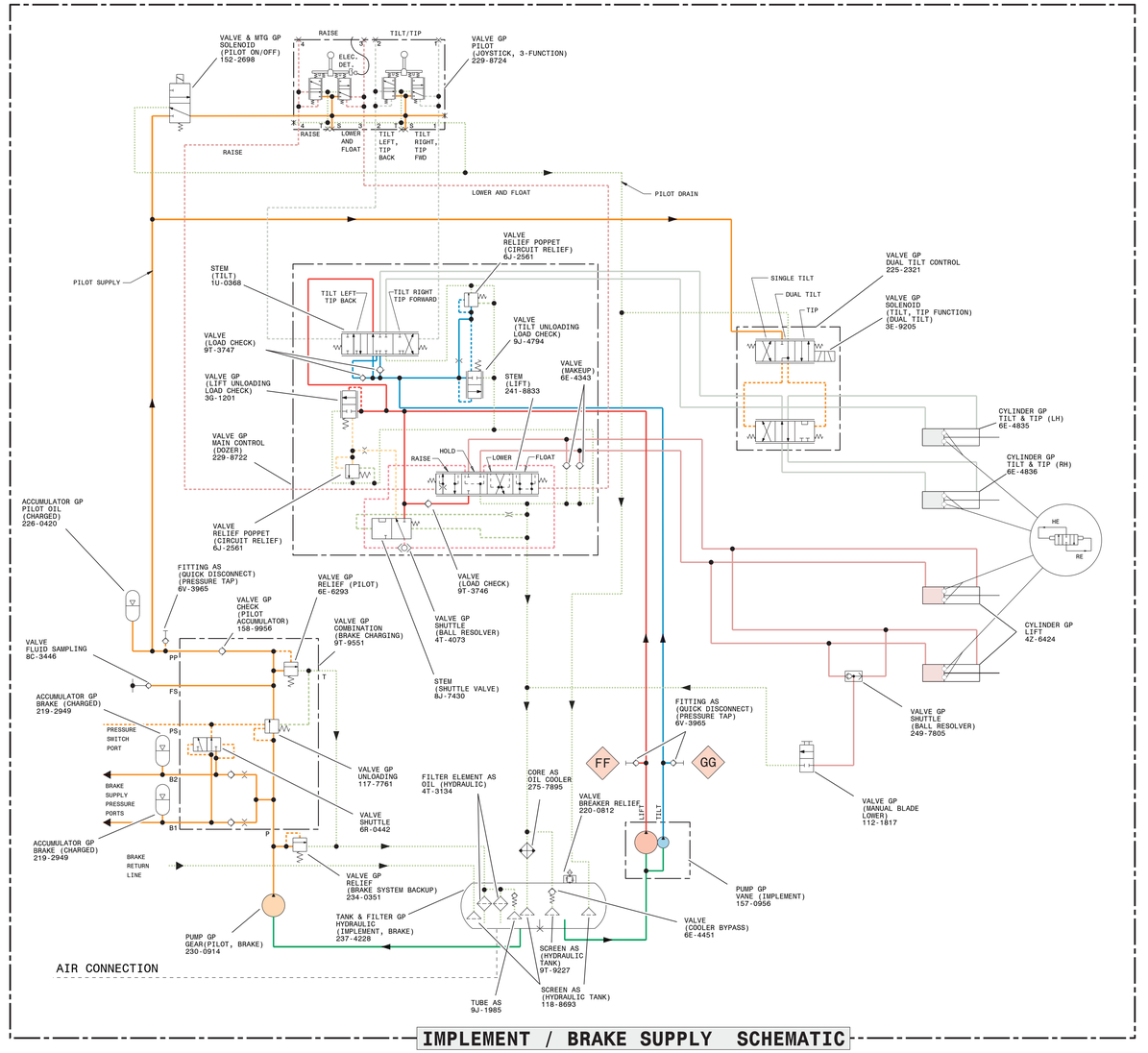


RENR8838-00
20 Page

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20 Page, Color 2



STEERING / FAN DRIVE SCHEMATIC



IMPLEMENT / BRAKE SUPPLY SCHEMATIC

Tap Locations
Pressure, Sampling, and Sensor

Tap Number	Description	Schematic Location
AA	Steer Pilot Supply Pressure Tap	D-8
BB	Steer Pump Cutoff	B-10
CC	Fan Pump Cutoff	D-7
DD	Fan Pump Discharge Pressure Tap	C-5
EE	Fan Pump Signal Pressure Tap	D-13
FF	Implement Relief - Lift Pressure Tap	I-2
GG	Implement Relief - Tilt Pressure Tap	G-2

HYDRAULIC CIRCUIT COLOR DESCRIPTIONS
LIFT PUMP OUTPUT
BRAKE/PILOT PUMP OUTPUT
SCAVENGE PUMP
TILT PUMP OUTPUT
PRIMARY STEERING PUMP CIRCUIT
FAN PUMP OUTPUT
SUPPLY LINE
DRAIN / RETURN LINE
STEERING CIRCUIT
LOAD SENSING CIRCUIT
TILT CYLINDER CIRCUIT
LIFT CYLINDER CIRCUIT
SECONDARY STEERING CIRCUIT

LINE PATTERNS	
	Pressure Line
	Pilot / Load Sensing Pressure
	Drain / Return Lines
	Component Group
	Attachment
	Air Line
CALLOUTS	
XX	Taps (Pressure, Sampling,Sensor) by letter
(xx)	Components by number

THIS SCHEMATIC IS FOR THE 844H WHEEL DOZER
PART #: 229-8718 CHG(05)

Components are shown installed on a fully operable machine with the key and engine off and transmission shifter in neutral.

Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations

RENR8830-05 844H Wheel Dozer Service Manual (Machine) BTW1-Up

RENR8830LBL Binder Label
SENR2301 Binder
SENR2910 Binder
Cat Tab Set - English - Machine

Name	Description	Section
RENR8830 Contents Page		
SENR7733 Safety		
SENR3130 Torque Specifications		
SENR9936 C27 Engine Specifications		Engine
SENR9937 C27 Engine Systems Operation Testing & Adjusting		Engine
RENR9317 C27 Engine Troubleshooting Guide		Engine
RENR9217 C27 Engine Disassembly & Assembly		Engine
RENR8809 Power Train Specifications		Systems
RENR8810 Power Train Systems Operation		Systems
RENR8811 Power Train Testing & Adjusting		Systems
RENR8812 Power Train Disassembly & Assembly		Systems
RENR8808 Power Train Disassembly & Assembly Supplement		Systems
RENR8815 Steering System Specifications		Systems
RENR8816 Steering System Systems Operation		Systems
RENR8817 Steering System Testing & Adjusting		Systems
RENR8818 Braking System Specifications		Systems
RENR8819 Braking System Systems Operation		Systems
RENR8820 Braking System Testing & Adjusting		Systems
RENR8835 Hydraulic System Specifications		Systems
RENR8836 Hydraulic System Systems Operation		Systems
RENR8837 Hydraulic System Testing & Adjusting		Systems
RENR8825 Machine Systems Specifications		Systems
SENR6615 Contour Series Seat Installation & Repair Service Manual		Systems
RENR8839 Machine Systems Disassembly & Assembly		Systems
SENR1394 Caterpillar Monitoring System Service Manual		Electrical System & Operator Station
SENR2947 Starting & Charging Systems Systems Operation, Testing & Adjusting		Electrical System & Operator Station
SEBU7893 Operation & Maintenance		Operation & Maintenance
RENR8838 Hydraulic System Schematic		Schematic
RENR8827 Electrical System Schematic		Schematic

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SENR7733-09
December 2004



Service Manual

General Service and Repair Safety Information

All Caterpillar Machines

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Systems Operation Section

Safety Information 4

Index Section

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Systems Operation Section

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Safety Information

SMCS Code: 7000

Introduction

Proper repair is important to the safe operation and the reliable operation of this machine. This document outlines basic recommended procedures. Some of the procedures require special tools, devices, or work methods.

Before you perform any repairs or before you perform any maintenance, read all safety information. Understand all safety information before you perform any repairs or before you perform any maintenance.

Safety information can be found in this document and the following documents for your machine:

- Operation and Maintenance Manual
- Testing and Adjusting Manual
- Disassembly and Assembly Manual
- Warning labels that are located on the machine and engine

If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

Basic Precautions

⚠ WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Always observe the list of basic precautions that follows:

Safety Messages

There are several specific safety messages on this machine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiarized with all safety messages.

Make sure that all of the safety messages are legible. Clean the safety messages or replace the safety messages if you cannot read the words. Replace the illustrations if the illustrations are not legible. When you clean the safety messages, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety messages. Loose adhesive will allow the safety messages to fall.

Replace any safety message that is damaged, or missing. If a safety message is attached to a part that is replaced, install a safety message on the replacement part. Any Caterpillar dealer can provide new safety messages.

Protective Equipment

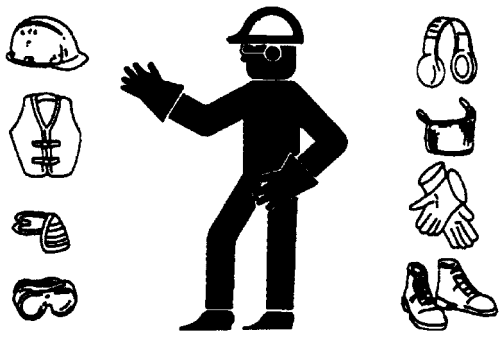


Illustration 1 g00702020

When you work around the machine, always wear protective equipment that is required by the job conditions. Protective equipment includes the items that follow: hard hat, protective glasses, and protective shoes. In particular, wear protective glasses when you use a hammer or when you use a sledge hammer. When you weld use the appropriate protective equipment that is required by the job conditions. Protective equipment for welding includes the items that follow: gloves, welding hood, goggles, and apron. Do not wear loose clothing or jewelry that can catch on parts of the machine.

Mounting and Dismounting

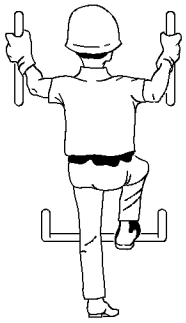


Illustration 2 g00037860

Use steps and handholds whenever you mount the machine. Use steps and handholds whenever you dismount the machine. Before you mount the machine, clean the step and the handholds. Inspect the step and handholds. Make all necessary repairs.

Face the machine whenever you mount the machine and whenever you dismount the machine. Maintain a three-point contact with the step and with handholds.

Note: Three-point contact can be two feet and one hand. Three-point contact can also be one foot and two hands.

Do not mount a moving machine. Do not dismount a moving machine. Never jump off the machine. Do not try to mount the machine when you carry tools or supplies. Do not try to dismount the machine when you are carrying tools or supplies. Use a hand line to pull equipment onto the platform. Do not use any controls as handholds when you enter the operator station or when you exit the operator station.

Lifting

If any component that weighs more than 23 kg (50 lb) is lifted, a hoist should be used. If any component is difficult to move due to the size, the grip, or any other difficulties, a hoist should be used.

Specifications for Cables, Chains, and Lifting Devices

Use approved cables, chains, and lifting devices in order to lift components. Refer to the manufacturer's weight's in order to determine the application when you select the following items: cable, chain, and lifting devices. When you lift a component, the lift angle is critical. Refer to the Illustration that follows in order to see the effect of the lift angle on the working load limit.

Note: The lifting devices that are shown in this publication are not Caterpillar parts.

Make sure that all chains, hooks, slings, and any other lifting devices are in good condition.

Ensure that the hooks are equipped with a safety latch. Do not place a side load on the lifting eyes during a lifting operation.

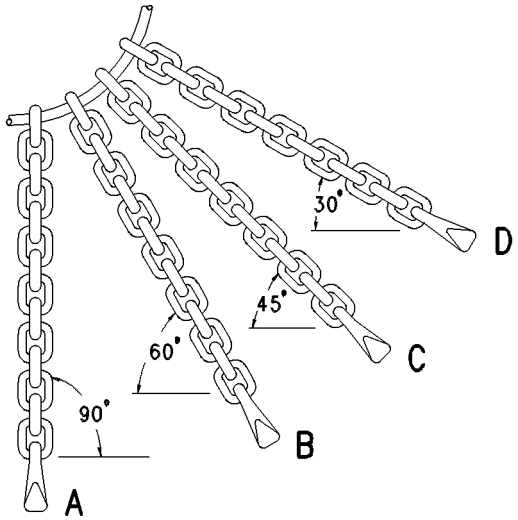


Illustration 3 g00629745

Lift angles for lifting slings.

(A) The load capacity is 100% of the working load limit for the sling.
(B) The load capacity is 86% of the working load limit for the sling.
(C) The load capacity is 70% of the working load limit for the sling.
(D) The load capacity is 50% of the working load limit for the sling.

Hot Fluids and Parts

To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments.

Be careful when you remove filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug in order to prevent being sprayed by pressurized liquids. When the machine has just been stopped, the possibility of hot fluids is greater.

Corrosion Inhibitor

Corrosion inhibitor contains alkali. Avoid contact with the eyes. Do not allow corrosion inhibitor to contact the skin for extended periods of time. Avoid repeated contact with the skin. Do not drink corrosion inhibitor. In case of contact, immediately wash skin with soap and water. For contact with the eyes, flush the eyes with large amounts of water for at least 15 minutes. **Seek medical attention.**

Batteries

Do not smoke when an inspection of the battery electrolyte level is made. Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Do not allow battery electrolyte to make contact with the skin or with the eyes. Battery electrolyte is an acid. In case of contact with battery electrolyte, immediately wash the skin with soap and water. For contact with the eyes, flush the eyes with large amounts of water for at least 15 minutes. **Seek medical attention.**

Pressurized Items

Pressure can be trapped in a hydraulic system. Releasing trapped pressure can cause sudden machine movement or attachment movement. Use caution if you disconnect hydraulic lines or fittings. High pressure oil that is released can cause a hose to whip. High pressure oil that is released can cause oil to spray. Fluid penetration can cause serious injury and possible death.

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the Service Manual for any procedures that are required to relieve the hydraulic pressure.

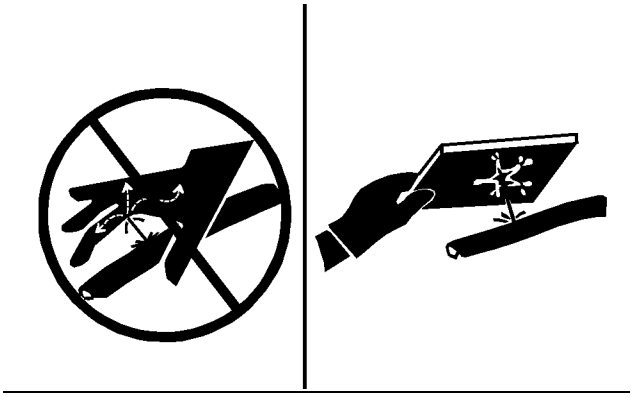


Illustration 4 g00687600

Always use a board or a piece of cardboard when you check for a leak. Leaking fluid under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure that all raised components are blocked correctly. Be alert for possible pressure when you disconnect any device from a system that utilizes pressure.

Fuel lines that are damaged and fuel lines that are loose may leak. This could result in a fire if the fluid comes in contact with a source of ignition. Lubrication lines that are damaged and lubrication lines that are loose can leak. This could result in a fire if the fluid comes in contact with a source of ignition. Hydraulic lines, tubes, and hoses that are damaged can leak. This could result in a fire if the fluid comes in contact with a source of ignition. Hydraulic lines, tubes, and hoses that are loose can leak. This could result in a fire if the fluid comes in contact with a source of ignition. Do not bend or strike high pressure lines. Do not install lines which have been bent or damaged. Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. If fluids are injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Pressure air or water can cause personal injury. When pressure air or water is used for cleaning, wear a protective face shield, protective clothing, and protective shoes. The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). When you use a pressure washer, keep in mind that the nozzle pressures are very high. The nozzle pressures are frequently above 13790 kPa (2000 psi). Follow all of the recommended practices that are provided by the manufacturer of the pressure washer.

General Hazard Information

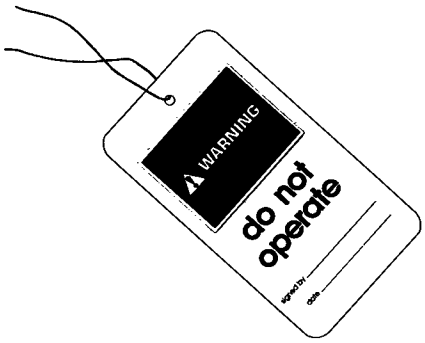


Illustration 5 g00104545

Attach a “Do Not Operate” warning tag or a similar warning tag to the start switch or to the controls before you service the equipment or before you repair the equipment. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer.

When possible, make all repairs with the machine parked on a level, hard surface. The machine should be blocked in order to prevent the machine from rolling.

Know the width of your equipment in order to maintain proper clearance when you operate the equipment near fences or near boundary obstacles.

Be aware of high voltage power lines and power cables that are buried. If the machine comes in contact with these hazards, serious injury or death may occur from electrocution.

Make sure that all protective guards and all covers are secured in place on the equipment. If a guard, a cover, or a shield must be removed in order to perform the repair work, use extra caution.

Keep the equipment free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps.

Secure all loose items such as lunch boxes, tools, and other items that are not a part of the equipment.

Know the appropriate work site hand signals and the personnel that are authorized to give the hand signals. Accept hand signals from one person only.

Do not smoke when you service an air conditioner. Also, do not smoke if refrigerant gas may be present. Inhaling the fumes that are released from a flame that contacts air conditioner refrigerant can cause bodily harm or death. Inhaling gas from air conditioner refrigerant through a lighted cigarette can cause bodily harm or death.

Use all cleaning solutions with care. Report all necessary repairs.

Do not allow unauthorized personnel on the equipment.

Disconnect the battery and discharge any capacitors before starting work on the machine.

Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands in order to support the machine before performing any service of disassembly.

Make sure that the work area around the machine is safe and be aware of any hazardous conditions that may exist. If an engine is started inside an enclosure, make sure that the engine’s exhaust is properly vented.

Always use tools that are in good working condition. Ensure that you understand the proper use of the tools before performing any service work.

Replace all fasteners with the same part number. Do not use a lesser quality fastener if replacements are necessary.

You should be prepared to stop an engine that has been recently overhauled. You should also be prepared to stop the machine if the fuel system has been recently worked on. If the engine has not been assembled correctly or if the fuel setting is not adjusted properly , the engine can possibly overspeed. This may cause bodily injury, death or property damage. You should be prepared to shut off the fuel and air supply to the engine in order to stop the engine.

Caution should be used when any cover plate is removed. Slowly back off the last two bolts or the last two nuts that are located at opposite ends of the cover or device. Then, pry the cover loose in order to relieve any spring or other pressure, before removing the last two bolts or nuts completely.

Repairs that require welding should be performed only with the benefit of the appropriate reference information. Repairs that require welding should be performed only by personnel that are adequately trained and knowledgeable in welding procedures. Refer to Instruction Manual, SEGV2549, “Techniques of Structural Repair Course”. The type of metal that is being welded should be determined prior to making any repairs. The correct procedures and materials should be used in order to provide a weld that is equivalent in strength to the parent material.

Do not damage wiring during the removal operations. Wiring should be reinstalled so that the wiring is not damaged. Wiring should also be installed so that the wiring will not be damaged during normal operation of the equipment. Do not connect wiring to a line that may contain fluid.

Always use lift arm supports in order to keep the lift arms raised. Keep all work tools tilted downward when repair work is being formed with the lift arms in the raised position. Prior to performing any maintenance or repairs, ensure that all hydraulic pressure has been relieved.

Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly in order to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in the event of a line, tube or seal failure must be installed correctly.

Do not operate a machine if there is damage to any rotating parts. Do not operate a machine if any rotating parts will contact any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing. Ensure that all safety devices are properly installed and that all safety devices are functioning correctly.

On track-type machines, be careful when servicing or separating tracks. Use caution when a track pin is removed or installed. Pieces of the track pin may break off and the pieces may become a flying hazard. Wear protective glasses. The tracks can unroll quickly, when the tracks are separated. Keep a safe distance from the front and the rear of the machine, when the tracks are separated. The machine can move unexpectedly when both tracks are disengaged from the sprockets. Always block the machine in order to prevent the machine from moving. Use caution when a bucket pin, a ripper tooth, or any other item is removed or installed. Pieces of those items may also break off and those pieces may become a flying hazard.

Unless you are instructed otherwise, perform maintenance with the equipment in the servicing position. Refer to Operation and Maintenance Manual for the procedure for placing the equipment in the servicing position.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the equipment. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component that contains fluids.

Refer to Special Publication, NENG2500, “Tools and Shop Products Guide” for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Asbestos Information

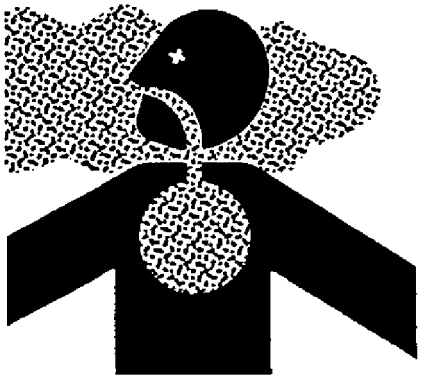


Illustration 6 g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.

- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in “29 CFR 1910.1001”.
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

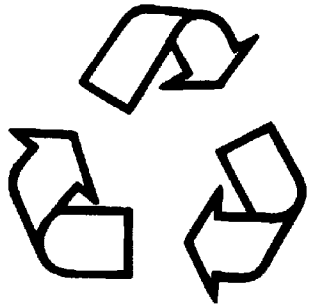


Illustration 7 g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

Crushing Prevention and Cutting Prevention

Support the equipment properly before you perform any work or maintenance beneath that equipment. Do not depend on the hydraulic cylinders to hold up the equipment. Equipment can fall if a control is moved, or if a hydraulic line breaks.

Do not work beneath the machine component of the machine unless the machine component is properly supported.

Unless you are instructed otherwise, never attempt adjustments while the machine is moving or while the engine is running.

Never jump across the starter solenoid terminals in order to start the engine. Unexpected machine movement could result.

Whenever there are equipment control linkages the clearance in the linkage area will change with the movement of the equipment or the machine. Stay clear of areas that may have a sudden change in clearance with machine movement or equipment movement.

Stay clear of all rotating and moving parts.

If it is necessary to remove guards in order to perform maintenance, always install the guards after the maintenance is performed.

Keep objects away from moving fan blades. The fan blade will throw objects or cut objects.

Do not use a kinked wire cable or a frayed wire cable. Wear gloves when you handle wire cable.

When you strike a retainer pin with force, the retainer pin can fly out. The loose retainer pin can injure personnel. Make sure that the area is clear of people when you strike a retainer pin. To avoid injury to your eyes, wear protective glasses when you strike a retainer pin.

Chips or other debris can fly off an object when you strike the object. Make sure that no one can be injured by flying debris before striking any object.

Burn Prevention

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the oil system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level only after the engine has been stopped.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Remove the hydraulic tank filler cap only after the engine has been stopped. The filler cap must be cool enough to touch with a bare hand. Follow the standard procedure in this manual in order to remove the hydraulic tank filler cap.

Fire Prevention and Explosion Prevention



Illustration 8 g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

Remove all flammable materials such as fuel, oil, and debris from the machine. Do not allow any flammable materials to accumulate on the machine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not operate the machine near any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil spray or fuel spray in case of a break in a line, in a hose, or in a seal. Exhaust shields must be installed correctly.

Do not weld on lines or on tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the machine. Clean all electrical connections and tighten all electrical connections.

Dust that is generated from repairing nonmetallic hoods or nonmetallic fenders can be flammable and/or explosive. Repair such components in a well ventilated area away from open flames or sparks.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and the hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.



Illustration 9 g00704059

Use caution when you are refueling a machine. Do not smoke while you are refueling a machine. Do not refuel a machine near open flames or sparks. Always stop the engine before refueling. Fill the fuel tank outdoors.

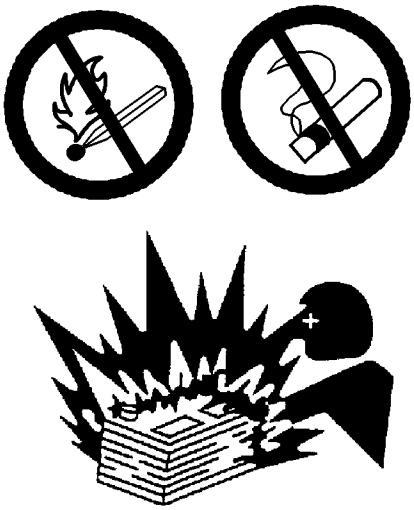


Illustration 10 g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation and Maintenance Manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

Ether is flammable and poisonous.

Use ether in well ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the operator compartment of a machine. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the machine is equipped with a thermal starting aid for cold weather starting.

Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During machine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

Tire Information

Explosions of air inflated tires have resulted from heat-induced gas combustion inside the tires. Explosions can be caused by heat that is generated by welding, by heating rim components, by external fire, or by excessive use of brakes.

A tire explosion is much more violent than a blowout. The explosion can propel the tire, the rim components, and the axle components as far as 500 m (1500 ft) or more from the machine. Both the force of the explosion and the flying debris can cause property damage, personal injury, or death.

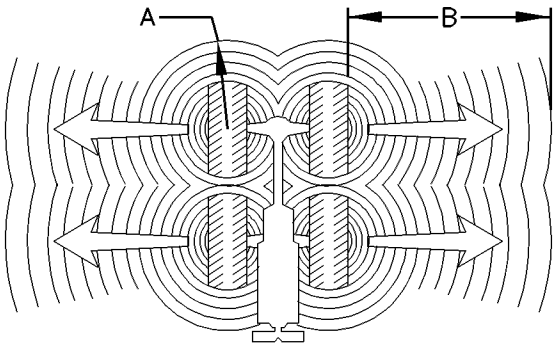


Illustration 11 g00337832

(A) At least 15 m (50 ft)
(B) At least 500 m (1500 ft)

Do not approach a warm tire. Maintain a minimum distance, as shown. Stay outside the shaded area in Illustration 11.

Do not use water or calcium as a ballast for the tires. Dry nitrogen gas is recommended for inflation of tires. If the tires were originally inflated with air, nitrogen is still preferred for adjusting the pressure. Nitrogen mixes properly with air.

Nitrogen inflated tires reduce the potential of a tire explosion because nitrogen does not aid combustion. Nitrogen helps to prevent oxidation of the rubber, deterioration of rubber, and corrosion of rim components.

To avoid overinflation, proper nitrogen inflation equipment and training in the usage of the equipment are necessary. A tire blowout or a rim failure can result from improper equipment or from misused equipment.

When you inflate a tire, stand behind the tread and use a self-attaching chuck.

Servicing tires and rims can be dangerous. Only trained personnel that use proper tools and proper procedures should perform this maintenance. If correct procedures are not used for servicing tires and rims, the assemblies could burst with explosive force. This explosive force can cause serious personal injury or death. Carefully obey the specific instructions from your tire dealer.

Work Tools

Make sure that all necessary guarding is in place on the host machine and on the work tool.

While you are performing any maintenance, any testing, or any adjustments to the work tool stay clear of the following areas: cutting edges, pinching surfaces, and crushing surfaces.

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Printed in U.S.A.

SENR3130-21 (en-us)
March 2021

Specifications

Torque Specifications

B9L 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

NOTICE

When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Specifications Section

i07167422

General Information

SMCS Code: 7553

⚠ WARNING

Mismatched or incorrect fasteners can result in damage or malfunction, or personal injury.

Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.

Introduction to Torque

“Torque” is measured in terms of force and distance. Force is the amount of pushing or pulling applied at the end of the lever. Distance is the length of the lever that is being used. Torque values are given in the following units: NEWTON meters (N·m), pound inches (lb in), and pound feet (lb ft)

This manual is intended to provide the operator with a reference. This manual will provide the standard torque settings for the following: bolts, nuts, plugs, fittings, and clamps.

Exceptions to these torques are given in the Service Manual, if necessary.

Be sure to use a torque wrench that has the proper range. Torque wrenches must be used properly in order to ensure that the correct torque is applied. Always use a smooth pull for torque wrenches. Do not jerk a torque wrench. Do not use adapters that change the length of the torque wrench. For the correct use of your torque wrench, refer to the instructions that were packaged with your torque wrench. For more information on the correct use of torque wrenches, refer to Special Publication, SEBV0516, “An Introduction to Torque”. This publication is available on the Caterpillar Media Information Center (CMIC) and through the normal literature distribution system at your local Cat ® dealer.

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean reused fasteners with a noncorrosive cleaner. Lightly lubricate the threads of reused fasteners. Lightly lubricate the mating surface of the head of reused fasteners. Other applications for lubricating fasteners may also be specified in the Service Manual. The Service Manual may also specify the use of sealants and compounds.

Note: Do not use sealants that are not specified in the Service Manual. Do not use compounds that are not specified in the Service Manual. Clean old compound from the bolt and from the hole before installation.

Torque-Turn

The torque-turn method is used when precise control over clamping force is required. There is an initial torque and an additional turn. The initial torque is required to bring all parts of the joint into contact. The additional turn provides the desired clamping force. Ensure that all fasteners have been torqued before you perform the additional turns. Turn the fastener according to the specified amount. The specified amount will normally be equal to or greater than 90°. The specified amount will normally be in 30° increments. Turns of 120° or 180° are preferred. Turns of 120° or 180° are easily measured by the points of the hex head of the fastener. Lubrication may be specified in order to reduce the effort that is required for the final turn. The use of the torque-turn method will allow the following:

- Increase the life of the fastener.
- Maximize the potential clamping force of a fastener.

Typical applications are the following:

- Track bolts
- Sprocket bolts
- Connecting rod bolts
- Engine Cylinder Heads
- Drive Shaft bolts

Note: Too much tension on the bolt will cause the bolt to be stretched beyond the point of yield. The bolt will be permanently stretched. The bolt will loosen the grip on the parts that are being fastened. If the bolt is tightened again, the bolt will break. Do not reuse bolts that have been permanently stretched.

Torque Sequence

Unless the bolt tightening sequence is specified by the Service Manual, the fasteners should be tightened in a cross pattern. Use Step 1 through Step 5 unless the tightening sequence is specified:

1. Hand tighten all fasteners. Larger fasteners may require the use of a small hand wrench.
2. Torque all fasteners to 40% of full torque.
3. Torque all fasteners to 70% of full torque.
4. Torque all fasteners to full torque by using a cross pattern. Large flanges may require additional passes.

5. Apply at least one final full torque to all fasteners in a clockwise direction until all torque is uniform. Large flanges may require additional passes.

Note: Final torque may be a turn.

Torque Marking (Best Practices)

Basic Process

1. Torque all bolts in the joint to a low torque or a snug torque.

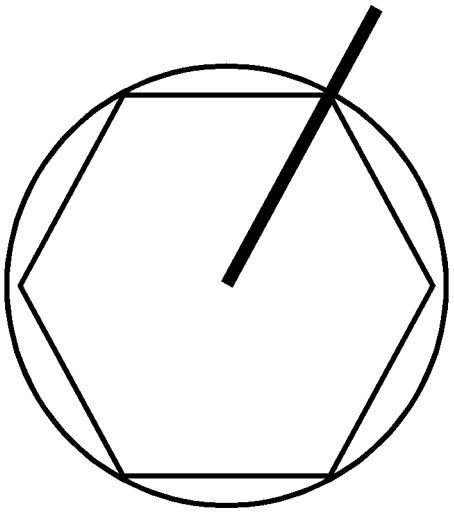


Illustration 1 g06223465

2. Mark bolt head corner to abutment.

3. Tighten bolt to specified torque.

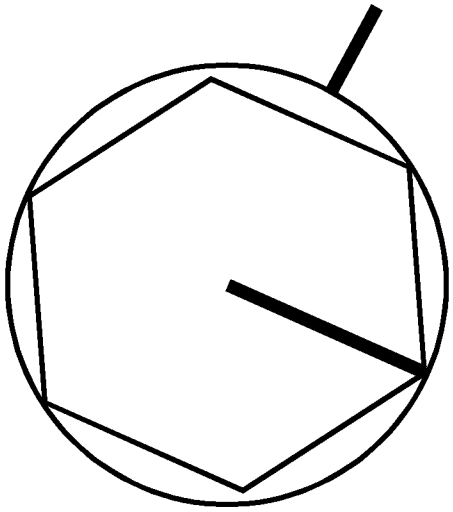


Illustration 2 g06223468

4. Verify that the lines are broken.

Circular Process

1. Torque all bolts in the joint to a low torque or a snug torque.

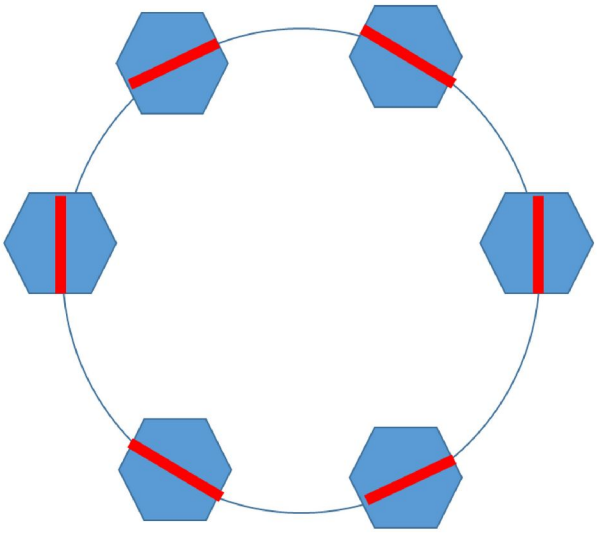


Illustration 3 g06223470

2. Mark bolt heads in a circular pattern.

3. Tighten bolt to specified torque.

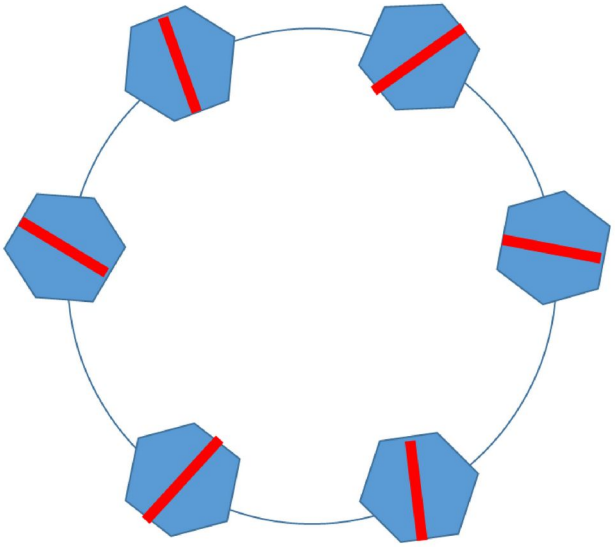


Illustration 4 g06223472

4. Verify that the lines are no longer in a circular pattern.

Torque-Turn

Torque-Turn applies to fasteners that need turned to a set angle after the initial torque is applied.

1. Torque the fastener to the initial torque.

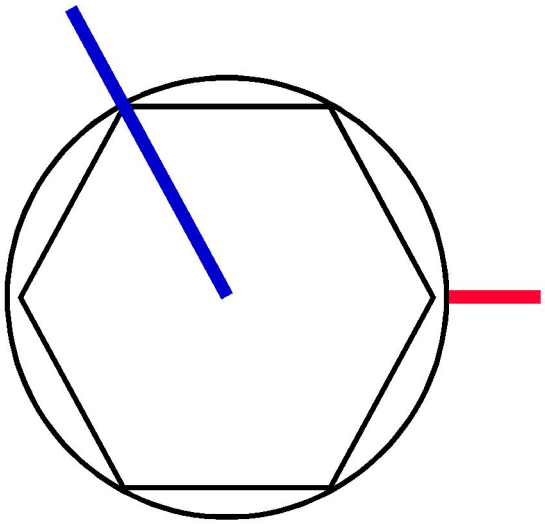


Illustration 5 g06241021

Example of 120° torque angle

2. Mark a line on the fastener and on the abutment.

3. Mark another line in a different color at the required angle on the abutment.

4. Turn the fastener to the appropriate torque angle.

Note: Marking the socket and aligning the mark on the socket with the original starting mark can aide in turning the fastener to the correct angle.

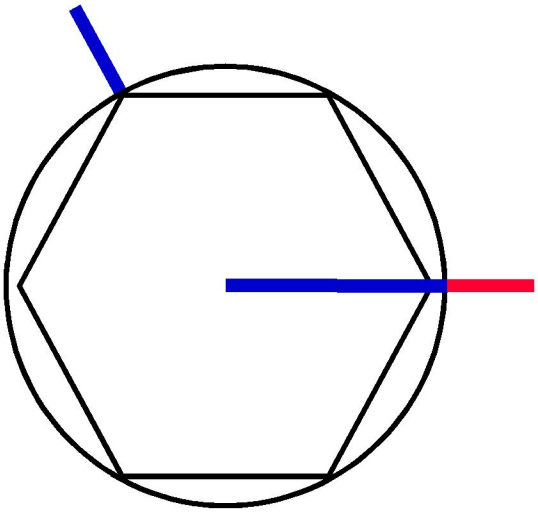


Illustration 6 g06241028

Example of 120° torque angle

5. Verify the mark on the fastener is in-line with the torque angle mark.

i08385507

Metric (ISO) Fasteners

SMCS Code: 7553

Metric (ISO) Nuts and Bolts

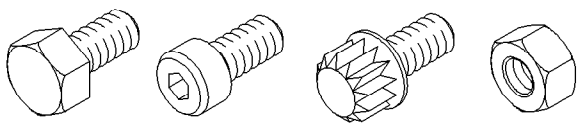


Illustration 7 g00909614

Note: The following table has the recommended standard torque values for metric nuts and bolts for use on all Cat ® equipment.

Table 1

Thread Size mm	Torque
M6	12 ± 3 N·m (105 ± 27 lb in)
M8	28 ± 7 N·m (250 ± 62 lb in)
M10	55 ± 10 N·m (41 ± 7 lb ft)
M12	100 ± 20 N·m (75 ± 15 lb ft)
M14	160 ± 30 N·m (120 ± 22 lb ft)
M16	240 ± 40 N·m (175 ± 30 lb ft)
M20	460 ± 60 N·m (340 ± 44 lb ft)
M24	800 ± 100 N·m (590 ± 75 lb ft)
M30	1600 ± 200 N·m (1180 ± 150 lb ft)
M36	2800 ± 350 N·m (2060 ± 260 lb ft)

Note: The following torque table applies for Class 8.8 metric fasteners used on engines or powertrains without a torque level specified in the Service Manual. (The fastener head mark will show “8.8” . A nut would be marked with an “8”).

Table 2

Thread Size mm	Torque
M6	5 N·m (44 lb in)
M8	22 N·m (195 lb in)
M10	44 N·m (32 lb ft)
M12	78 N·m (60 lb ft)
M14	124 N·m (90 lb ft)
M16	177 N·m (130 lb ft)
M18	200 N·m (150 lb ft)
M20	400 N·m (300 lb ft)
M24	790 N·m (580 lb ft)

Metric (ISO) Machine Screws

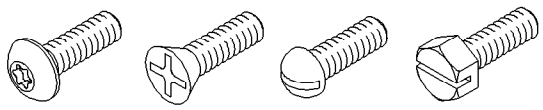


Illustration 8 g00908932

Table 3

Thread Size mm	Torque
M2.5	0.40 ± 0.10 N·m (3.5 ± 0.9 lb in)
M3	0.70 ± 0.15 N·m (6.2 ± 1.3 lb in)
M4	1.70 ± 0.40 N·m (15.1 ± 3.5 lb in)
M5	3.30 ± 0.70 N·m (29.2 ± 6.2 lb in)

Hex Button Head Screw and Set Screws



Illustration 9 g01186742

Table 4

Thread Size mm	Torque
M3	.6 ± .1 N·m (5 ± 0.9 lb in)
M4	2 ± .3 N·m (18 ± 3 lb in)
M5	4 ± .5 N·m (35 ± 4 lb in)
M6	6 ± 1 N·m (55 ± 9 lb in)
M8	15 ± 2 N·m (135 ± 18 lb in)
M10	30 ± 7 N·m (265 ± 62 lb in)
M12	50 ± 10 N·m (37 ± 7 lb ft)
M14	80 ± 15 N·m (60 ± 11 lb ft)
M16	125 ± 20 N·m (90 ± 15 lb ft)
M20	250 ± 40 N·m (185 ± 30 lb ft)

(continued)

(Table 4, contd)

M24	425 ± 50 N·m (310 ± 37 lb ft)
M30	850 ± 100 N·m (620 ± 75 lb ft)
M36	1500 ± 200 N·m (1100 ± 150 lb ft)

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English (SAE) Fasteners

SMCS Code: 7553

English (SAE) Nuts and Bolts

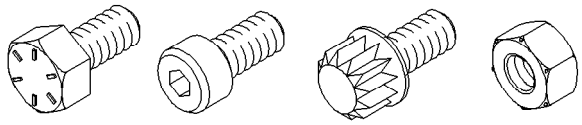


Illustration 10 g00908911

Table 5

Thread Size Inch	Torque
1/4	12 ± 3 N·m (105 ± 27 lb in)
5/16	25 ± 6 N·m (220 ± 53 lb in)
3/8	47 ± 9 N·m (35 ± 7 lb ft)
7/16	70 ± 15 N·m (50 ± 11 lb ft)
1/2	105 ± 20 N·m (75 ± 15 lb ft)
9/16	160 ± 30 N·m (120 ± 22 lb ft)
5/8	215 ± 40 N·m (160 ± 30 lb ft)
3/4	370 ± 50 N·m (275 ± 37 lb ft)
7/8	620 ± 80 N·m (460 ± 60 lb ft)
1	900 ± 100 N·m (660 ± 75 lb ft)
1 1/8	1300 ± 150 N·m (960 ± 110 lb ft)
1 1/4	1800 ± 200 N·m (1320 ± 150 lb ft)
1 3/8	2400 ± 300 N·m (1780 ± 220 lb ft)
1 1/2	3100 ± 350 N·m (2280 ± 260 lb ft)

English (SAE) Machine Screws

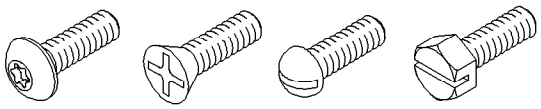


Illustration 11 g00908932

Table 6

Thread Size No.	Torque
No. 4 (.112)	**0.50 ± 0.10 N·m (4.4 ± 0.9 lb in)**
No. 5 (.125)	**0.70 ± 0.15 N·m (6.2 ± 1.3 lb in)**
No. 6 (.138)	**0.90 ± 0.20 N·m (8.0 ± 1.8 lb in)**
No. 8 (.164)	**1.70 ± 0.40 N·m (15.0 ± 3.5 lb in)**
No. 10 (.190)	**2.30 ± 0.50 N·m (20.4 ± 4.4 lb in)**
No 12 (.216)	3.40 ± 0.70 N·m (30.1 ± 6.2 lb in)

Hex Button Head Screw and Set Screws



Illustration 12 g01186972

Table 7

Thread Size inch	Torque
# 4 & #5	.6 ± .1 N·m (5 ± 0.9 lb in)
#6 & #8	2 ± .3 N·m (18 ± 3 lb in)
#10 & #12	4 ± .5 N·m (35 ± 4 lb in)
1/4	6 ± 1 N·m (55 ± 9 lb in)
5/16	13 ± 3 N·m (115 ± 27 lb in)
3/8	25 ± 6 N·m (220 ± 53 lb in)
7/16	40 ± 8 N·m (20 ± 6 lb ft)
1/2	60 ± 12 N·m (44 ± 9 lb ft)
9/16	85 ± 15 N·m (65 ± 11 lb ft)

(continued)

(Table 7, contd)

5/8	115 ± 20 N·m (85 ± 15 lb ft)
3/4	200 ± 40 N·m (150 ± 30 lb ft)
7/8	325 ± 40 N·m (240 ± 30 lb ft)
1	500 ± 65 N·m (370 ± 48 lb ft)
1 1/8	700 ± 90 N·m (520 ± 65 lb ft)
1 1/4	1000 ± 125 N·m (740 ± 90 lb ft)
1 3/8	1300 ± 150 N·m (960 ± 110 lb ft)
1 1/2	1700 ± 200 N·m (1260 ± 150 lb ft)

i03518060

Ground Engaging Tool (G.E.T.) Fasteners

SMCS Code: 7553

Ground Engaging Tools (G.E.T.) are secured by many types of bolts. Refer to Table 8 for the correct torque for the following combinations of fasteners for G.E.T.:

- Plow bolts and nuts
- Hex head bolts and nuts

Table 8

Thread Size Inch	Torque(1)	
	N·m	lb ft
5/8 inch	270 ± 40	200 ± 30
3/4 inch	475 ± 60	350 ± 45
7/8 inch	750 ± 90	550 ± 65
1 inch	1150 ± 150	850 ± 110
1 1/4 inch	2300 ± 300	1700 ± 220

(1) These values are only for Caterpillar bolts for cutting edges.

⚠ WARNING

Personal injury can result when installing plow bolts. The appropriate safety equipment must be worn when striking the plow bolts. To avoid injury to your eyes and ears, wear protective glasses and hearing protection during this procedure.

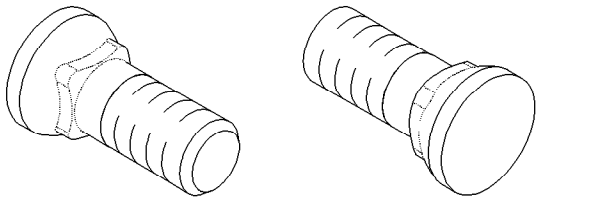


Illustration 13 g00909058

View of a typical plow bolt

Plow bolts must be installed properly. Refer to the following procedure for the correct installation of plow bolts.

1. Clean all surfaces that contact the bolt. Remove all occurrences of the following conditions:rust, paint, nicks and burrs
2. Tighten the nut to the correct torque. Refer to Table 8 for the correct torque.
3. Use a hammer to strike the head of the bolt. The bolt must be struck with significant force.

Note: The head of the bolt may be recessed below the mounting surface. Use a suitable punch in order to transfer the hammer blow to the bolt head.

4. Tighten the nut to the correct torque. Refer to Table 8 for the correct torque.

i08337129

Installation of Fittings

SMCS Code: 7553

Note: The tightening sequence of the threaded adapters that attaches a tube assembly or hose assembly to the machine is critical to the proper function of the machine. The sealing surfaces of the tube assembly or hose assembly should be secured squarely. The sealing surfaces of the tube assembly or hose assembly should be tightened to the serviced component (control valve, cylinder, hydraulic motor, etc.). Perform this procedure prior to the final tightening of any clamps or clips that are used in order to fasten the tube assembly or the hose assembly to the machine.

Fittings have different connections. Fittings may have two different ends. Be sure to use the proper torque for the end of the fitting that is used. The following list contains some common types of fittings.

Protective caps and plugs should not be removed until the connector is ready to be assembled. All sealing surfaces should be free of contamination and damage. If a connector is damaged before or after assembly, it should be replaced.

- Straight Thread O-Ring (STOR)

- O-Ring Face Seal (ORFS)
- Tapered Pipe Thread (NPT and NPTF)
- 37 Degree Flare Fitting
- 45 Degree Flare Fitting
- Inverted Flare Fitting
- Hydraulic Four Bolt Flange

Installation of Hydraulic Four Bolt Flange

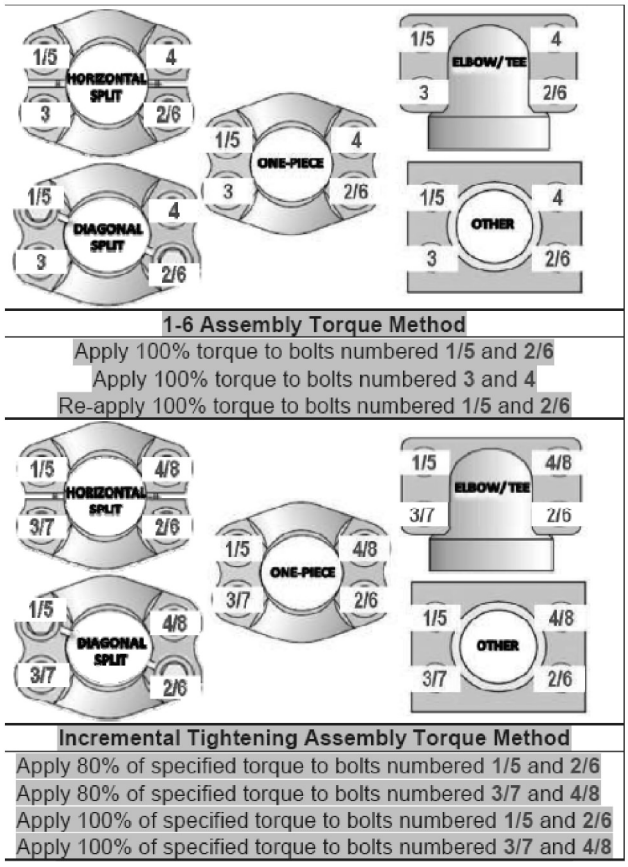


Illustration 14 g02724217

1. Position the flanges parallel over the port.

2. Evenly install bolts hand-tight, keeping the gap between flanges at a minimum.

3. Put the hose in a position so that the hose does not contact the machine or with another hose.

4. Tighten using one of the assembly torque values for bolts, used in Illustration 14 for proper torque sequence of various flange fittings.

5. Start the engine.

6. Move the implement control levers to all of the positions.

7. Look at the hose during movement of the implement. Ensure that the hose is not in contact with the machine or with other hoses.

Note: For hoses that cross an articulation hitch, check for contact during articulation. For hoses that connect to the steering system, check for contact during steering.

8. Shut off the engine.

9. If the hose contacts other hoses or the machine during the test, loosen the bolts and reposition the hose. Repeat steps 3 through 8 until there is no contact.

Installation of Adjustable STOR Fittings

This type of fitting is used in many applications. One end of the fitting will be an adjustable STOR fitting. The other end will be different. Always use the same installation procedure for the STOR end. Adjustable STOR fittings can be positioned before tightening.

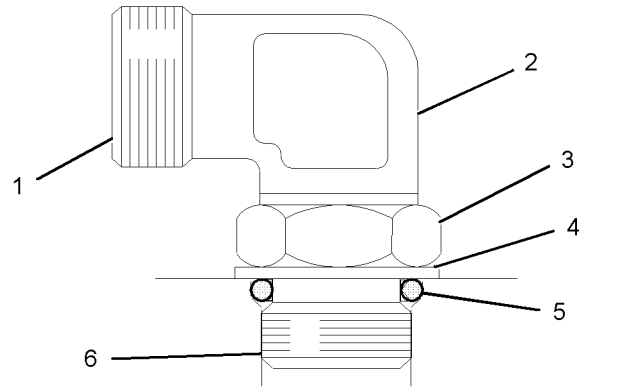


Illustration 15 g01848653

Elbow body assembly

(1) End that connects to the tube or hose
(2) Fitting body
(3) Locknut
(4) Backup washer
(5) O-ring seal
(6) End that is assembled to the mating part

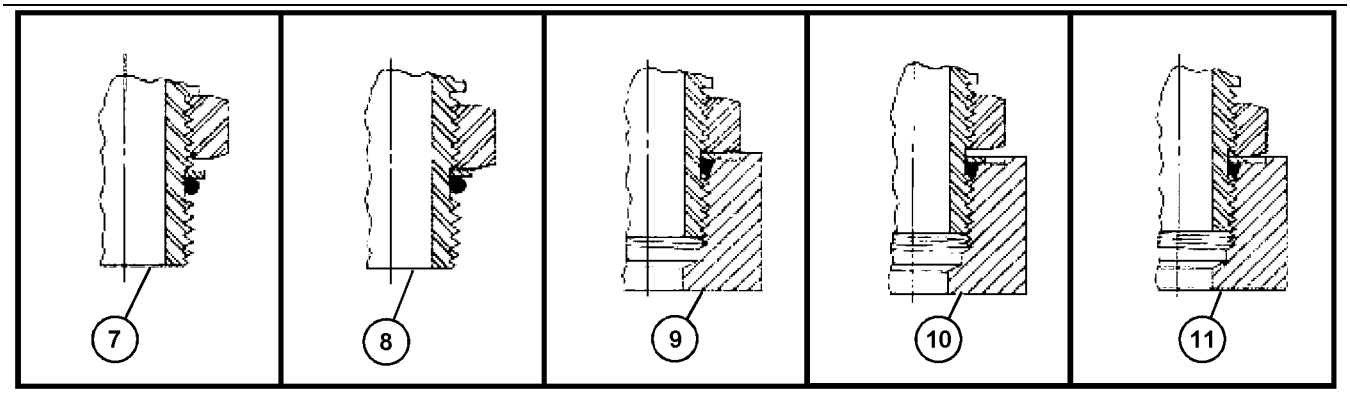


Illustration 16 g06633845

View of adjustable STOR installation positions

(7) Locknut and washer backed off with O-Ring in position.
(8) Locknut in position to protect the back-up washer from damage during installation
(9) Hand tightened into port until back-up washer contacts port face.
(10) Connector backed off for alignment to mating connector, tube assembly, or hose assembly.
(11) Connector tightened to final position.

1. Rotate locknut (3) until it contacts adapter body, slide backup washer (4), and O-ring seal (5) until they contact upper threads. Hold these components in this position. Rotate locknut (3) down until it makes contact with the backup washer (4).

Note: Failure to support the backup washer with the locknut prior to installation into the port will result in distortion of the washer. Distortion of the washer will prevent proper sealing.

2. Put the fitting assembly in the correct position. loosen fitting (2) until the correct assembly position is achieved. Do not loosen the fitting more than 360 degrees. Install the tube or hose hand tight to verify the orientation of the fitting. Tighten the fitting (2) to the torque that is shown in the correct chart for the fitting that is used. Tighten locknut (3) to the torque that is shown in the correct chart for the fitting that is used. Use a backup wrench, when the locknut is tightened.

Note: Torque the fitting prior to the locknut.

Note: If the fitting is not adjustable, the hex on the body replaces the locknut. To install this type of fitting, tighten the hex against the face of the mating part.

Excessive tightening of the connectors can cause failure. Connectors that are under-tightened can also cause failures. The following failures occur:

- Excessive tightening can expand a loose ferrule into the nut. This will cause the ferrule to lock up in the nut and the nut will not function properly.
- Excessive tightening can split the nut on the end of the tube or can split the ferrule.
- Excessive tightening can gall or excessive tightening can strip the threads of the nut.

Note: If the above conditions occur due to excessive tightening, the damaged fluid connector must be scrapped and the fluid connectors must be replaced.

i08292420

Straight Thread O-Ring Fittings

SMCS Code: 7553

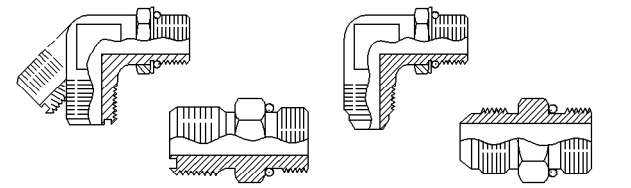


Illustration 17 g00911924

Note: For torques for plugs, refer to Specifications, “Plugs”.

Note: Straight Thread O-Ring fittings for medium pressure usage will have shorter threaded ends than high-pressure fittings. The torque value for medium pressure Straight Thread O-Ring fittings will be lower than the torque values that are required for Straight Thread O-Ring fittings for high-pressure fittings.

Table 9

Ferrous Straight Thread O-Ring Fitting Torques for Mating with Ferrous Materials Medium Pressure use Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16 - 24	10 ± 2 N·m (89 ± 18 lb in)
4.76 mm (0.188 inch)	3/8 - 24	13 ± 2 N·m (115 ± 18 lb in)
6.35 mm (0.250 inch)	7/16 - 20	30 ± 5 N·m (266 ± 44 lb in)
7.94 mm (0.312 inch)	1/2 - 20	30 ± 5 N·m (266 ± 44 lb in)
9.52 mm (0.375 inch)	9/16 - 18	40 ± 6 N·m (30 ± 4 lb ft)
12.70 mm (0.500 inch)	3/4 - 16	80 ± 12 N·m (59 ± 9 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	110 ± 17 N·m (81 ± 13 lb ft)
19.05 mm (0.750 inch)	1 1/16 - 12	130 ± 20 N·m (96 ± 15 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	200 ± 30 N·m (148 ± 22 lb ft)

(continued)

(Table 9, contd)

Ferrous Straight Thread O-Ring Fitting Torques for Mating with Ferrous Materials Medium Pressure use Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
25.40 mm (1.000 inch)	1 5/16 - 12	180 ± 27 N·m (133 ± 20 lb ft)
31.75 mm (1.250 inch)	1 5/8 - 12	300 ± 45 N·m (221 ± 33 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	350 ± 53 N·m (258 ± 39 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	420 ± 63 N·m (310 ± 46 lb ft)

Note: Use 50 percent of the torque values from Table 9 when the fitting or the port material is nonferrous.

Note: Straight Thread O-Ring fittings for high-pressure usage will have longer threaded ends than medium pressure fittings. The torque value for high-pressure Straight Thread O-Ring fittings will be higher than the torque values that are required for Straight Thread O-Ring fittings for medium pressure fittings.

Table 10

Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials High Pressure use Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
4.76 mm (0.188 inch)	3/8 - 24	20 ± 3 N·m (177 ± 27 lb in)
6.35 mm (0.250 inch)	7/16 - 20	30 ± 5 N·m (266 ± 44 lb in)
7.94 mm (0.312 inch)	1/2 - 20	45 ± 7 N·m (33 ± 5 lb ft)
9.52 mm (0.375 inch)	9/16 - 18	55 ± 8 N·m (41 ± 6 lb ft)
12.7 mm (0.500 inch)	3/4 - 16	100 ± 15 N·m (74 ± 11 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	140 ± 21 N·m (103 ± 15 lb ft)
19.05 mm (0.750 inch)	1 1/16 - 12	220 ± 33 N·m (162 ± 24 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	260 ± 39 N·m (192 ± 29 lb ft)
25.40 mm (1.000 inch)	1 5/16 - 12	350 ± 53 N·m (258 ± 39 lb ft)

(continued)

(Table 10, contd)

31.75 mm (1.250 inch)	1 5/8 -12	400 ± 60 N·m (295 ± 44 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	420 ± 63 N·m (310 ± 46 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 10 when the fitting or the port material is nonferrous.

Table 11

Metric Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials Medium Pressure use Fittings		
Ref Nominal Outer Diameter of the Tube	**Thread Size**	**Standard Torque Tolerance**
4 mm	M8 X 1	10 ± 2 N·m (89 ± 18 lb in)
5 mm	M10 X 1	17 ± 3 N·m (150 ± 27 lb in)
6 mm	M12 X 1.5	30 ± 5 N·m (266 ± 44 lb in)
8 mm	M14 X 1.5	35 ± 5 N·m (26 ± 4 lb ft)
10 mm	M16 X 1.5	45 ± 7 N·m (33 ± 5 lb ft)
12 mm	M18 X 1.5	50 ± 8 N·m (37 ± 6 lb ft)
16 mm	M22 X 1.5	80 ± 12 N·m (59 ± 9 lb ft)
20 mm	M27 X 2	120 ± 18 N·m (89 ± 13 lb ft)
22 mm	M30 X 2	160 ± 24 N·m (118 ± 18 lb ft)
25 mm	M33 X 2	180 ± 27 N·m (133 ± 20 lb ft)
30 mm	M42 X 2	260 ± 39 N·m (192 ± 29 lb ft)
38 mm	M48 X 2	300 ± 45 N·m (221 ± 33 lb ft)
50 mm	M60 X 2	350 ± 53 N·m (258 ± 39 lb ft)

Note: Use 50 percent of the torque values from Table 11 when the fitting or the port material is nonferrous.

Table 12

Metric Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials High Pressure use Fittings		
Ref Nominal Outer Diameter of the Tube	**Thread Size**	**Standard Torque Tolerance**
5 mm	M10 X 1	20 ± 3 N·m (177 ± 27 lb in)
6 mm	M12 X 1.5	40 ± 6 N·m (30 ± 4 lb ft)
8 mm	M14 X 1.5	50 ± 8 N·m (37 ± 6 lb ft)
10 mm	M16 X 1.5	60 ± 9 N·m (44 ± 7 lb ft)
12 mm	M18 X 1.5	80 ± 12 N·m (59 ± 9 lb ft)
16 mm	M22 X 1.5	140 ± 21 N·m (103 ± 15 lb ft)
20 mm	M27 X 2	220 ± 33 N·m (162 ± 24 lb ft)
22 mm	M30 X 2	260 ± 39 N·m (192 ± 29 lb ft)
25 mm	M33 X 2	350 ± 53 N·m (258 ± 39 lb ft)
30 mm	M42 X 2	400 ± 60 N·m (295 ± 44 lb ft)
38 mm	M48 X 2	420 ± 63 N·m (310 ± 46 lb ft)
50 mm	M60 X 2	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 12 when the fitting or the port material is nonferrous.

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Plugs

SMCS Code: 7553

Straight Thread O-Ring Plugs

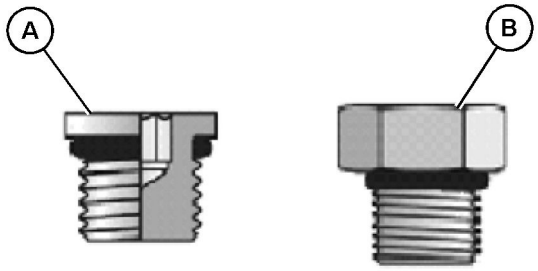


Illustration 18 g06616232

(A) Internal Hex
(B) External Hex

Table 13

Ferrous Straight Thread O-Ring Plug Torques for Mating with Ferrous Materials		
Thread Size Inch	**Internal Hex Plug Torque**	**External Hex Plug Torque**
5/16	7 ± 1 N·m (62 ± 9 lb in)	13 ± 2 N·m (115 ± 18 lb in)
3/8	13 ± 2 N·m (115 ± 18 lb in)	20 ± 3 N·m (177 ± 27 lb in)
7/16	20 ± 3 N·m (177 ± 27 lb in)	40 ± 6 N·m (30 ± 4 lb ft)
1/2	25 ± 4 N·m (221 ± 35 lb in)	45 ± 7 N·m (33 ± 5 lb ft)
9/16	45 ± 7 N·m (33 ± 5 lb ft)	60 ± 9 N·m (44 ± 7 lb ft)
3/4	80 ± 12 N·m (59 ± 9 lb ft)	100 ± 15 N·m (74 ± 11 lb ft)
7/8	110 ± 17 N·m (81 ± 13 lb ft)	130 ± 20 N·m (96 ± 15 lb ft)
1 1/16	180 ± 27 N·m (133 ± 20 lb ft)	220 ± 33 N·m (162 ± 24 lb ft)
1 3/16	220 ± 33 N·m (162 ± 24 lb ft)	260 ± 39 N·m (192 ± 29 lb ft)

(continued)

(Table 13, contd)

1 5/16	300 ± 45 N·m (221 ± 33 lb ft)	350 ± 53 N·m (258 ± 39 lb ft)
1 5/8	350 ± 53 N·m (258 ± 39 lb ft)	400 ± 60 N·m (295 ± 44 lb ft)
1 7/8	420 ± 63 N·m (310 ± 46 lb ft)	420 ± 63 N·m (310 ± 46 lb ft)
2 1/2	500 ± 75 N·m (369 ± 55 lb ft)	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 13 when the fitting or the port material is nonferrous.

Table 14

Metric Ferrous Straight Thread O-Ring Plug Torques for Mating with Ferrous Materials		
Thread Size Metric	**Internal Hex Plug Torque**	**External Hex Plug Torque**
M8	10 ± 2 N·m (89 ± 18 lb in)	10 ± 2 N·m (89 ± 18 lb in)
M10	17 ± 3 N·m (150 ± 27 lb in)	20 ± 3 N·m (177 ± 27 lb in)
M12	25 ± 4 N·m (221 ± 35 lb in)	35 ± 5 N·m (26 ± 4 lb ft)
M14	45 ± 7 N·m (33 ± 5 lb ft)	45 ± 7 N·m (33 ± 5 lb ft)
M16	55 ± 8 N·m (41 ± 6 lb ft)	55 ± 8 N·m (41 ± 6 lb ft)
M18	70 ± 11 N·m (52 ± 8 lb ft)	90 ± 13 N·m (66 ± 10 lb ft)
M20	80 ± 12 N·m (59 ± 9 lb ft)	110 ± 17 N·m (81 ± 13 lb ft)
M22	100 ± 15 N·m (74 ± 11 lb ft)	130 ± 20 N·m (96 ± 15 lb ft)
M27	180 ± 27 N·m (133 ± 20 lb ft)	220 ± 33 N·m (162 ± 24 lb ft)
M30	220 ± 33 N·m (162 ± 24 lb ft)	260 ± 39 N·m (192 ± 29 lb ft)
M33	300 ± 45 N·m (221 ± 33 lb ft)	350 ± 53 N·m (258 ± 39 lb ft)
M42	350 ± 53 N·m (258 ± 39 lb ft)	400 ± 60 N·m (295 ± 44 lb ft)
M48	420 ± 63 N·m (310 ± 46 lb ft)	420 ± 63 N·m (310 ± 46 lb ft)
M60	500 ± 75 N·m (369 ± 55 lb ft)	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 14 when the fitting or the port material is nonferrous.

Drain Plugs with Straight Threads

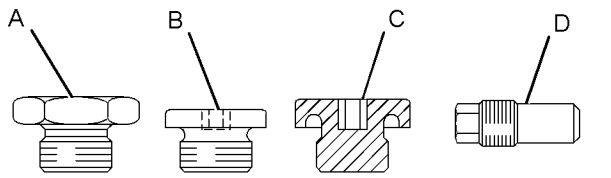


Illustration 19 g01848045

Note: Plug (A), plug (B), and plug (C) are used with a gasket. Conical seal plug (D) does not use a gasket.

Table 15

Type of Plug	Thread Size Inch	Torque
A	1/2 - 13	20 ± 3 N·m (177 ± 27 lb in)
	5/8 - 11	35 ± 5 N·m (26 ± 4 lb ft)
	3/4 - 12 3/4 - 16	50 ± 8 N·m (37 ± 6 lb ft)
	7/8 - 14 1 1/8 - 12	70 ± 11 N·m (52 ± 8 lb ft)
B	1 5/16 - 12 1 1/2 - 12	90 ± 13 N·m (66 ± 10 lb ft)
	2 - 12	130 ± 20 N·m (96 ± 15 lb ft)
C	1 1/8 - 12	70 ± 11 N·m (52 ± 8 lb ft)
	1 5/16 - 12	90 ± 13 N·m (66 ± 10 lb ft)
D	1/2 - 20	13 ± 2 N·m (115 ± 18 lb in)
	7/8 -14	55 ± 8 N·m (41 ± 6 lb ft)
	1 3/8 -13	90 ± 13 N·m (66 ± 10 lb ft)
	1 1/2 - 12	110 ± 17 N·m (81 ± 13 lb ft)

Note: Use 50 percent of the torque values from Table 15 when the fitting or the port material is nonferrous.

i08067922

O-Ring Face Seal Fittings

SMCS Code: 7553

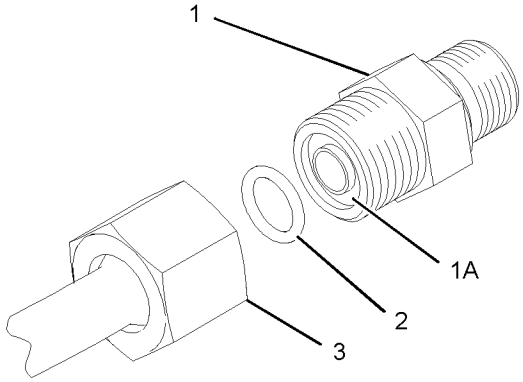


Illustration 20 g01848710

O-ring face seal fitting (ORFS fitting)

(1) O-ring face seal connector
(1A) O-ring groove
(2) O-ring seal
(3) Nut for the O-ring face seal

Table 16

Ferrous ORFS Fitting	
Thread Size Inch	**Torque**
9/16 - 18	27 ± 4 N·m (239 ± 35 lb in)
11/16 - 16	45 ± 5 N·m (33 ± 4 lb ft)
13/16 - 16	65 ± 10 N·m (48 ± 7 lb ft)
1 - 14	110 ± 17 N·m (81 ± 13 lb ft)
1 3/16 - 12	140 ± 21 N·m (103 ± 15 lb ft)
1 7/16 - 12	220 ± 33 N·m (162 ± 24 lb ft)
1 11/16 - 12	300 ± 45 N·m (221 ± 33 lb ft)
2 - 12	350 ± 53 N·m (258 ± 39 lb ft)

Note: Use 50 percent of the torque values from Table 16 when the fitting or the port material is nonferrous.

i08341068

Bulkhead Nuts

SMCS Code: 7553

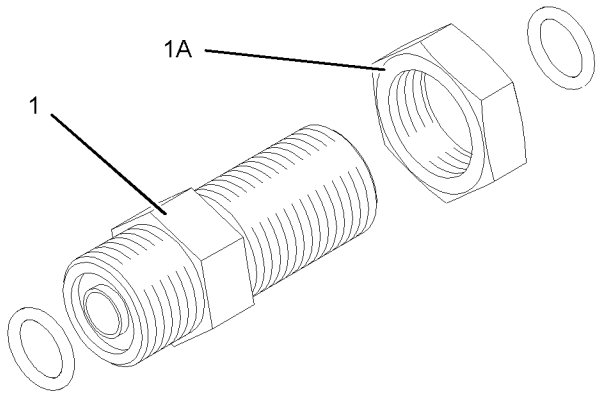


Illustration 21 g01848733

(1) Bulkhead connector
(1A) Bulkhead nut

Note: The bulkhead connector may have different connections. The type of fluid connection does not affect the torque for nut (1A).

Note: When you assemble the fluid connection, do not use the bulkhead nut (1A) as leverage for a backup wrench. Use the hex on the body (1) of the connector for leverage.

Table 17

Thread Size Inch	Torque for O-ring Face Bulkhead Nuts
9/16	45 ± 7 N·m (33 ± 5 lb ft)
11/16	80 ± 12 N·m (59 ± 9 lb ft)
13/16	110 ± 17 N·m (81 ± 12 lb ft)
1	130 ± 20 N·m (96 ± 15 lb ft)
1 3/16	180 ± 27 N·m (133 ± 20 lb ft)
1 7/16	350 ± 53 N·m (258 ± 39 lb ft)
1 11/16	420 ± 63 N·m (310 ± 46 lb ft)
2	500 ± 75 N·m (369 ± 55 lb ft)

Table 18

Thread Size Inch	Torque for 37 degree Flare Bulkhead Nuts
5/16	13 ± 2 N·m (115 ± 18 lb in)
3/8	17 ± 3 N·m (150 ± 27 lb in)
7/16	30 ± 5 N·m (266 ± 44 lb in)

(continued)

(Table 18, contd)

1/2	35 ± 5 N·m (26 ± 4 lb ft)
9/16	40 ± 6 N·m (30 ± 4 lb ft)
3/4	70 ± 11 N·m (52 ± 8 lb ft)
7/8	100 ± 15 N·m (74 ± 11 lb ft)
1 1/16	160 ± 24 N·m (118 ± 18 lb ft)
1 3/16	180 ± 27 N·m (132 ± 20 lb ft)
1 5/16	260 ± 39 N·m (192 ± 29 lb ft)
1 5/8	350 ± 53 N·m (258 ± 39 lb ft)
1 7/8	400 ± 60 N·m (295 ± 44 lb ft)
2 1/2	500 ± 75 N·m (369 ± 55 lb ft)

i08291838

Flare Fittings

SMCS Code: 7553

The torques in Table 19 are for 37 degree flare fittings. The torques in Table 20 are for 45 degree flare fittings and 45 degree inverted flare fittings.

Note: Certain swivel nut connections contain a dual seat that is intended to mate with either 37° or 45° connectors. For these connections, use the torque specified for the mating adapter.

37 Degree Flare Fittings

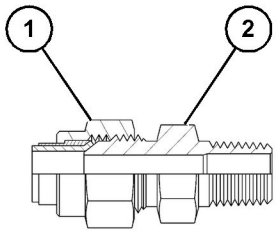


Illustration 22 g06615997

(1) 37 degree flare fitting
(2) Swivel nuts

Table 19

Nuts for 37 Degree Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16 - 24	10 ± 2 N·m (89 ± 18 lb in)
4.76 mm (0.188 inch)	3/8 - 24	13 ± 2 N·m (115 ± 18 lb in)
6.35 mm (0.250 inch)	7/16 - 20	20 ± 3 N·m (177 ± 27 lb in)
7.94 mm (0.312 inch)	1/2 - 20	25 ± 4 N·m (221 ± 35 lb in)
9.52 mm (0.375 inch)	9/16 - 18	30 ± 5 N·m (266 ± 44 lb in)
12.70 mm (0.500 inch)	3/4 - 16	60 ± 9 N·m (44 ± 7 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	90 ± 13 N·m (66 ± 10 lb ft)
19.05 mm (0.750 inch)	1 1/16 - 12	120 ± 18 N·m (89 ± 13 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	130 ± 20 N·m (96 ± 15 lb ft)
25.40 mm (1.000 inch)	1 5/16 - 12	160 ± 24 N·m (118 ± 18 lb ft)
31.75 mm (1.250 inch)	1 5/8 - 12	260 ± 39 N·m (192 ± 29 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	260 ± 39 N·m (192 ± 29 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	350 ± 53 N·m (258 ± 39 lb ft)

Note: Use 50 percent of the torque values from Table 19 when the fitting or the port material is nonferrous.

45 Degree Flare and Inverted Flare Fittings

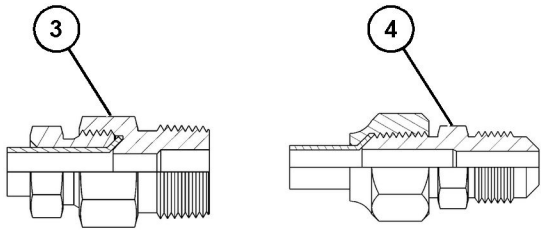


Illustration 23 g06616162

(3) Inverted Flare Fittings
(4) 45 Degree Flare Fittings

Table 20

45 Degree Flare Fittings and 45 Degree Inverted Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16	7 ± 1 N·m (62 ± 9 lb in)
4.76 mm (0.188 inch)	3/8	10 ± 2 N·m (89 ± 18 lb in)
6.35 mm (0.250 inch)	7/16	13 ± 2 N·m (115 ± 18 lb in)
7.94 mm (0.312 inch)	1/2	20 ± 3 N·m (177 ± 27 lb in)
9.52 mm (0.375 inch)	5/8	35 ± 5 N·m (26 ± 4 lb ft)
11.11 mm (0.438 inch)	11/16	35 ± 5 N·m (26 ± 4 lb ft)
12.70 mm (0.500 inch)	3/4	40 ± 6 N·m (30 ± 4 lb ft)
15.88 mm (0.625 inch)	7/8	55 ± 8 N·m (41 ± 6 lb ft)

(continued)

(Table 20, contd)

45 Degree Flare Fittings and 45 Degree Inverted Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
19.05 mm (0.750 inch)	1 1/16	100 ± 15 N·m (74 ± 11 lb ft)
22.22 mm (0.875 inch)	1 1/4	110 ± 17 N·m (81 ± 13 lb ft)

i08336184

Air Conditioning Fittings

SMCS Code: 7553

When making line connections, clean and lubricate all connectors and seals with Refrigerant Mineral Oil (special oil compatible with R-134a and R1234yf).

Note: Never use any other lubrication on seals or connectors.

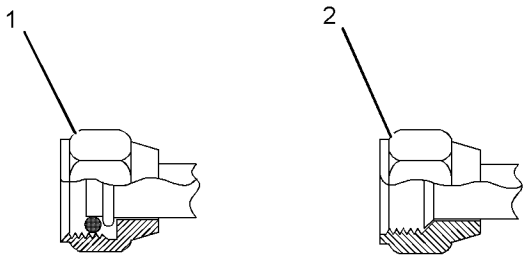


Illustration 24 g01848052

(1) O-ring seal
(2) 45 degree flare fitting

Table 21

Air Conditioning Fittings			
Thread Size Inch	**O-Ring Fitting End**	**45 Degree Flare Fitting End**	
	Torque	**Torque for Steel Tubes**	**Torque for Aluminum Tubes**
5/8	13 ± 2 N·m (115 ± 18 lb in)	30 ± 5 N·m (266 ± 44 lb in)	25 ± 4 N·m (221 ± 35 lb in)
3/4	25 ± 4 N·m (221 ± 35 lb in)	50 ± 8 N·m (37 ± 6 lb ft)	35 ± 5 N·m (26 ± 4 lb ft)

(continued)

(Table 21, contd)

Air Conditioning Fittings			
Thread Size Inch	**O-Ring Fitting End**	**45 Degree Flare Fitting End**	
	Torque	**Torque for Steel Tubes**	**Torque for Aluminum Tubes**
7/8 1	40 ± 6 N·m (30 ± 4 lb ft)	60 ± 9 N·m (44 ± 7 lb ft)	40 ± 6 N·m (30 ± 4 lb ft)
1 1/16	45 ± 7 N·m (33 ± 5 lb ft)	70 ± 11 N·m (51 ± 8 lb ft)	50 ± 8 N·m (37 ± 6 lb ft)

Table 22

Quick Disconnect Air Conditioning Fittings	
Thread Size Inch	**Torque**
7/8	45 ± 7 N·m (33 ± 5 lb ft)
1 1/4	60 ± 9 N·m (44 ± 7 lb ft)

i08390174

Air Brake Fittings

SMCS Code: 7553

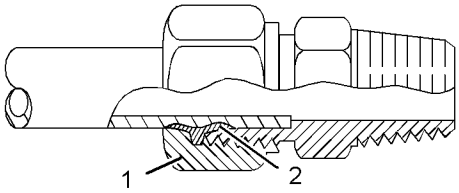


Illustration 25 g01848737

Put nut (1) and sleeve (2) over the tube. Push the tube into the counterbore of the fitting body as far as possible. There are two methods that may be used to tighten the nut. Tighten the nut with one of two methods.

- Tighten nut (1) to the torque that is specified in Table 23 .
- Tighten nut (1) by the number of turns that is specified in Table 23 . The number of turns is for the turns after the nut is finger tight.

Table 23

Nominal Outer Diameter of the Tube	Torque	Turn Tightening	
		Nonmetallic Tubing	Copper Tubing
6.35 mm (0.250 inch)	11 ± 3 N·m (97 ± 27 lb in)	3	2
9.53 mm (0.375 inch)	20 ± 3 N·m (175 ± 27 lb in)	4	2
12.70 mm (0.500 inch)	35 ± 6 N·m (26 ± 4 lb ft)	4	2
15.88 mm (0.625 inch)	40 ± 6 N·m (30 ± 4 lb ft)	3 1/2	3
19.05 mm (0.750 inch)	50 ± 6 N·m (37 ± 4 lb ft)	3 1/2	3

Note: Clean the connectors and the seals and lubricate the connectors and seals by using Refrigerant Mineral Oil. This is a special oil that is compatible with R−134a.

i08389282

Tapered Pipe Thread Fittings

SMCS Code: 7553

Torque is based on the diameter of the thread. The torque values are identical for coarse threads and fine threads.

Note: The following table has the recommended standard torque value for tapered pipe thread fitting for use on all Cat ® equipment. Use Table 24 as a general recommendation only. Actual values may vary due to variations in the material of the connector. Actual values may vary due to variations in the characteristics of the threads.

Table 24

Tapered Pipe Thread Fittings		
Diameter of the Pipe Thread (Inch)	Standard Torque	
	Assembly Turns after Hand Tight	Torque
1/16	2	10 ± 2 N·m (89 ± 18 lb in)
1/8	2	17 ± 3 N·m (150 ± 27 lb in)
1/4	2	25 ± 4 N·m (221 ± 35 lb in)
3/8	2	40 ± 6 N·m (30 ± 4 lb ft)
1/2	2	55 ± 8 N·m (41 ± 6 lb ft)
3/4	2	70 ± 11 N·m (52 ± 8 lb ft)
1	1 1/2	100 ± 15 N·m (74 ± 11 lb ft)
1 1/4	1 1/2	110 ± 17 N·m (81 ± 13 lb ft)
1 1/2	1 1/2	120 ± 18 N·m (89 ± 13 lb ft)
2	1 1/2	160 ± 24 N·m (118 ± 18 lb ft)

Note: Use 50 percent of the torque values from Table 24 when fitting, plug, or the port material is nonferrous.

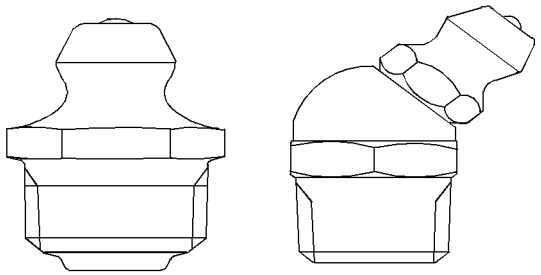


Illustration 26 g06015417

Table 25

Grease Fittings (Zerk Fittings)		
Diameter of the Pipe Thread (Inch)	**Assembly Turns after Hand Tight**	**Torque**
1/8–27 PTF Special Short	Torque Values Specified in Table 24	
1/8–27 NPTF		
1/4–28 SAE-LT	8.5 ± 1 N·m (75.23 ± 8.85 lb in)	6 N·m (53.11 lb in)

Note: Torque values listed above are recommended when assembling a steel fitting to a steel port. Other materials require additional validation.

1. Torque values for tapered external pipe threads (e. g., NPT, NPTF, BSPT) mated with NPSF or BSPP straight internal pipe threads shall use 50% of the value and tolerance shown in Table 24 . Values for NPSM connections are shown in Table 24 .

Note: “Turns After Hand Tight” method shall not be used for straight internal pipe threads.

2. Apply thread sealant to male tapered pipe threads, unless one of the following conditions exists:

- Connector is a lubrication (grease) connector.
- Connector is used in non water-cooled exhaust-related engine parts.
- On pipe threads which have pre-applied sealants.

Connector is mated with an NPSM swivel nut.

3. Hand-tighten swivel nut/connector to connector/ port.

4. Apply assembly torque by using the "Assembly Turns after Hand Tight" values or the "Dynamic Assembly Torque" values from Table 24 .

5. One clockwise rotation past the "Maximum Assembly Torque" is allowed for orientation.

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Miscellaneous Fittings

SMCS Code: 7553

Hi Duty Tube Fittings (Shear Sleeve)

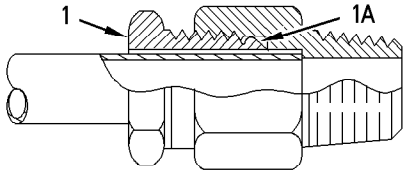


Illustration 27 g00909648

Put nut (1) over the tube and push the tube into the counterbore of the fitting body as far as possible. Turn the nut with a wrench until a small decrease in torque is felt. The small decrease in torque indicates that the sleeve (1A) has been broken off the nut. Hold the tube in order to prevent the tube from turning. Tighten the nut for an additional 1 1/2 turns.

SAE Flareless Fittings

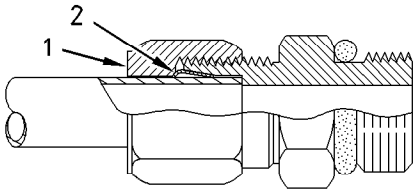


Illustration 28 g00909647

Installing a New Flareless Fitting

Put nut (1) and sleeve (2) over the tube. The head end of the sleeve should be next to the nut. The head end has a shoulder. The nut will be seated against this shoulder when the nut is tightened. Push the tube into the counterbore of the fitting body as far as possible. Turn nut (1) clockwise until the sleeve grips the tube. The sleeve must prevent all movement of the tube. Tighten the nut for an additional 1 1/4 turns. The sleeve should be seated and the sleeve should give a locking action.

Installing a Used Flareless Fitting

Less turns are required for a used fitting. Put nut (1) and sleeve (2) over the tube. The head of the sleeve should be next to the nut. Push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until a sudden increase in torque is felt. Next, tighten the fitting for an additional 1/6 to 1/3 turn in order to seat the sleeve.

Flex Fittings

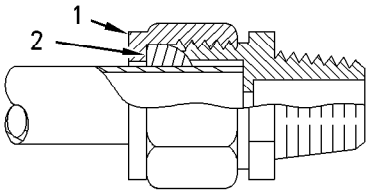


Illustration 29 g00909645

Put nut (1) and sleeve (2) over the tube and push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until the nut is against the hex part of the fitting body.

i08336068

Hose Clamps

SMCS Code: 7553

Worm Drive Band Type Clamps

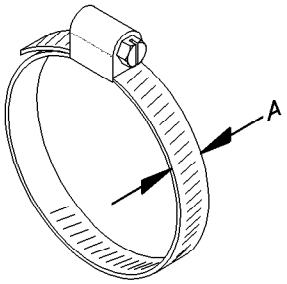


Illustration 30 g00910017

Table 26

Standard Worm Drive			
Width (A) of Clamp	**Torque for New Hose**	**Torque for Reused Hose(1)**	**Maximum Torque(2)**
8 mm (0.3 inch) or greater	1.4 ± 0.3 N·m (12 ± 3 lb in)	1.1 ± 0.3 N·m (10 ± 3 lb in)	2 N·m (18 lb in)
12 mm (0.5 inch) or greater	4.5 ± 0.7 N·m (40 ± 6 lb in)	3.0 ± 0.5 N·m (27 ± 4 lb in)	7 N·m (62 lb in)

(continued)

(Table 26, contd)

Standard Worm Drive			
Width (A) of Clamp	**Torque for New Hose**	**Torque for Reused Hose(1)**	**Maximum Torque(2)**
14 mm (0.55 inch) or greater	7.5 ± 1 N·m (66 ± 9 lb in)	4.5 ± 0.7 N·m (40 ± 6 lb in)	11 N·m (97 lb in)
16 mm (0.6 inch) or greater	11 ± 2 N·m (97 ± 18 lb in)	6.8 ± 1 N·m (60 ± 9 lb in)	14 N·m (124 lb in)

(1) Use this value when the hose is reused. The clamp may be new or reused.
(2) Exceeding this torque risks damage to the clamp and hose material

Table 27

Non- Perforated Band			
Width (A) of Clamp	**Torque for New Hose**	**Torque for Reused Hose(1)**	**Maximum Torque(2)**
SAE 8 through SAE 16	4 ± 0.7 N·m (35 ± 6 lb in)	3.0 ± 0.5 N·m (27 ± 4 lb in)	5 N·m (44 lb in)
SAE 20 through SAE 72	5 ± 1 N·m (44 ± 9 lb in)	4 ± 0.7 N·m (35 ± 6 lb in)	7 N·m (62 lb in)

(1) Use this value when the hose is reused. The clamp may be new or reused.
(2) Exceeding this torque risks damage to the clamp and hose material.

Constant Torque Hose Clamps

Use a constant torque hose clamp in place of any worm drive band type clamp. Ensure that the constant torque hose clamp is the same size as the worm drive band type clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause worm drive band type clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by worm drive band type clamps that have loosened. The constant torque hose clamp will help prevent these failures.

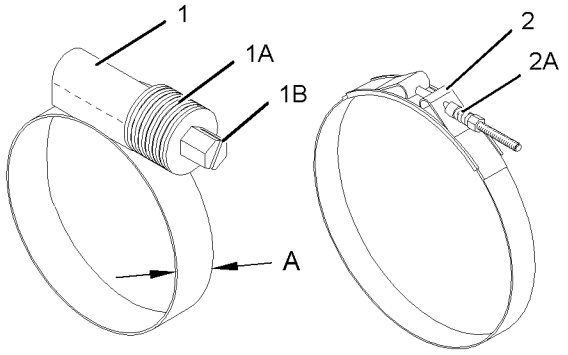


Illustration 31 g06631823

(1) Constant Torque Hose Clamp (Belleville Washer)
(2) Constant Torque Hose Clamp (Tee bolt and Spring)

Use a torque wrench for proper installation of all constant torque hose clamps. There are two types of constant torque hose clamps: Belleville washer (1) and Tee bolt and spring (2)

When the constant torque hose clamp (Belleville washer) (1) is assembled correctly, the Belleville washers (1A) are nearly collapsed flat. Refer to the following table for the correct torque.

Table 28

Constant Torque Hose Clamps			
Clamp Type	**Width (A) of Clamp**	**Standard Torque**	**Maximum Torque(1)**
Constant Torque Hose Clamp (Belleville Washer) (1)	14 mm (0.55 inch) or greater	7.5 ± 1 N·m (65 ± 10 lb in)	11 N·m (97 lb in)
	16 mm (0.6 inch) or greater	11 ± 1 N·m (95 ± 10 lb in)	14 N·m (124 lb in)
Constant Torque Hose Clamp (Tee bolt and Spring) (2)	14 mm (0.55 inch) or greater	5.6 ± 1 N·m (50 ± 9 lb in)	8 N·m (71 lb in)
	19 mm (0.75 inch) or greater	7.5 ± 1 N·m (66 ± 9 lb in)	11 N·m (97 lb in)

(1) Exceeding this torque risks damage to the clamp and hose material.

Wave Liner Clamps

The wave liner worm drive clamp is a clamp with a special liner. this liner has a "v grove" that causes greater pressure points on the hose. This greater compression will offer better sealing capability at the hose connection.

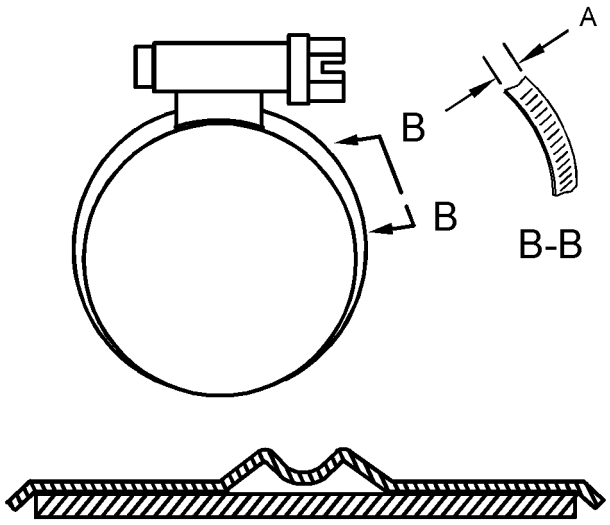


Illustration 32 g03869499

Table 29

Width (A) of Clamp	Torque for New Hose
14 mm (0.6 inch) or greater	7.5 ± 1 N·m (66.4 ± 8.9 lb in)

i06269737

Tie Rods

SMCS Code: 4318

Locking nuts used to orient rod assemblies shall be torqued according to the torque specifications in the chart below.

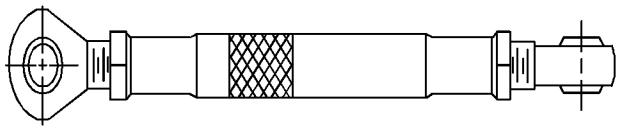


Illustration 33 g03876778

Table 30

Tie Rods		
Thread Size Metric	**Thread Size Inch**	**Dynamic Torque Values These Values Apply to the Jam Nuts on Swaged Tube Assemblies**
M5	No. 10 (.190)	4.5 ± 1 N·m (40 ± 9 lb in)
M6	1/4	6 ± 1 N·m (53 ± 9 lb in)
M8	5/16	7 ± 1 N·m (62 ± 9 lb in)
M10	3/8	10 ± 2 N·m (88.5 ± 17.7 lb in)
-	7/16	17 ± 3.4 N·m (150.5 ± 30.1 lb in)
M12	1/2	20 ± 4 N·m (177 ± 35 lb in)
M14	9/16	25 ± 5 N·m (221 ± 44 lb in)
M16	5/8	25 ± 5 N·m (221 ± 44 lb in)
M18	11/16	35 ± 7 N·m (25.8 ± 5.2 lb ft)
	3/4	35 ± 7 N·m (25.8 ± 5.2 lb ft)
M20	13/16	40 ± 8 N·m (29.5 ± 5.9 lb ft)
M22	7/8	45 ± 9 N·m (33.2 ± 6.6 lb ft)
M24	1	60 ± 12 N·m (44.3 ± 8.9 lb ft)
M27	1 1/16	40 ± 14 N·m (29.5 ± 10.3 lb ft)
M30	1 3/16	80 ± 16 N·m (59.0 ± 11.8 lb ft)
M33	1 5/16	110 ± 22 N·m (81.1 ± 16.2 lb ft)
M36	1-7/16	120 ± 24 N·m (88.5 ± 17.7 lb ft)

(continued)

(Table 30, contd)

M40	1 5/8	140 ± 28 N·m (103.3 ± 20.7 lb ft)
M42	1-11/16	160 ± 32 N·m (118.0 ± 23.6 lb ft)
M48	1 7/8	180 ± 36 N·m (132.8 ± 26.6 lb ft)
M50	2	200 ± 40 N·m (147.5 ± 29.5 lb ft)
M64	2 1/2	220 ± 44 N·m (162.3 ± 32.5 lb ft)

i06269753

Cable

SMCS Code: 5154

To prevent undesired assembly twisting use two wrenches. Use one wrench as a torque wrench and the other wrench as a backup wrench. Using two wrenches, hold the assembly in the desired position to prevent assembly movement and tighten the locknut suing the values from the figure below.

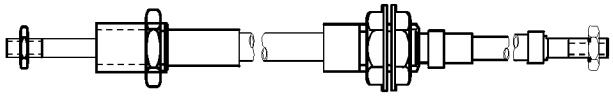


Illustration 34 g03876780

Table 31

Cable		
Thread Size Metric	**Thread Size Inch**	**Standard Torque Use 50% if the Torque Values Listed When the Hub Fitting is Nonferrous**
M5x0.8	10-32	4.5 ± 1 N·m (39.8 ± 8.9 lb in)
M6x1	1/4-28	6 ± 1 N·m (53.1 ± 8.9 lb in)
M8x1.25	5/16-24	7 ± 1.4 N·m (62 ± 12.4 lb in)
M10x1.5	3/8-24	10 ± 2 N·m (88.5 ± 17.7 lb in)
	7/16-20 or 7/16-28	17 ± 3 N·m (150.5 ± 26.6 lb in)
M12x1.75	1/2-20	18 ± 3 N·m (159.3 ± 26.6 lb in)

(continued)

(Table 31, contd)

M14x2	9/16-12 or 9/16-18	27 ± 3 N·m (239.0 ± 26.6 lb in)
M16x2	5/8-18	27 ± 3 N·m (239.0 ± 26.6 lb in)
M18x1.5	11/16-16	35 ± 5 N·m (25.8 ± 3.7 lb ft)
	3/4-16	35 ± 5 N·m (25.8 ± 3.7 lb ft)
M20x2.5	13/16-16	40 ± 5 N·m (29.5 ± 3.7 lb ft)
M22x2.5	7/8-14 or 7/8-20	45 ± 5 N·m (33.2 ± 3.7 lb ft)
M24x3	1-14	60 ± 6 N·m (44.3 ± 4.4 lb ft)

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SENR9936-25 (en-us)
July 2019

Specifications

C27 and C32 Engines for Caterpillar Built Machines

E9Z 1-UP (Machine)
JRP 1-UP (Machine)
EED 1-UP (Machine)
DLS 1-UP (Machine)
BTW 1-UP (Machine)
221 1-UP (Machine)
JNW 1-UP (Machine)
EXD 1-UP (Machine)
JXP 1-UP (Machine)
EYG 1-UP (Machine)
DR2 1-UP (Machine)
DR4 1-UP (Machine)
DS7 1-UP (Machine)
DS6 1-UP (Machine)
DT6 1-UP (Machine)
DT7 1-UP (Machine)
DT4 1-UP (Machine)
DT9 1-UP (Machine)
DS9 1-UP (Machine)
DN2 1-UP (Machine)
DN3 1-UP (Machine)
DN6 1-UP (Machine)
DW9 1-UP (Machine)
DLK 1-UP (Machine)
DN7 1-UP (Machine)
KNW 1-UP (Machine)
NNW 1-UP (Machine)
KDP 1-UP (Machine)
KDZ 1-UP (Machine)
RJG 1-UP (Machine)
BWX 1-UP (Machine)
GEB 1-UP (Machine)
TPB 1-UP (Machine)
530 1-UP (Machine)
LWA 1-UP (Machine)
Z9K 1-UP (Machine)
H4C 1-UP (Machine)
RAB 1-UP (Machine)
DHL 1-UP (Machine)
DHJ 1-UP (Machine)
DHG 1-UP (Machine)
DHX 1-UP (Machine)
FKD 1-UP (Machine)
WSN 1-UP (Machine)
PZE 1-UP (Machine)
HLD 1-UP (Machine)
PWW 1-UP (Machine)
ZEN 1-UP (Machine)
HSE 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Specifications Section

i04403763

Fuel Transfer Pump

SMCS Code: 1256

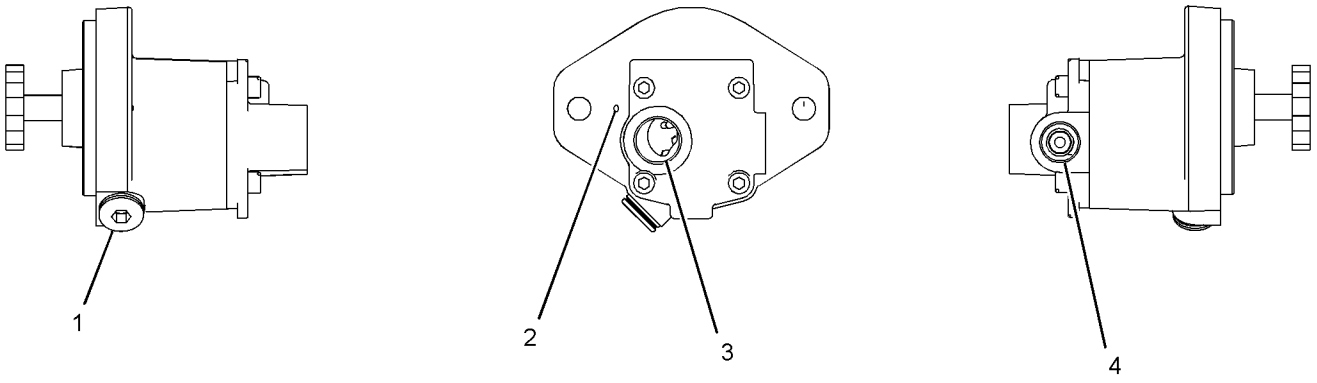


Illustration 1 g02592116

(1) Pressure regulating valve
(2) Weep hole
(3) Inlet port
(4) Outlet port

Table 1

Specification for 286-2531 Fuel Transfer Pump Gp			
Item	**Qty**	**Part**	**Specification Description**
-	-	-	When the fuel transfer pump is using diesel fuel, the fuel transfer pump has the following specifications:
			Run the pump at 2940 rpm. The full bypass pressure should be 716 to 786 kPa (104 to 114 psi).
			Run the pump at 840 rpm. The flow at 550 kPa (80 psi) must be 6.0 L/min (1.6 US gpm).
			Run the pump at 2940 rpm. The flow at 650 kPa (94 psi) must be 9.0 L/min (2.38 US gpm).
			Run the pump at 120 rpm. Keep the inlet open to the atmosphere for 10 seconds. Block the inlet. The pump must maintain the vacuum of 30.0 kPa (4.5 psi) minimum in 30 seconds.
			Run the pump at 840 rpm. Keep the inlet open to the atmosphere for 10 seconds. Block the inlet. The pump must maintain the vacuum of 45.0 kPa (6.5 psi) minimum in 30 seconds.
			Run the pump at 120 rpm with a blocked inlet for 30 seconds. The pump inlet must have a suction lift of 60.9 kPa (9.0. psi) minimum.

i05870122

Fuel Transfer Pump

SMCS Code: 1256

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 394-1398
S/N: E9Z1–Up

S/N: KDZ1–Up

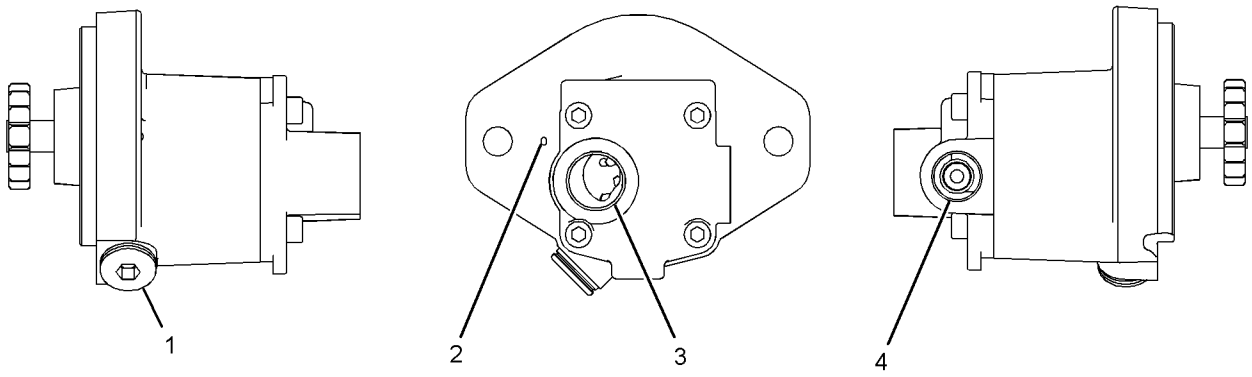


Illustration 2 g03703963

(1) Pressure regulating valve
(2) Weep hole
(3) Inlet port
(4) Outlet port

Table 2

Specification for 394 - 1398 Fuel Transfer Pump Gp			
Item	**Qty**	**Part**	**Specification Description**
-	-	-	When the fuel transfer pump is using diesel fuel, the fuel transfer pump has the following specifications:
			Run the pump at 2940 rpm. The full bypass pressure should be 895 to 1000 kPa (130 to 145 psi).
			Run the pump at 840 rpm. The flow at 550 kPa (80 psi) must be 6.0 L/min (1.6 US gpm) minimum.
			Run the pump at 2940 rpm. The flow at 815 kPa (118 psi) must be 9.00 L/min (2.38 US gpm) minimum.
			Run the pump at 120 rpm. Keep the inlet open to the atmosphere for 10 seconds. Block the inlet. The pump must maintain the vacuum of 30 kPa (4.5 psi) minimum in 30 seconds.
			Run the pump at 840 rpm. Keep the inlet open to the atmosphere for 10 seconds. Block the inlet. The pump must maintain the vacuum of 45.0 kPa (6.5 psi) minimum in 30 seconds.
			Run the pump at 120 rpm with a blocked inlet for 30 seconds. The pump inlet must have a suction lift of 60.9 kPa (9.0 psi) minimum.
			Run the pump at 140 rpm. The flow at 100 kPa (14.5 psi) must be 0.82 L/min (0.22 US gpm) minimum.

i02864490

Fuel Filter Base

SMCS Code: 1261; 1262

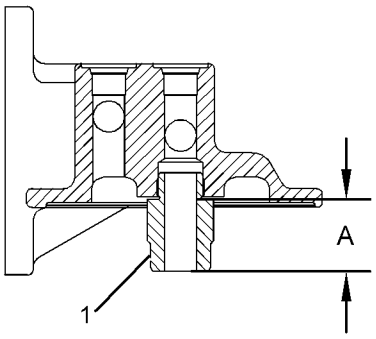


Illustration 3 g01426884

(A) Length for applying 154-9731 Thread Lock Compound to the threads on the taperlock end of the stud . . . . . 39.5 ± 0.5 mm ((1.56 ± 0.02 inch))

(1) Torque for the stud . . . 70 ± 15 N·m ((50 ± 11 lb ft))

i04405525

Fuel Filter Base

SMCS Code: 1261; 1262

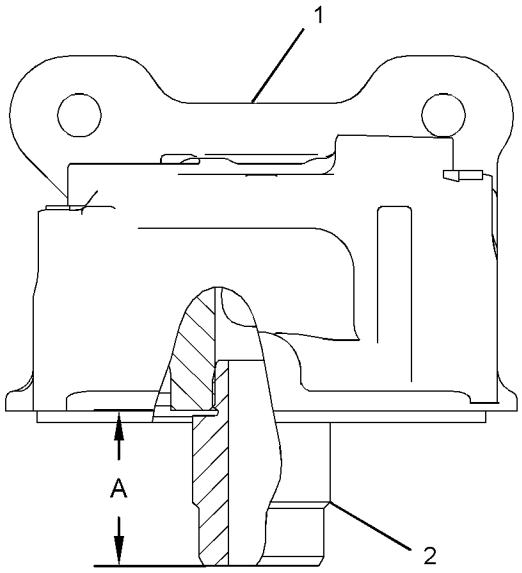


Illustration 4 g02599076

(1) Base

Table 3

Specifications for 237 - 9307 Fuel Filter Base As			
Item	**Qty**	**Part**	**Specification Description**
A	-	-	Dimension from the surface of the base to the end of the hollow stud is 39.5 ± 1.0 mm (1.56 ± 0.04 inch).
2	1	237 - 9323 Stud	Before assembly, apply red Loctite 271 to the threads on the tapered end of the stud.
			Torque to 70 ± 15 N·m (52 ± 11 lb ft).

i06167016

Fuel Filter Base
(Electric Fuel Priming Pump)

SMCS Code: 1261; 1262

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 217-7455
S/N: E9Z1–Up

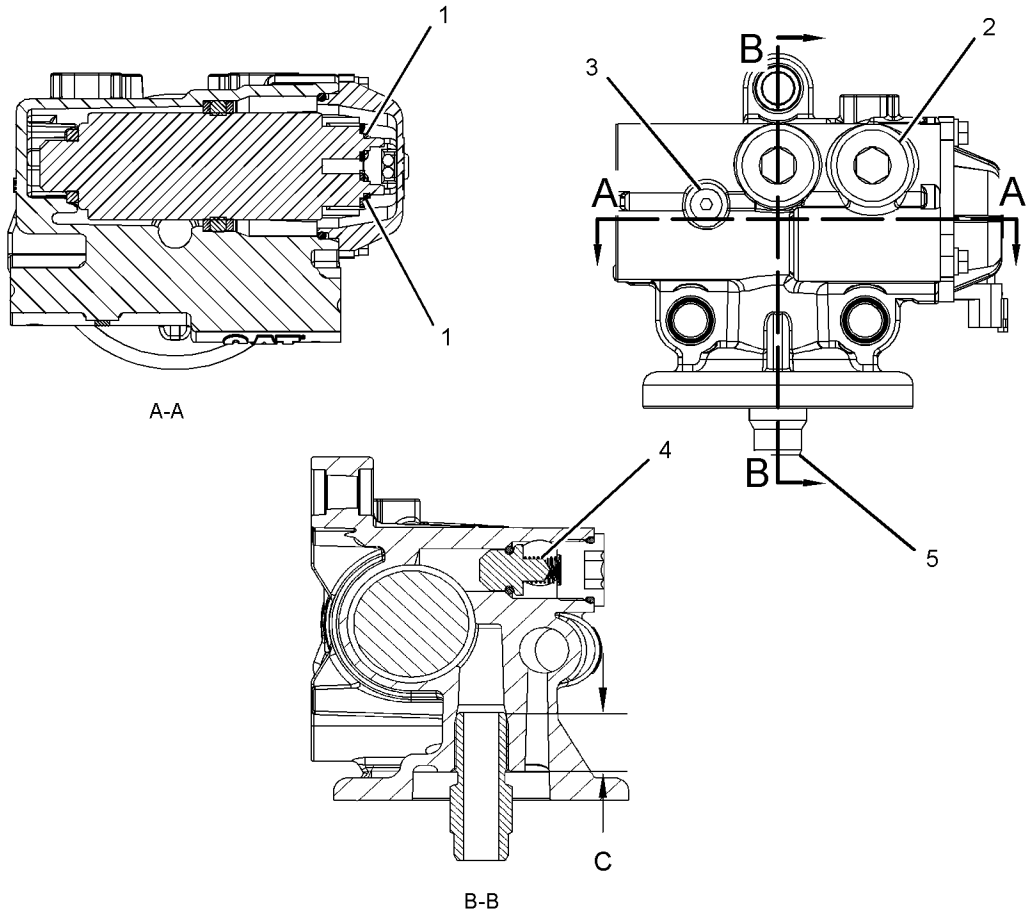


Illustration 5 g03834750

Table 4

Specifications for 217-7455 Fuel Filter Base			
Item	**Qty**	**Part**	**Specification Description**
1	2	6D-5801 Locknut	Torque to 1.7 ± 0.4 N·m (15.0 ± 3.5 lb in).
2	2	179-7267 Plug	Torque to 95 ± 10 N·m (70 ± 7 lb ft).

(continued)

(Table 4, contd)

Specifications for 217-7455 Fuel Filter Base			
Item	**Qty**	**Part**	**Specification Description**
3	1	9S-8002 Plug	Torque to 11 ± 2 N·m (97 ± 18 lb in).
4	1	162-2222 Spring	Length under test force is 20.21 mm (0.796 inch). Test force is 1.01 ± 0.05 N (0.23 ± 0.01 lb). Free length after test is 31.75 mm (1.250 inch).
5	1	170-5146 Hollow Stud	Apply red Loctite 263 to the threads to the length (C) of 26.0 ± 0.5 mm (1.02 ± 0.02 inch). Torque to 70 ± 15 N·m (52 ± 11 lb ft).

i06991056

Fuel Filter Base

SMCS Code: 1261; 1262

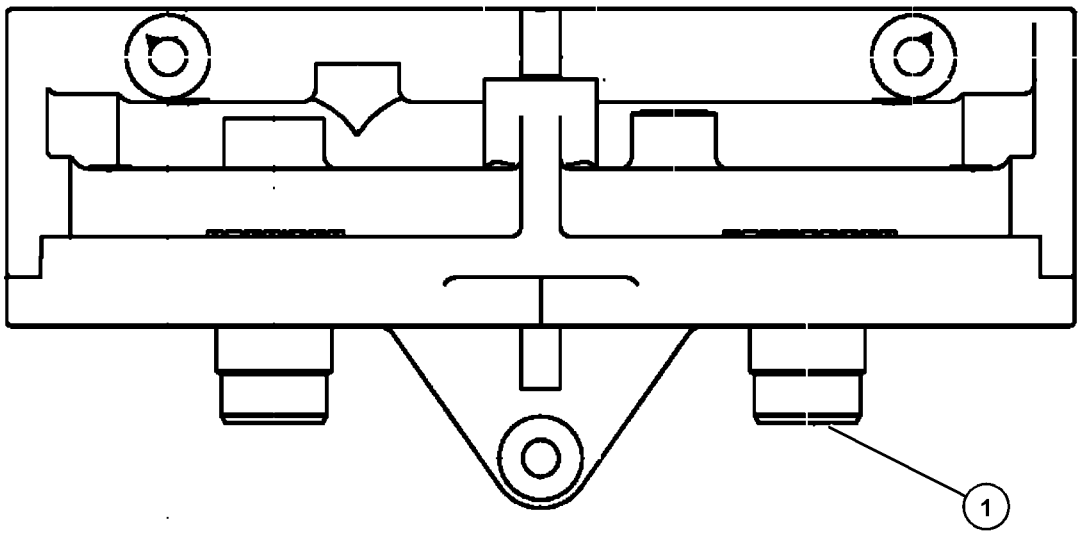


Illustration 6 g06190630

Table 5

Item	Qty	Part	Specification Description
1	2	8N-3653 Taperlock Stud	Before assembly, apply red Loctite 263 to the threads. Torque to 70 ± 15 N·m (52 ± 11 lb ft).

i07201503

Fuel Filter Base

SMCS Code: 1261; 1262

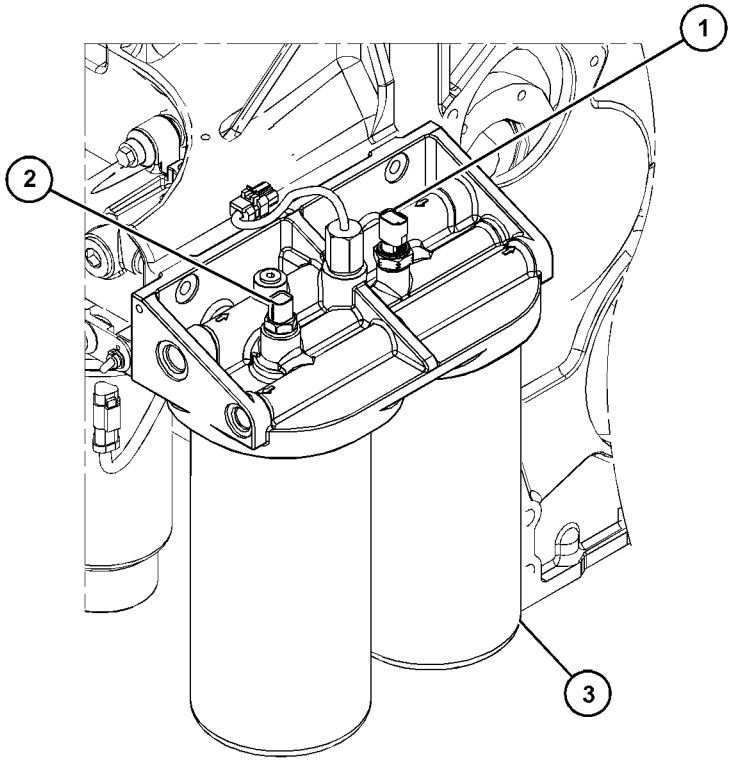


Illustration 7 g06219669

Table 6

Item	Qty	Part	Specification Description
-	-	Before assembly, ensure that all the openings are covered and clean. Also, remove coverings at applicable time.	
1	1	325-8634 Pressure Sensor Gp	Torque to 10 ± 2 N.m (89 ± 18 lb in).
2	1	234-5013 Temperature Sensor Gp	Torque to 20 ± 3 N·m (177 ± 27 lb in).
3	2	422-7587 Fuel Filter	Lubricate seal and bore lightly with the lubricant that is being sealed. Torque to 74 ± 7 N·m (55 ± 5 lb ft).

i07318232

Fuel Filter Base

SMCS Code: 1261; 1262

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 321-1326
S/N: E9Z1–Up

S/N: KDZ1–Up

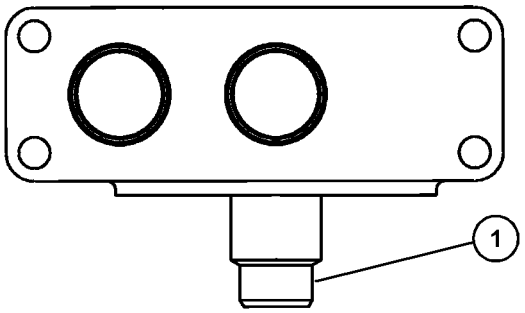


Illustration 8 g06186213

Table 7

Item	Qty	Part	Specification Description
1	1	323-2268 Hollow Stud	Before assembly, apply red Loctite 263 to the tapered end of the hollow stud for the length of 10.0 ± 1.5 mm (0.39 ± 0.06 inch). Torque to 68 ± 7 N·m (50 ± 5 lb ft).

i07397506

Fuel Filter Base

SMCS Code: 1261; 1262

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 344-5583
S/N: E9Z1–Up

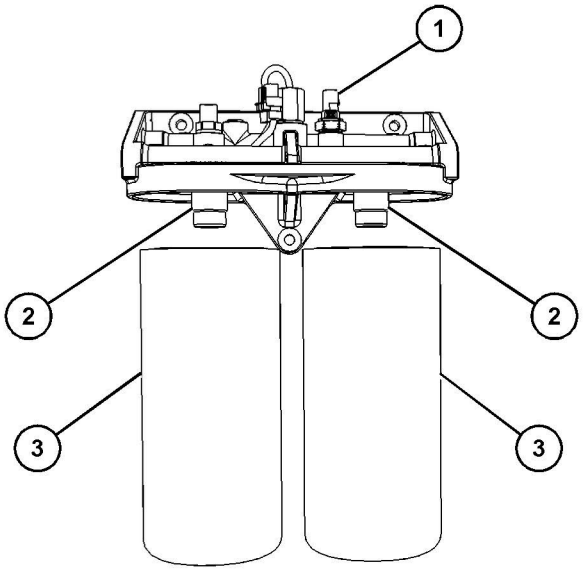


Illustration 9 g06309046

Table 8

Item	Qty	Part	Specification Description
1	1	325-8634 Pressure Sensor Gp	Torque to 10 ± 2 N·m (89 ± 18 lb in).
2	2	8N-3653 Taperlock Stud	Before assembly, apply red Loctite 271 on the tapered end of the taperlock stud to a length of 9.6 ± 0.8 mm (0.38 ± 0.03 inch). Torque to 70 ± 15 N·m (52 ± 11 lb ft).
3	2	1R-0755 Fuel Filter	Before assembly, lightly lubricate the seal of the fuel filter and the bore of the fuel filter base with the lubricant that is being sealed. Torque to 74 ± 7 N·m (55 ± 5 lb ft).

i04403749

Electronic Unit Injector Mechanism

SMCS Code: 1290

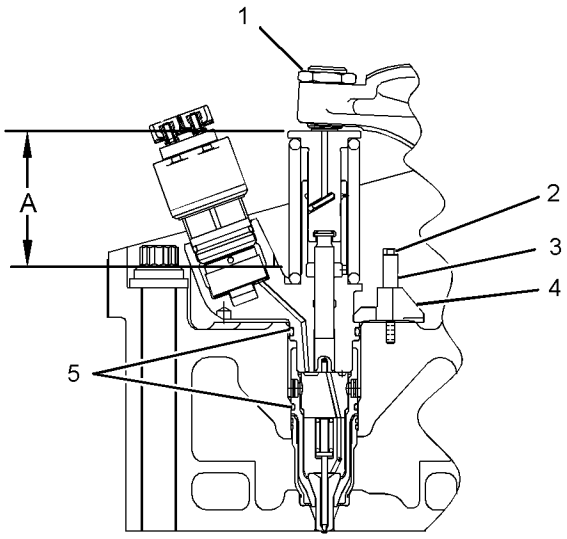


Illustration 10 g02557382

(3) Spacer (4) Unit injector clamp

Table 9

Specification for the 190-0009 Fuel Pump and Valve Mechanism, 148-7482 Fuel Pump and Valve Mechanism, 128-8510 Fuel Injector Gp, 130-9701 Fuel Injection Pump Gp, 153-2875 Fuel Injector Gp, 235-1401 Fuel Injection Pump Gp, 297-1027 Fuel Injection Pump Gp, 252-5786 Fuel Injection Pump Gp, 253-8352 Fuel Injection Pump Gp, 261-0048 Fuel Injection Pump Gp and 235-1402 Fuel Injection Pump Gp			
Item	**Qty**	**Part**	**Specification Description**
Before installation of the unit injector, lubricate the O-ring seals (5) with a 50/50 mixture of clean engine oil and 8T-2998 Lubricant.			
1	1	-	Torque the locknut to 100 ± 10 N·m (74 ± 7 lb ft).
2	1	-	Use the following procedure to tighten the bolt:
			1. Tighten the bolt to 55 ± 10 N·m (41 ± 7 lb ft).
			2. Loosen the bolt until the bolt is finger tight.
			3. Again, tighten the bolt to 55 ± 10 N·m (41 ± 7 lb ft).
A	-	-	Adjust the unit injector height to 78.0 ± 0.2 mm (3.07 ± 0.01 inch).

i06111998

Electronic Unit Injector Mechanism

SMCS Code: 1290

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 255-8001
S/N: E9Z1–Up

S/N: KDZ1–Up

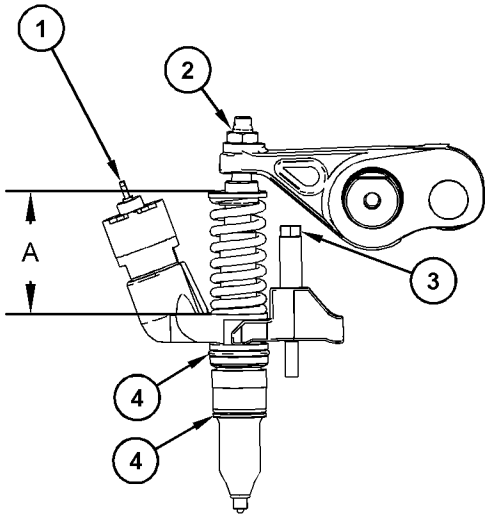


Illustration 11 g03349377

Table 10

Specification for 260-9631 Fuel Pump and Valve Mechanism and 255-8001 Fuel Pump and Valve Mechanism			
Item	**Qty**	**Part**	**Specification Description**
1	1	-	Tighten the cap nut to 2.50 ± 0.25 N·m (22.13 ± 2.21 lb in).
2	1	-	Tighten the locknut to 100 ± 10 N·m (74 ± 7 lb ft).
3	1	-	Use the following procedure in order to tighten the bolt: 1. Tighten the bolt to 55 ± 10 N·m (41 ± 7 lb ft). 2. Loosen the bolt until the bolt is finger tight. 3. Again, tighten the bolt to 55 ± 10 N·m (41 ± 7 lb ft).

i05389132

Electronic Unit Injector Rocker Arm

SMCS Code: 1123

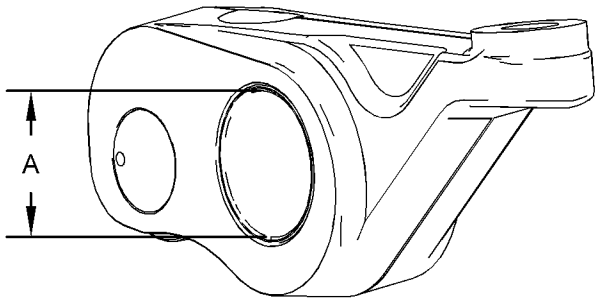


Illustration 12 g03407477

Typical example

Table 11

Specification for 278-1365 Rocker Arm As, 243-2465 Rocker Arm, and 278-1363 Rocker Arm As			
Item	**Qty**	**Part**	**Specification Description**
A	-	207-9576 Bushing	Bushing must not extend beyond either face of the rocker arm.
			Bore of the new bushing after installation is 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch).

i07582829

Electronic Unit Injector Wiring

SMCS Code: 1290

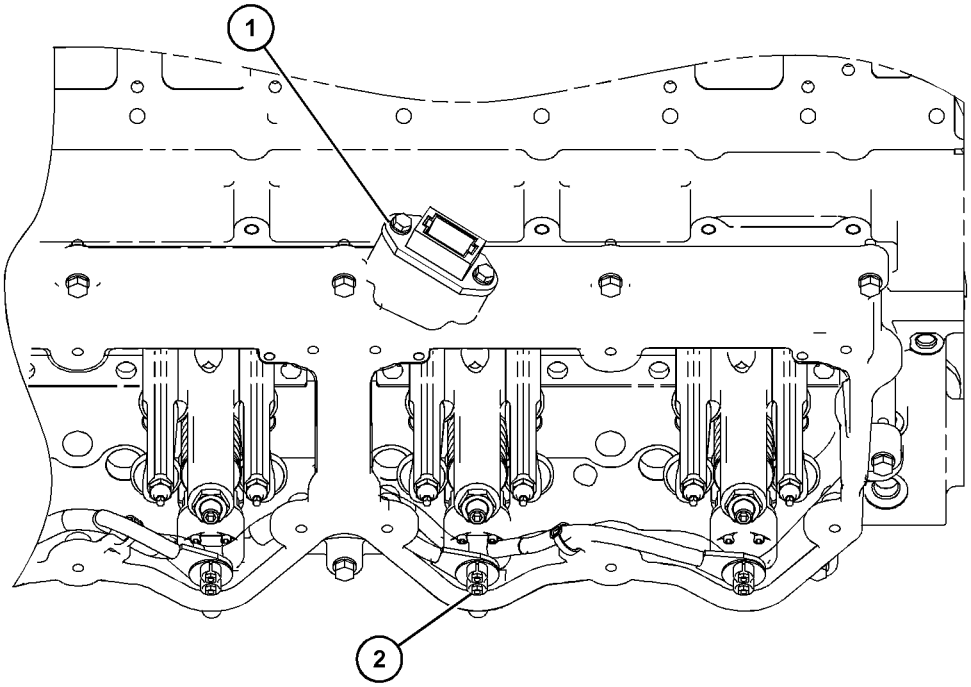


Illustration 13 g06370289

Typical example

Table 12

Item	Qty	Part	Specification Description
1	1	6V-0128 Connector Seal	Install the flat part of the connector seal against the connector surface.
			The curved part of the seal must be installed so that the seal is against the valve mechanism cover base.
2	12	7E-6508 Cap As	Orient connectors so wires are not contacting metal surfaces.
			Torque to 2.5 ± 0.25 N·m (22 ± 2 lb in).

i04955711

Valve Mechanism

SMCS Code: 1102

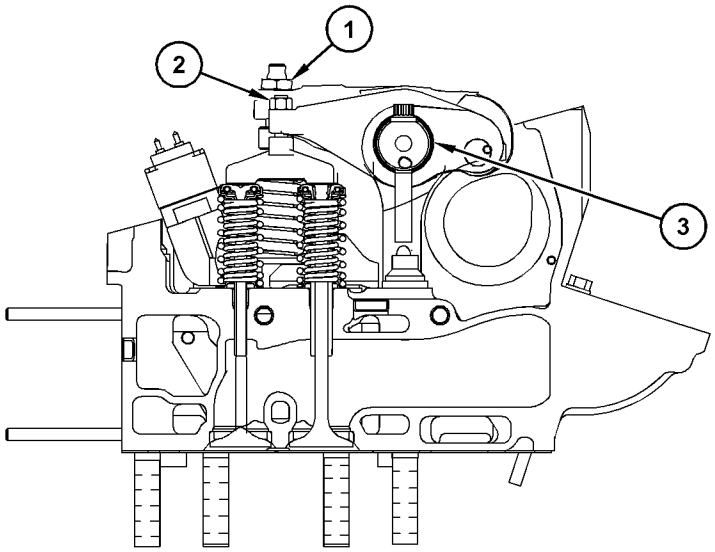


Illustration 14 g03141143

Table 13

Specification for 255-8001 Fuel Pump and Valve Mechanism and 417-0080 Fuel Pump and Valve Mechanism			
Item	**Qty**	**Part**	**Specification Description**
1	-	-	Tighten the unit injector rocker arm locknut to 100 ± 10 N·m (74 ± 7 lb ft).
2	-	-	Tighten the valve rocker arm locknut to 30 ± 7 N·m (266 ± 62 lb in).
3	1	313-4085 Rocker Shaft Assembly	Diameter of a new rocker shaft is 40.000 ± 0.010 mm (1.5748 ± 0.0004 inch).
			After installation, bore in the injector rocker arm bushing for rocker shaft is 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch).
			Bore in the valve rocker arm for rocker shaft is 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch).
-	-	-	Inlet valve lash setting is 0.38 ± 0.08 mm (0.015 ± 0.003 inch). Exhaust valve lash setting is 0.76 ± 0.08 mm (0.030 ± 0.003 inch).

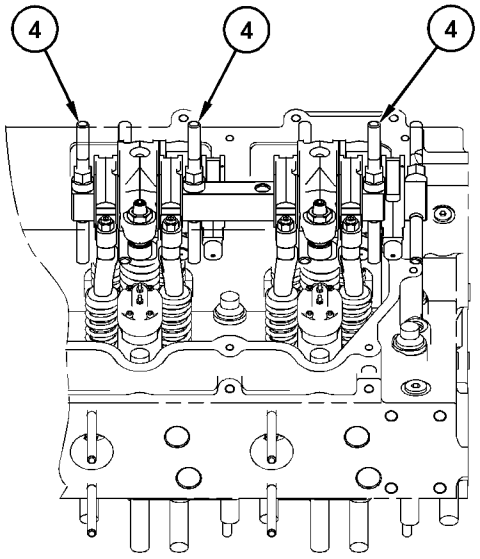


Illustration 15 g03141145

Left side view of engine

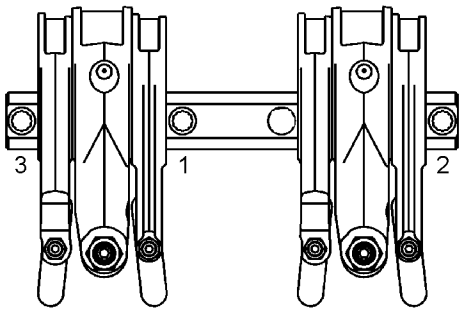


Illustration 16 g03141146

Tightening sequence

Table 14

Item	Qty	Part	Specification Description
4	18	304-9553 Stud	Use the following procedure in order to tighten the stud for the rocker arm: Before assembly, apply black 4C-5592 Anti-Seize Compound to the threads and the under head of studs. Refer Illustration 16 for stud tightening sequence. 1. Tighten the studs in a numerical sequence to 55 ± 5 N·m (41 ± 4 lb ft). 2. Retighten the studs in a numerical sequence to 55 ± 5 N·m (41 ± 4 lb ft). 3. Again, tighten all the studs to an additional angle in the numerical sequence to 60 ± 5 degrees.

i07582811

Valve Mechanism

SMCS Code: 1102

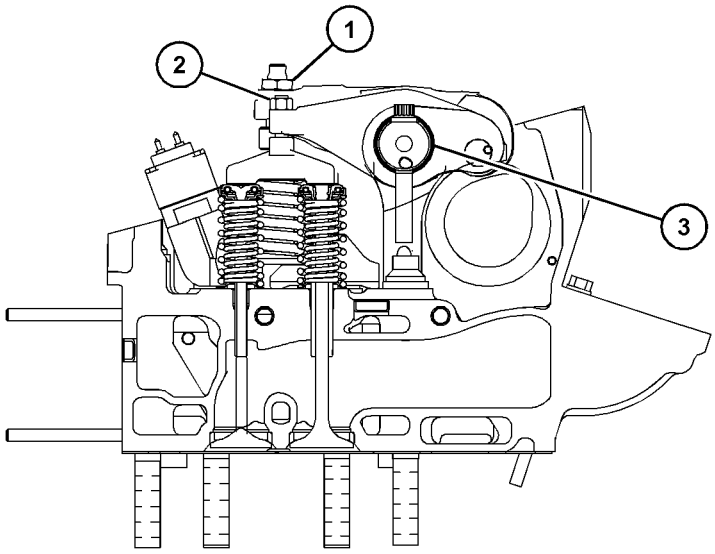


Illustration 17 g06253158
Typical example

Table 15

Item	Qty	Part	Specification Description
1	-	-	Tighten the unit injector rocker arm locknut to 100 ± 10 N·m (74 ± 7 lb ft).
2	-	-	Tighten the valve rocker arm locknut to 30 ± 7 N·m (266 ± 62 lb in).
3	1	313-4085 Rocker Shaft Assembly	Diameter of a new rocker shaft is 40.000 ± 0.010 mm (1.5748 ± 0.0004 inch).
			After installation, bore in the rocker arm bushing for rocker shaft is 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch).
			Bore in the valve rocker arm for rocker shaft is 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch).
-	-	-	Inlet valve lash setting is 0.38 ± 0.08 mm (0.015 ± 0.003 inch). Exhaust valve lash setting is 0.76 ± 0.08 mm (0.030 ± 0.003 inch).

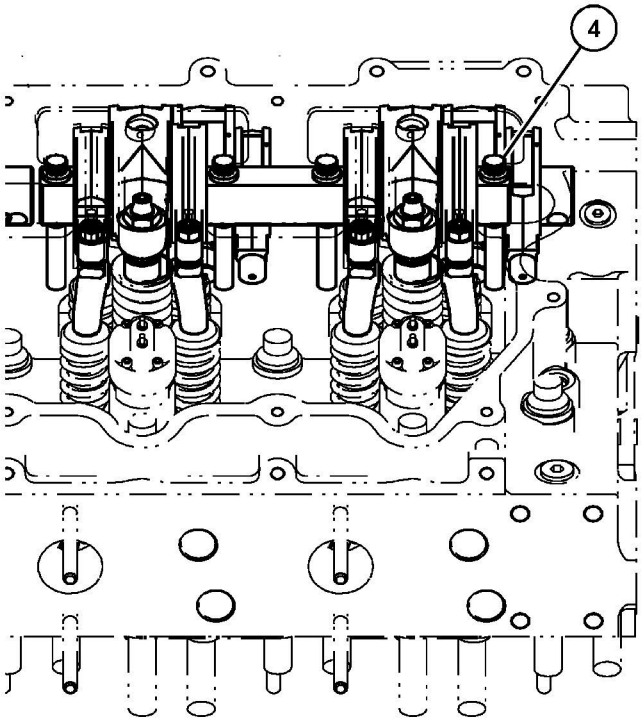


Illustration 18 g06253165

Typical example

Left side view of engine

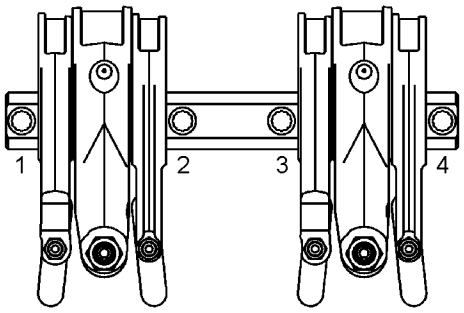


Illustration 19 g03141256

Typical example

Tightening sequence

Table 16

Item	Qty	Part	Specification Description
4	24	356-5212 Bolt	Use the following procedure to tighten the bolts for the rocker arm: Before assembly, lubricate the threads and shaft to bolt interface with clean engine oil. 1. Tighten the bolts in 2, 3, 1, 4 sequence to 55 ± 5 N·m (41 ± 4 lb ft). 2. Retighten the bolts in 2, 3, 1, 4 sequence to 55 ± 5 N·m (41 ± 4 lb ft). 3. Again, tighten the bolts in 2, 3, 1, 4 sequence to an additional angle of 60 ± 5 degrees.

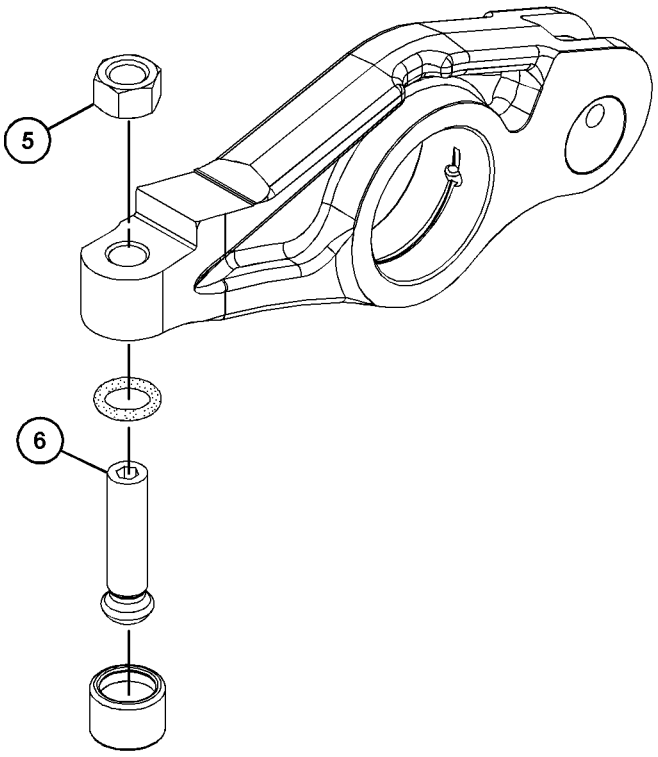


Illustration 20 g06248453

437-3877 Rocker Arm

Table 17

Item	Qty	Part	Specification Description
5	1	3S-2713 Full Nut	Hold the Arm adjustment screw in position and tighten the locknut to 6 ± 3 N.m (53 ± 27 lb in).
6	1	274-4491 Arm Adjustment Screw	Free running torque of Arm adjustment screw must not exceed 0.4 N.m (3.5 lb in).

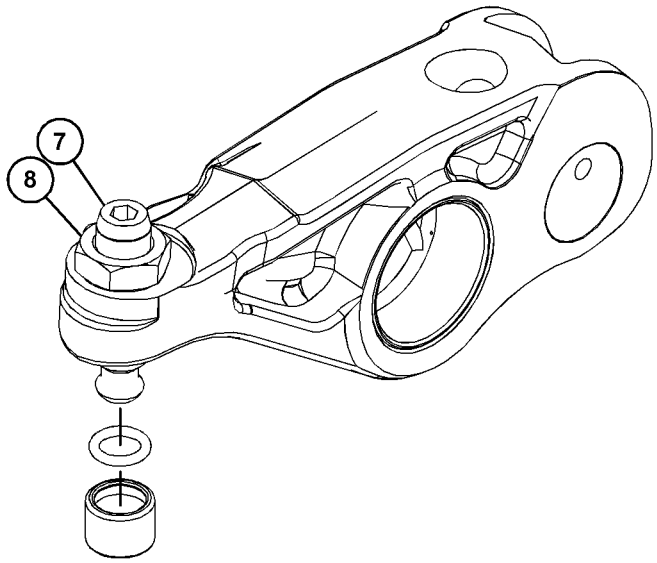


Illustration 21 g06248456

Typical example

Table 18

Item	Qty	Part	Specification Description
7	1	274-4492 Arm Adjustment Screw	Free running torque of Arm adjustment screw must not exceed 0.4 N.m (3.5 lb in).
8	1	196-5070 Jam Nut	Hold the Arm adjustment screw in position and tighten the nut to 6 ± 3 N.m (53 ± 27 lb in).

i04958317

Cylinder Head Valves

SMCS Code: 1105

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 339-3585
S/N: E9Z1–Up

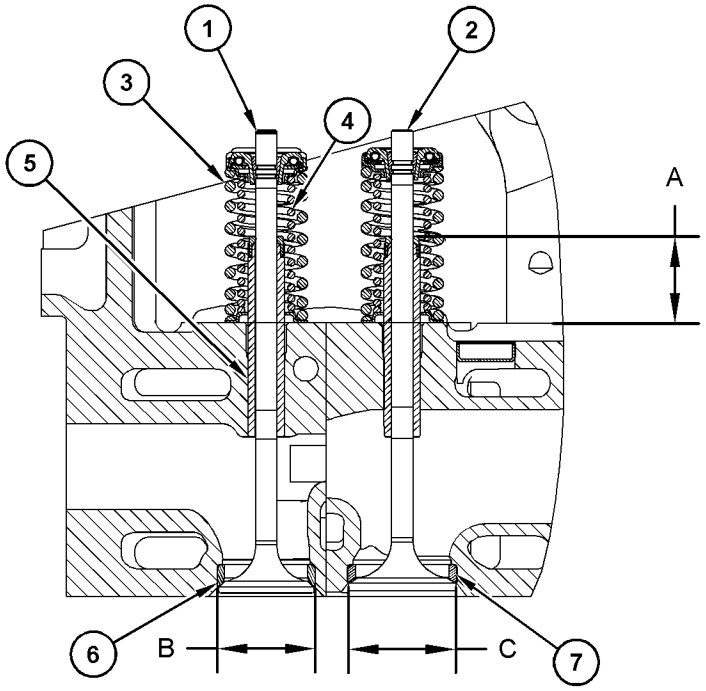


Illustration 22 g03143316

Table 19

Specification for 339-3585 Cylinder Head Gp			
Item	**Qty**	**Part**	**Specification Description**
1	12	153-7024 Exhaust Valve	Stem diameter is 9.441 ± 0.010 mm (0.3717 ± 0.0004 inch). Valve head diameter (B) is 41.81 ± 0.13 mm (1.646 ± 0.005 inch). Face angle is 45.75 ± 0.25 degrees.
2	12	236-5605 Inlet Valve	Stem diameter is 9.441 ± 0.010 mm (0.3717 ± 0.0004 inch). Valve head diameter (C) is 47.00 ± 0.13 mm (1.850 ± 0.005 inch). Face angle is 60.75 ± 0.25 degrees.
3	24	247-9908 Springs	Length under test force is 67.12 mm (2.643 inch). Test force is 320 ± 25 N (72 ± 6 lb). Approximate free length after test is 76.70 mm (3.020 inch).

(continued)

(Table 19, contd)

4	24	211-3122 Springs	Length under test force is 60.14 mm (2.368 inch). Test force is 150 ± 12 N (34 ± 3 lb). Approximate free length after test is 71.70 mm (2.823 inch).
A	-	-	Height from the cylinder surface to top of the valve guide is 35.0 ± 0.5 mm (1.38 ± 0.02 inch).
5	24	122-7375 Valve Guide	Lubricate inner diameter of valve guides with 1E1867B clean engine oil immediately prior to valve installation in the cylinder. Before installation, bore in the valve guide for inlet valve and exhaust valve is 9.502 ± 0.013 mm (0.3741 ± 0.0005 inch).
6	12	226-5561 Valve Seat Insert	Face angle is 45.25 ± 0.25 degrees. Outside diameter is 42.840 ± 0.013 mm (1.6866 ± 0.0005 inch). Depth of the bore in the cylinder head is 13.90 ± 0.05 mm (0.547 ± 0.002 inch). Bore in the cylinder head is 42.774 ± 0.025 mm (1.6840 ± 0.0010 inch).
7	12	280-3979 Valve Seat Insert	Face angle is 30.25 ± 0.25 degrees. Outside diameter is 48.025 ± 0.013 mm (1.8907 ± 0.0005 inch). Depth of the bore in the cylinder head is 14.00 ± 0.05 mm (0.551 ± 0.002 inch). Bore in the cylinder head is 47.950 ± 0.025 mm (1.8878 ± 0.0010 inch).

i07142399

Cylinder Head Valves

SMCS Code: 1105

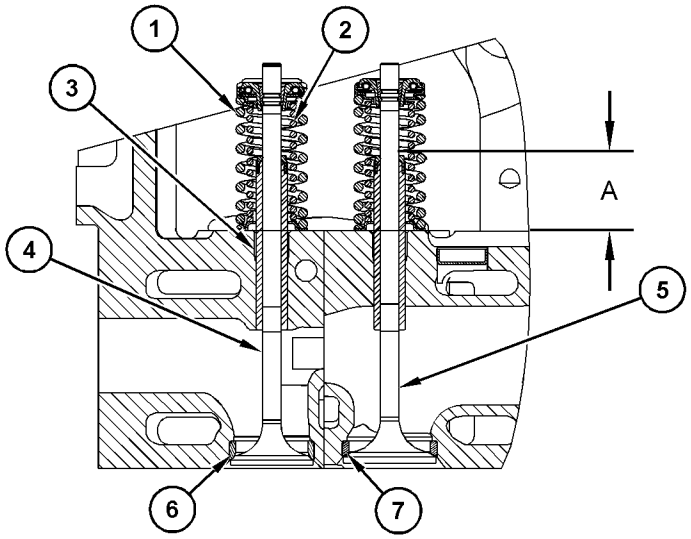


Illustration 23 g03347670

Typical example

Table 20

Item	Qty	Part	Specification Description
1	24	247-9908 Springs	Length under test force is 67.12 mm (2.643 inch). Test force is 320 ± 25 N (71.9 ± 5.6 lb). Approximate free length after test is 76.70 mm (3.020 inch).
2	24	211-3122 Springs	Length under test force is 60.14 mm (2.368 inch). Test force is 150 ± 12 N (33.7 ± 2.7 lb). Approximate free length after test is 71.70 mm (2.823 inch).
3	24	122-7375 Valve Guide	Height (A) to the step that is in the valve guide is 35.0 ± 0.5 mm (1.38 ± 0.02 inch). Before installation, bore in the valve guide is 9.502 ± 0.013 mm (0.3741 ± 0.0005 inch).
Lubricate inner diameter of valve guides with 1E1867B clean engine oil immediately prior to valve installation in the cylinder.			
4	12	490-7200 Exhaust Valve	Face angle is 45.75 ± 0.25 degrees. Stem diameter is 9.441 ± 0.010 mm (0.37169 ± 0.00039 inch). Valve head diameter is 41.81 ± 0.13 mm (1.646 ± 0.005 inch).
5	12	490-7199 Inlet Valve	Face angle is 60.75 ± 0.25 degrees. Stem diameter is 9.441 ± 0.010 mm (0.37169 ± 0.00039 inch). Valve head diameter is 47.00 ± 0.13 mm (1.850 ± 0.005 inch).
Shrink the valve seat inserts by reducing the temperature. Shrinking the valve seat inserts allows placement into the counterbore.			
6	12	226-5561 Valve Seat Insert	Angle of face of valve seat insert is 45.25 ± 0.25 degrees. Outside diameter is 42.840 ± 0.013 mm (1.6866 ± 0.0005 inch). Depth of the bore in the cylinder head is 13.90 ± 0.05 mm (0.547 ± 0.002 inch). Bore in the cylinder head is 42.774 ± 0.025 mm (1.6840 ± 0.0010 inch).
7	12	224-3983 Seat Insert	Angle of face of valve seat insert is 30.25 ± 0.25 degrees. Outside diameter is 48.025 ± 0.013 mm (1.8907 ± 0.0005 inch). Depth of the bore in the cylinder head is 14.00 ± 0.05 mm (0.551 ± 0.002 inch). Bore in the cylinder head is 47.950 ± 0.025 mm (1.8878 ± 0.0010 inch).

i07304792

Cylinder Head Valves

SMCS Code: 1105

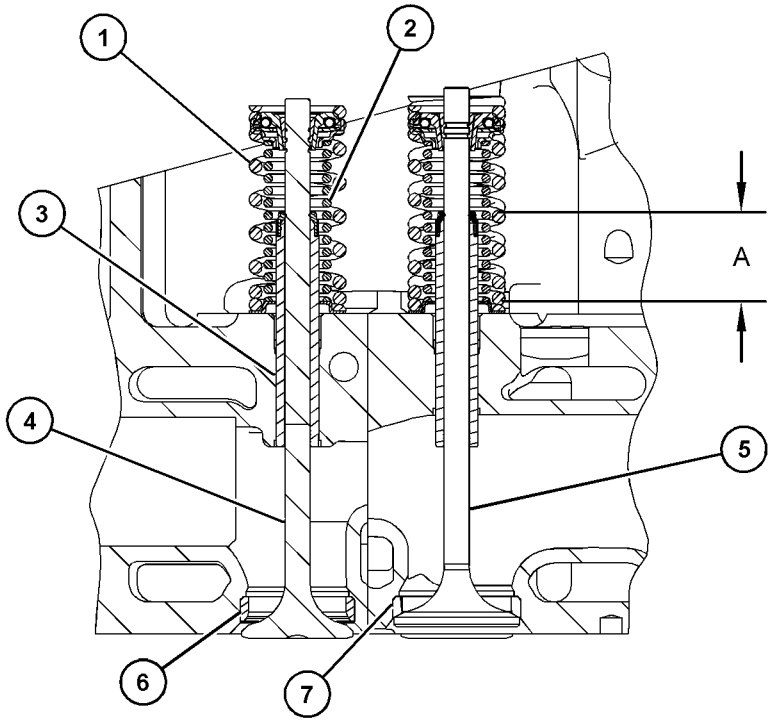


Illustration 24 g06055872

Table 21

Item	Qty	Part	Specification Description
1	24	247-9908 Springs	Length under test force is 67.12 mm (2.643 inch). Test force is 320 ± 25 N (71.9 ± 5.6 lb). Approximate free length after test is 76.70 mm (3.020 inch).
2	24	211-3122 Springs	Length under test force is 60.14 mm (2.368 inch). Test force is 150 ± 12 N (33.7 ± 2.7 lb). Approximate free length after test is 71.70 mm (2.823 inch).
3	24	122-7375 Valve Guide	Height (A) to the step that is in the valve guide is 35.0 ± 0.5 mm (1.38 ± 0.02 inch). Before installation, bore in the valve guide is 9.502 ± 0.013 mm (0.3741 ± 0.0005 inch).
Lubricate inner diameter of valve guides with 1E1867B clean engine oil immediately prior to valve installation in the cylinder.			
4	12	490-7200 Exhaust Valve	Face angle is 45.75 ± 0.25 degrees. Stem diameter is 9.441 ± 0.010 mm (0.37169 ± 0.00039 inch). Valve head diameter is 41.81 ± 0.13 mm (1.646 ± 0.005 inch).
5	12	490-7198 Inlet Valve	Face angle is 60.75 ± 0.25 degrees. Stem diameter is 9.441 ± 0.010 mm (0.37169 ± 0.00039 inch). Valve head diameter is 47.00 ± 0.13 mm (1.850 ± 0.005 inch).

(continued)

(Table 21, contd)

6	12	226-5561 Valve Seat Insert	Angle of face of valve seat insert is 45.25 ± 0.25 degrees. Outside diameter is 42.840 ± 0.013 mm (1.6866 ± 0.0005 inch). Depth of the bore in the cylinder head is 13.90 ± 0.05 mm (0.547 ± 0.002 inch). Bore in the cylinder head is 42.774 ± 0.025 mm (1.6840 ± 0.0010 inch).
7	12	280-3979 Valve Seat Insert	Angle of face of valve seat insert is 30.25 ± 0.25 degrees. Outside diameter is 48.025 ± 0.013 mm (1.8907 ± 0.0005 inch). Depth of the bore in the cylinder head is 14.00 ± 0.05 mm (0.551 ± 0.002 inch). Bore in the cylinder head is 47.950 ± 0.025 mm (1.8878 ± 0.0010 inch).

i06061955

Cylinder Head

SMCS Code: 1100

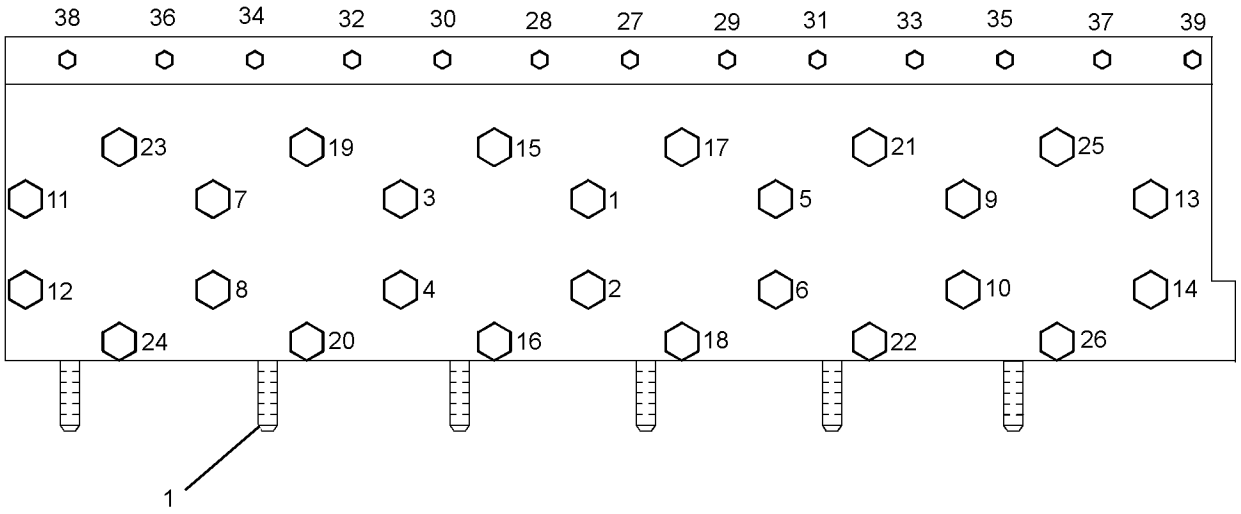


Illustration 25 g01590677

Bolt tightening sequence

Use 194 mm (7.6 inch) length for the following bolts: bolt 1 through bolt 10, bolt 15, bolt 17, bolt 19, bolt 21, bolt 23 and bolt 25

Use 216 mm (8.5 inch) length for the following bolts: bolt 11 through bolt 14, bolt 16, bolt 18, bolt 20, bolt 22, bolt 24 and bolt 26

Use 149.9 mm (5.90 inch) length for the bolt 27 through bolt 39.

Use the following procedure in order to tighten the cylinder head bolts:

Note: Before assembly, apply 4C-5592 Anti-Seize Compound to the bolt threads and to both sides of the washers for bolt 1 through bolt 26.

1. Tighten the bolt 1 through bolt 26 in a numerical sequence to 270 ± 15 N·m (200 ± 11 lb ft).

2. Tighten the bolt 1 through bolt 26 in a numerical sequence to 450 ± 15 N·m (330 ± 11 lb ft).

3. Again, tighten the bolt 1 through bolt 26 in a numerical sequence to 450 ± 15 N·m (330 ± 11 lb ft).

4. Tighten the bolt 27 through bolt 39 in a numerical sequence to 45 ± 7 N·m (33 ± 5 lb ft).

Note: Install the taperlock studs so that the letter “Y” is showing.

(1) Torque for 24 taperlock studs . . . . . 35 ± 5 N·m ((26 ± 4 lb ft))

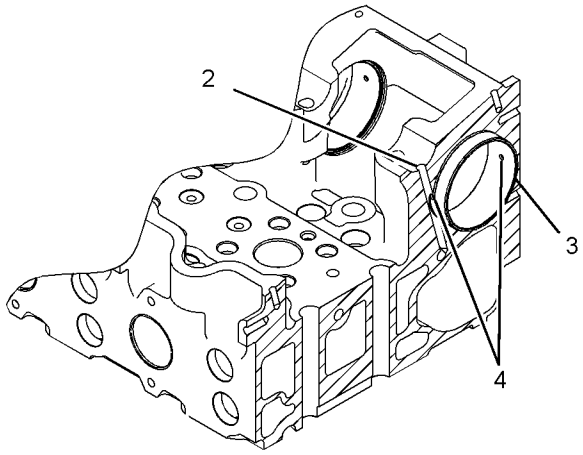


Illustration 26 g01590856

(2) Oil gallery
(3) Camshaft bearing
(4) Oil holes

NOTICE
Camshaft bearings must be installed into their correct position. Failure to do so will result in engine damage.

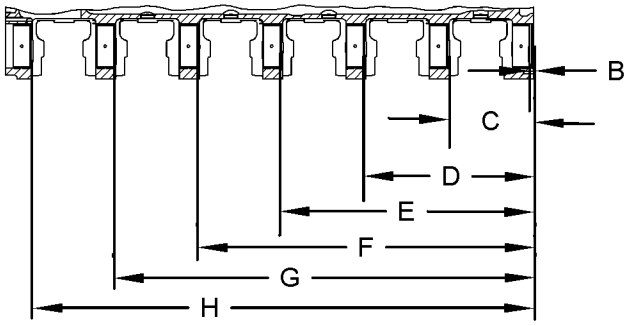


Illustration 27 g01590713

Installation depth of the sleeve bearing (3) for camshaft is very important. Install the sleeve bearings to the following depths:

Dimension (B) . . . . . .8.0 ± 0.5 mm ((0.31 ± 0.02 inch))
Dimension (C) . . . . . .227.5 ± 0.5 mm ((8.96 ± 0.02 inch))
Dimension (D) . . . . . .411.7 ± 0.5 mm ((16.21 ± 0.02 inch))
Dimension (E) . . . . . .595.8 ± 0.5 mm ((23.46 ± 0.02 inch))
Dimension (F) . . . . . .780.0 ± 0.5 mm ((30.71 ± 0.02 inch))
Dimension (G) . . . . . .964.1 ± 0.5 mm ((37.96 ± 0.02 inch))
Dimension (H) . . . . . .1140.3 ± 0.5 mm ((44.89 ± 0.02 inch))

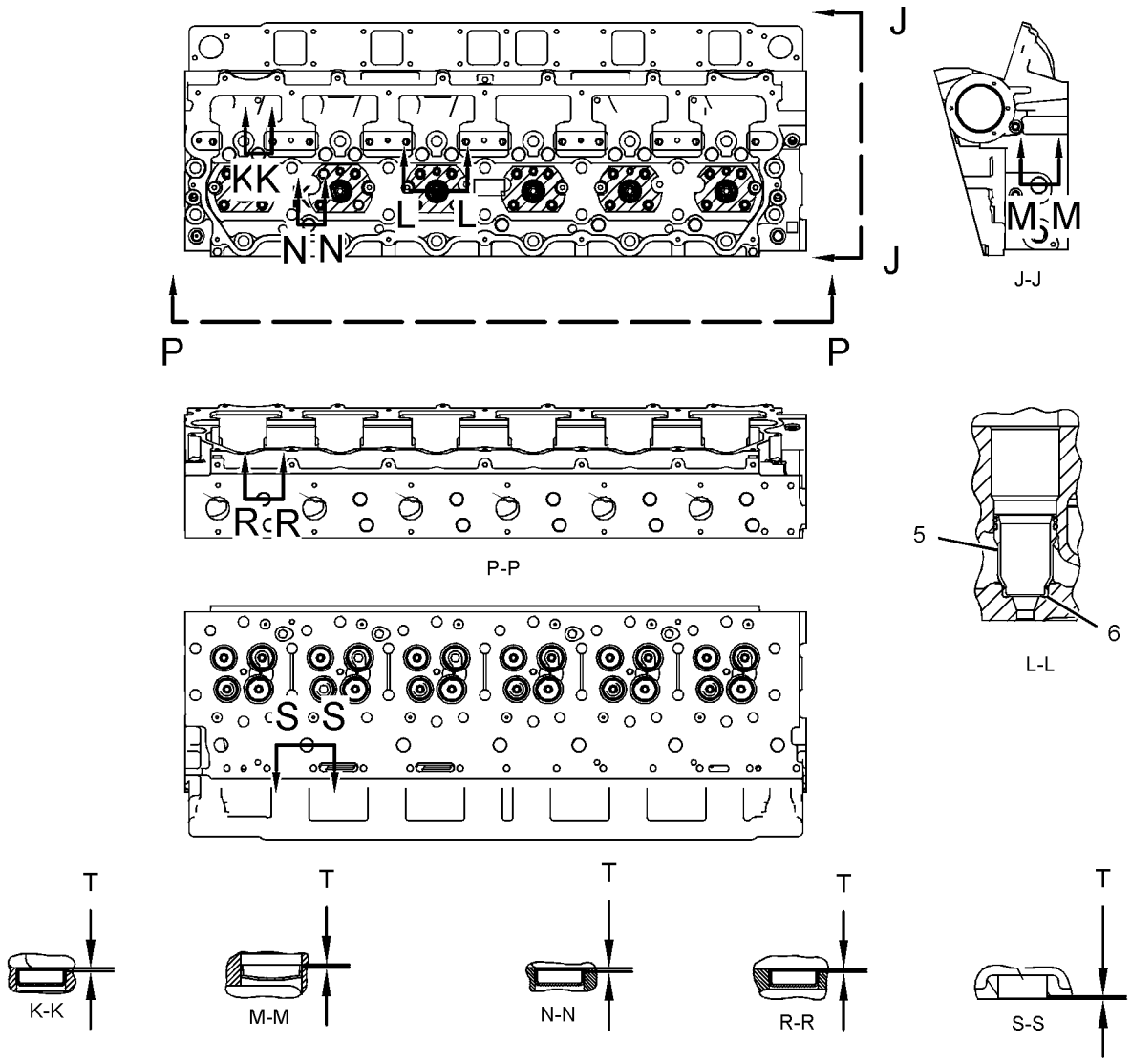


Illustration 28 g01595834

(5) Before assembly, apply 4C-9506 Retaining Compound to press fit diameter of the lower end of six injector sleeves.

Note: Press the injector sleeve to the bottom of the face (6).

Note: Before assembly, apply 4C-9506 Retaining Compound to the bore of the cup plugs.

(T) Installation depth for 38 cup plugs
. . . . . 1.25 ± 0.25 mm ((0.049 ± 0.010 inch))

i07679267

Cylinder Head

SMCS Code: 1100

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 369-4607
S/N: E9Z1–Up

S/N: KDZ1–Up

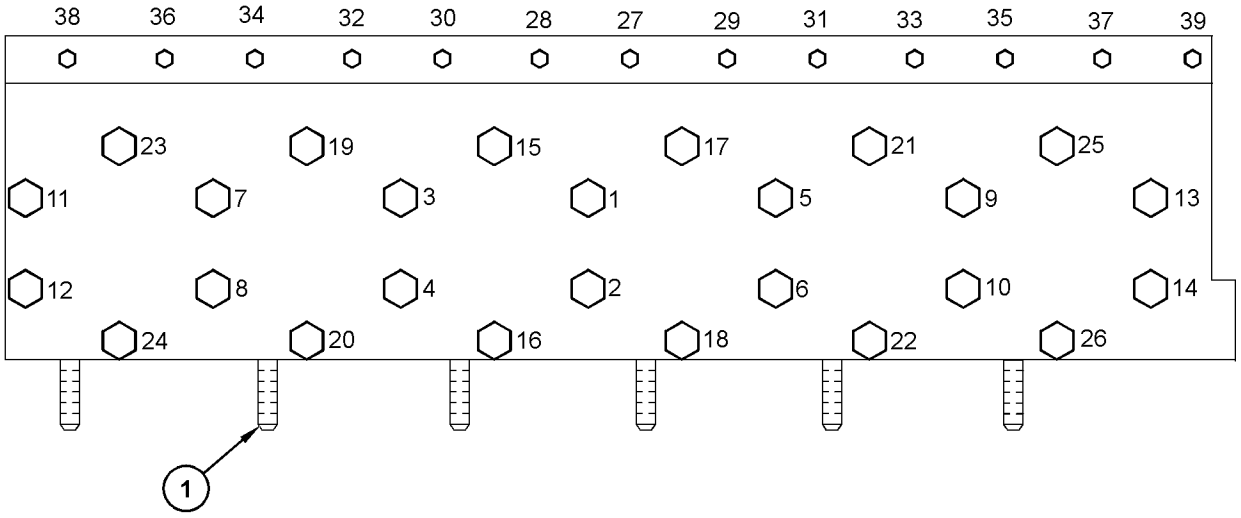


Illustration 29 g03143567

Bolt tightening sequence

Table 22

Specification for 339-3585 Cylinder Head Gp and 396-8374 Cylinder Head As			
Item	**Qty**	**Part**	**Specification Description**
1	24	106-1792 Taperlock Stud	Torque to 35 ± 5 N·m (26 ± 4 lb ft).
-	16	124-1855 Bolt	Use 194 mm (7.6 inch) length for the following bolts: Bolt 1 through bolt 10, bolt 15, bolt 17, bolt 19, bolt 21, bolt 23, and bolt 25.
-	10	124-1854 Bolt	Use 216 mm (8.5 inch) length for the following bolts: Bolt 11 through bolt 14, bolt 16, bolt 18, bolt 20, bolt 22, bolt 24, and bolt 26.
-	13	248-0036 Bolt	Use 149.9 mm (5.90 inch) length for the bolt 27 through bolt 39.
-	-	-	Use the following procedure in order to tighten the cylinder head bolts: Refer Illustration 29 for bolt tightening sequence. Before assembly, apply black 4C-5592 Anti-Seize Compound to the bolt threads and to both sides of the washers for bolt 1 through bolt 26. 1. Tighten bolt 1 through bolt 26 in a numerical sequence to 270 ± 15 N·m (199 ± 11 lb ft). 2. Tighten bolt 1 through bolt 26 in a numerical sequence to 450 ± 15 N·m (332 ± 11 lb ft). 3. Again, tighten bolt 1 through bolt 26 in a numerical sequence to 450 ± 15 N·m (332 ± 11 lb ft). 4. Tighten bolt 27 through bolt 39 in a numerical sequence to 45 ± 7 N·m (33 ± 5 lb ft).

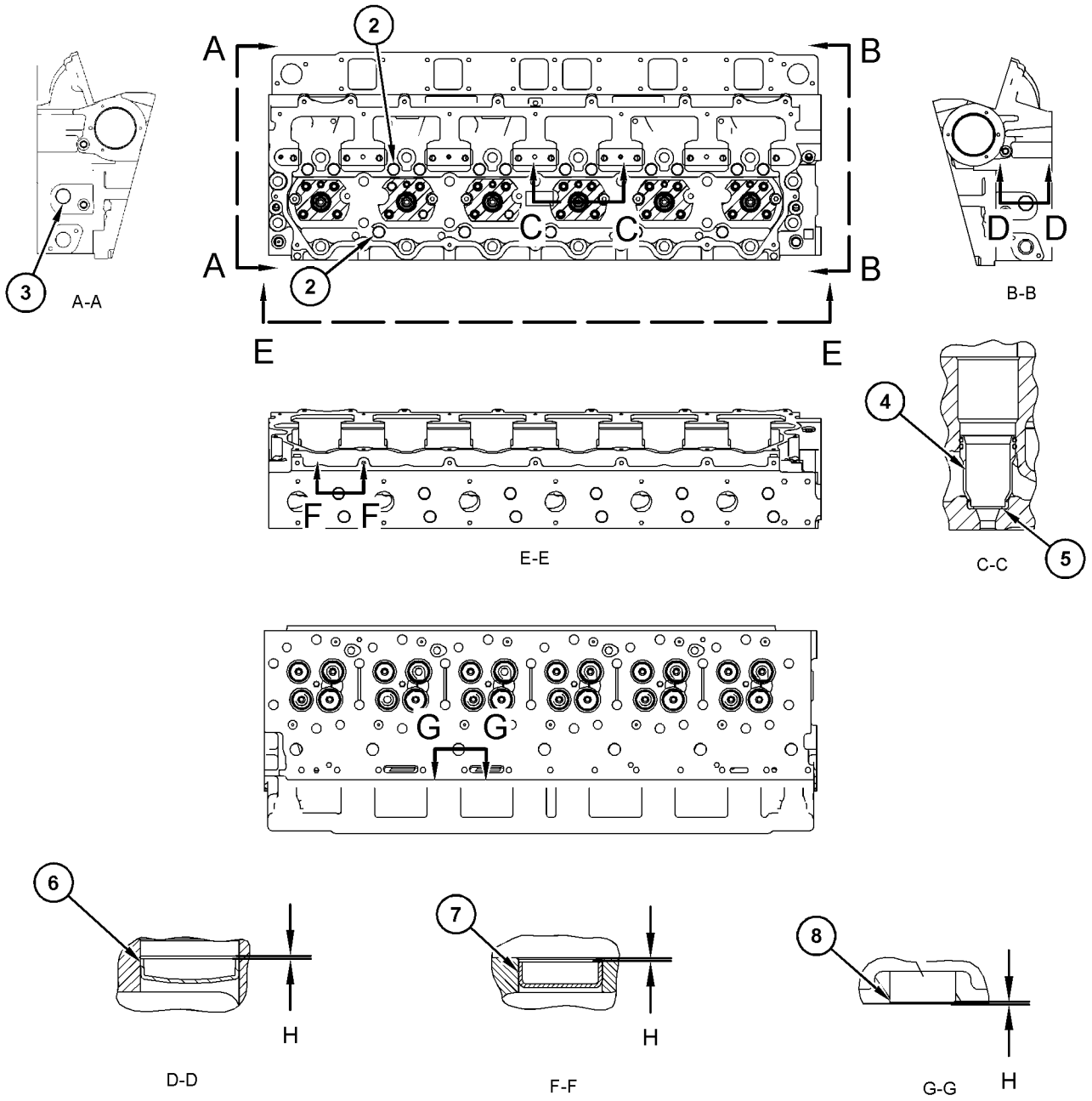


Illustration 30 g03143574

Table 23

Item	Qty	Part	Specification Description
2	29	3B - 0623 Cup Plug	Before assembly, apply High Strength or High Temperature Anaerobic Flange Sealant to the surface.
3	2	3B - 0645 Cup Plug	Before assembly, apply High Strength or High Temperature Anaerobic Flange Sealant to the surface.

(continued)

(Table 23, contd)

4	12	263-4920 Injector Sleeve	Before assembly, apply green Loctite ® 620 to the surface.(1) Press the injector sleeve to the bottom of the face (5).
6	1	3B-0645 Cup Plug	Before assembly, apply High Strength or High Temperature Anaerobic Flange Sealant to the surface. Installation depth (H) is 1.25 ± 0.25 mm (0.049 ± 0.010 inch).
7	7	3B-0623 Cup Plug	Before assembly, apply High Strength or High Temperature Anaerobic Flange Sealant to the surface. Installation depth (H) is 1.25 ± 0.25 mm (0.049 ± 0.010 inch).
8	-	-	Before assembly, apply High Strength or High Temperature Anaerobic Flange Sealant to the cup plug surface. Installation depth of the cup plug is 1.25 ± 0.25 mm (0.049 ± 0.010 inch).

(1) Refer to Loctite Technical Data Sheet for appropriate curing information.

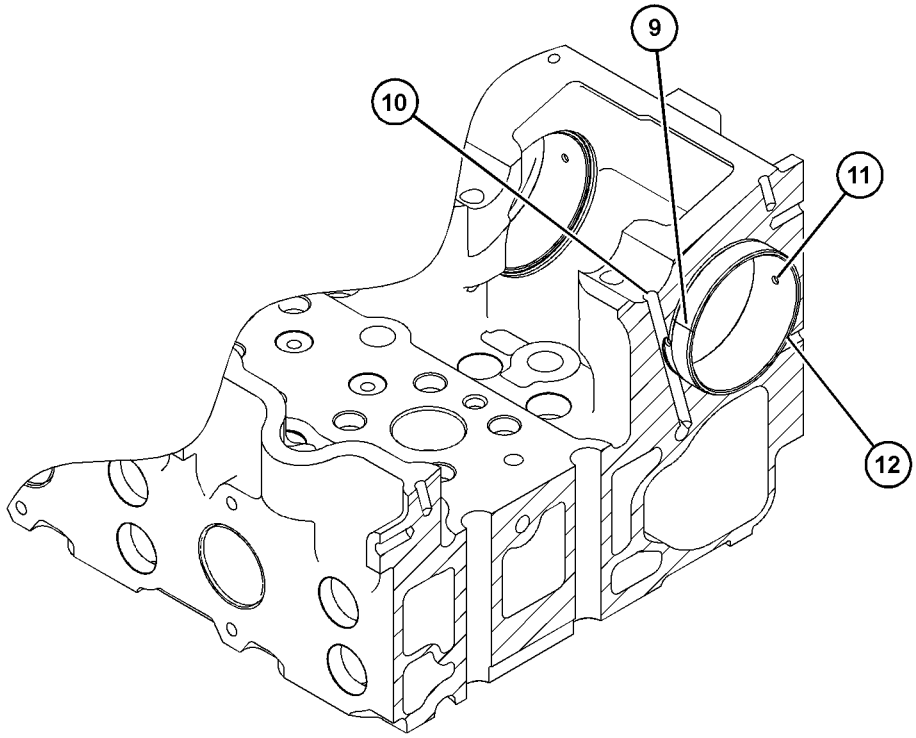


Illustration 31 g06392298

(9) Sleeve bearing joint
(10) Oil gallery
(11) Oil holes
(12) Sleeve bearing

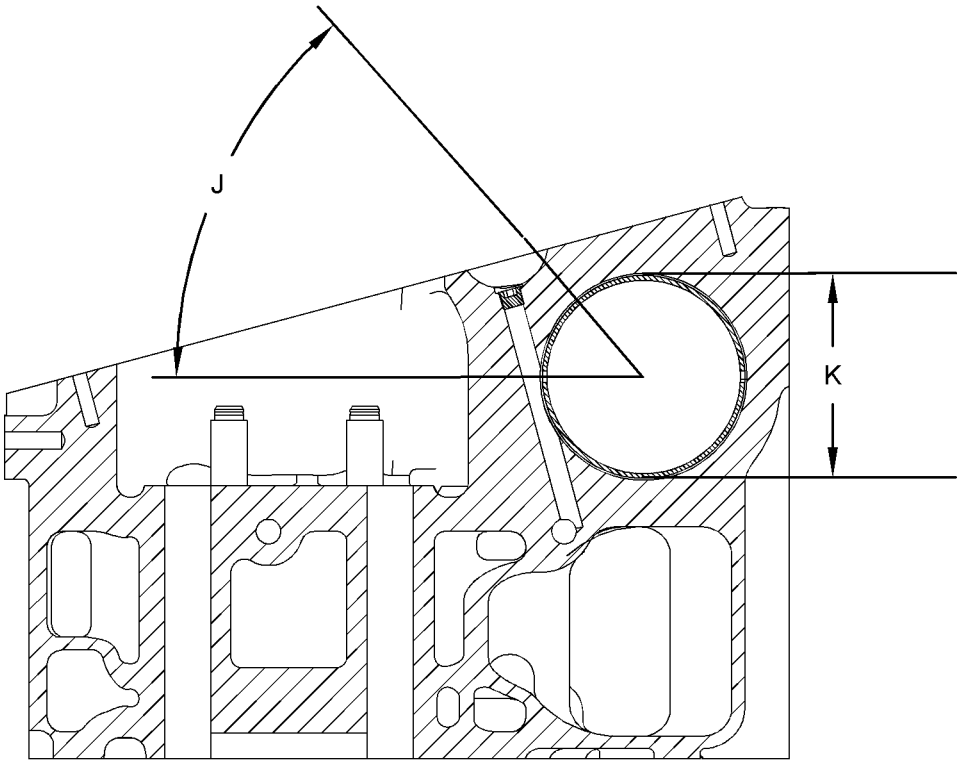


Illustration 32 g06393022

Table 24

Item	Qty	Part	Specification Description
J	-	-	Orientation of the sleeve bearing joint is 20 ± 5 degrees above horizontal
K	-	-	Bore for camshaft sleeve bearing is 90.985 ± 0.020 mm (3.5821 ± 0.0008 inch)

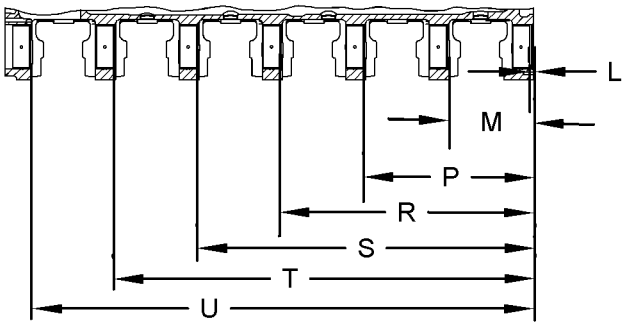


Illustration 33 g06393031

Table 25

Item	Qty	Part	Specification Description
Install the 216-5582 Bushing in the cylinder head to the following distance			

(continued)

(Table 25, contd)

-	-	-	Distance (L) is 8.0 ± 0.5 mm (0.31 ± 0.02 inch).
-	-	-	Distance (M) is 227.5 ± 0.5 mm (8.96 ± 0.02 inch).
-	-	-	Distance (P) is 411.7 ± 0.5 mm (16.21 ± 0.02 inch).
-	-	-	Distance (R) is 595.8 ± 0.5 mm (23.46 ± 0.02 inch).
-	-	-	Distance (S) is 780.0 ± 0.5 mm (30.71 ± 0.02 inch).
-	-	-	Distance (T) is 964.1 ± 0.5 mm (37.96 ± 0.02 inch).
-	-	-	Distance (U) is 1140.3 ± 0.5 mm (44.89 ± 0.02 inch).

i07397966

Compression Brake

SMCS Code: 1119; 1129

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 379-3929
S/N: E9Z1–Up

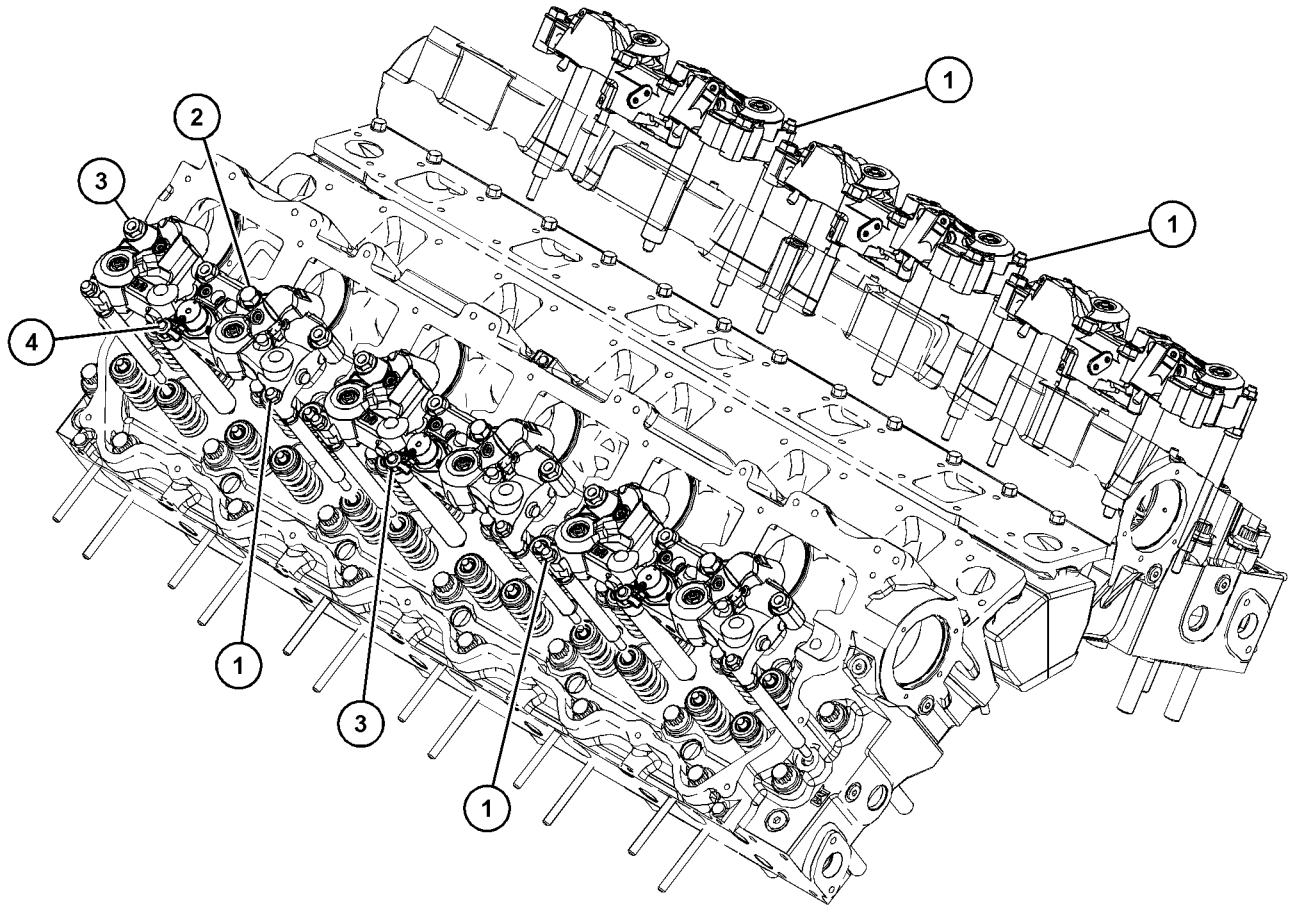


Illustration 34 g06307601

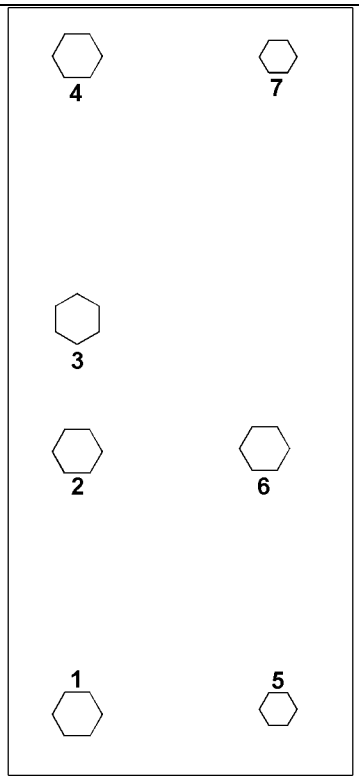


Illustration 35 g06307667

Torque sequence

Table 26

Item	Qty	Part	Specification Description
1	12	235-1088 Nut	Tighten the nuts, the bolt, and flange nuts of each valve actuator group in the sequence 3, 6, 2, 4, 1, 3, 7, 5 to standard torque. Refer to Illustration 35
2	6	234-9508 Bolt	
3	24	235-1089 Flange Nut	
4	6	8T-7062 Taperlock Stud	Torque to 65 ± 10 N·m (48 ± 7 lb ft).

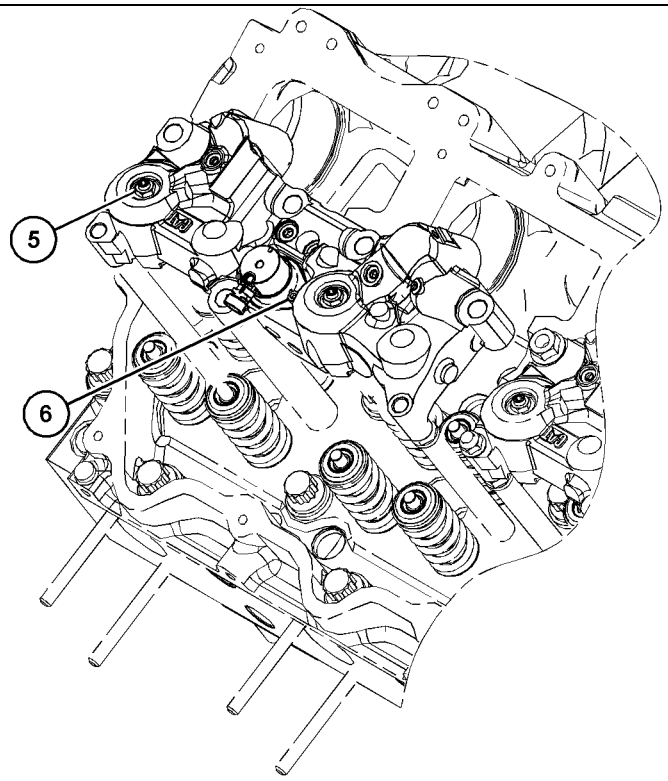


Illustration 36 g06308092

Table 27

Item	Qty	Part	Specification Description
5	2	230-9447 Jam Nut	Torque to 6 ± 1 N·m (53 ± 9 lb in).
6	2	236-5958 Bolt	

i07824401

Compression Brake

SMCS Code: 1119; 1129

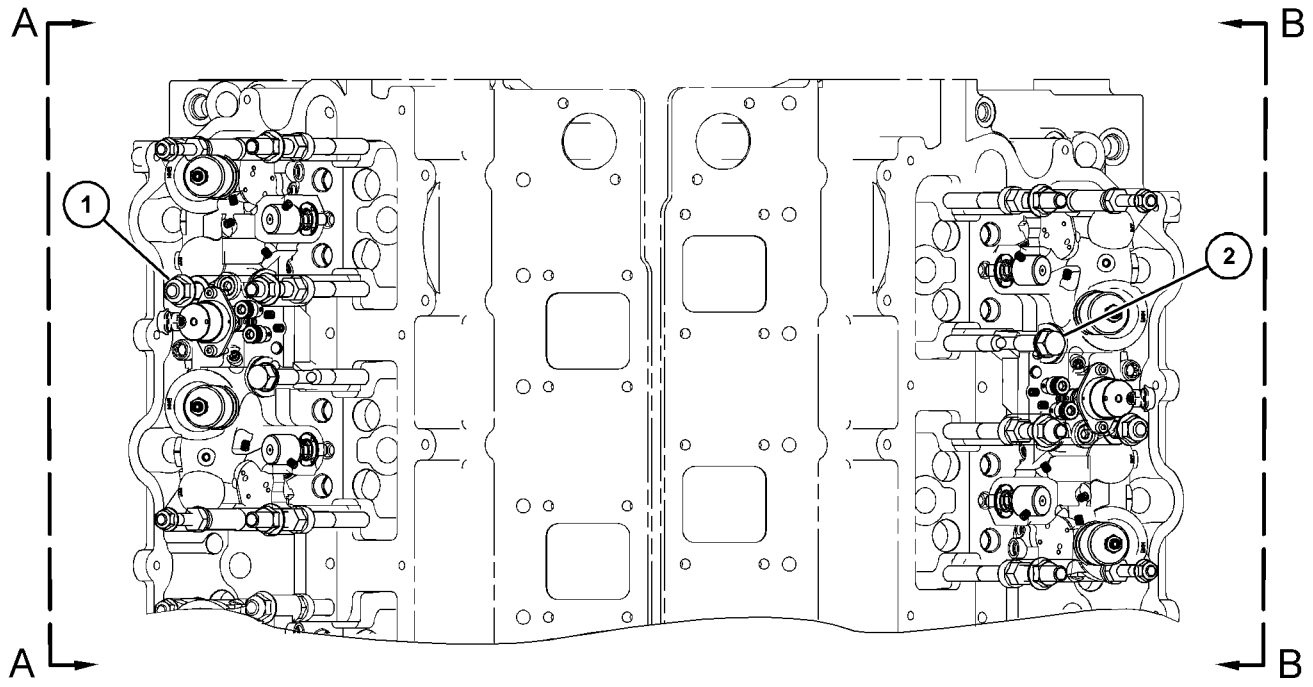


Illustration 37 g06448034

Top view of engine

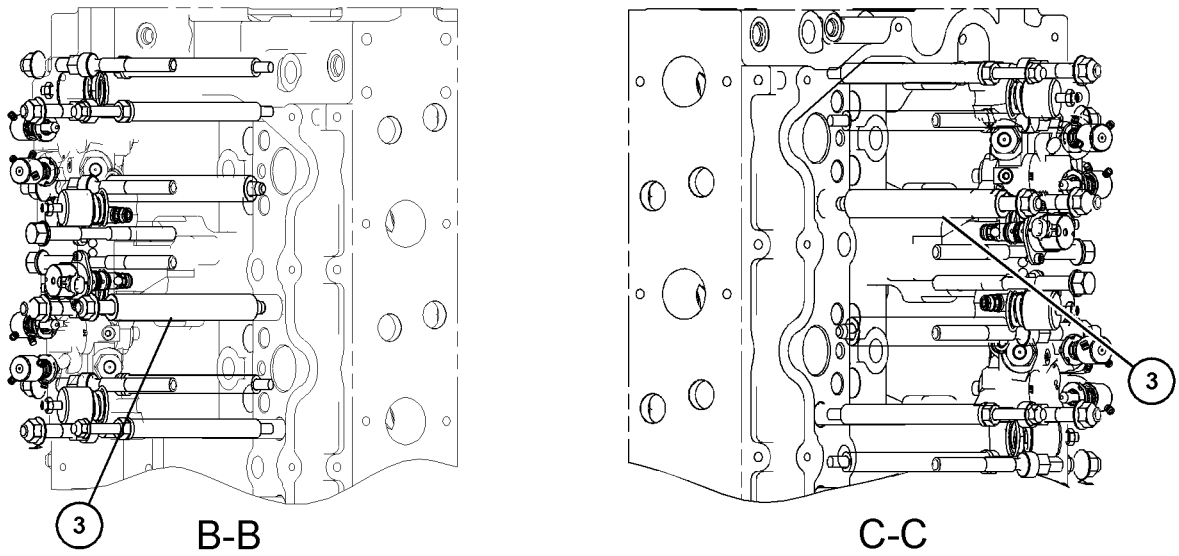


Illustration 38 g06448035

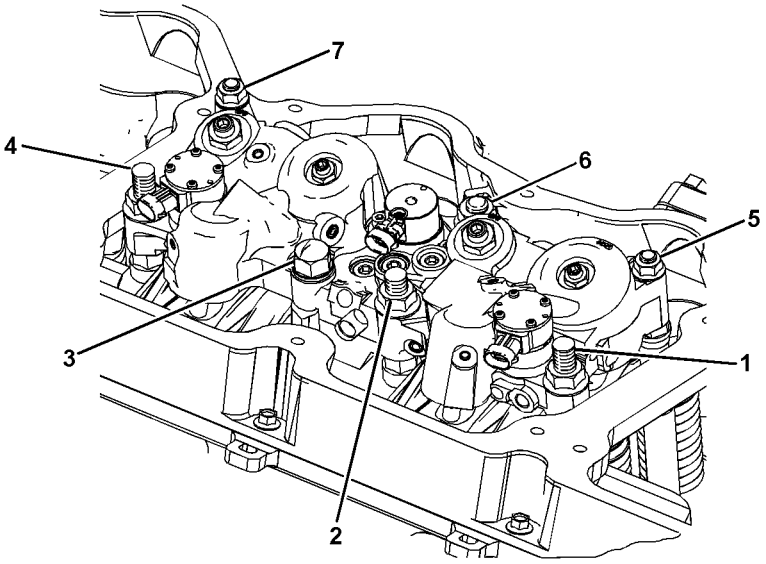


Illustration 39 g06448036

Right side view of engine

Tightening sequence for the valve actuator group

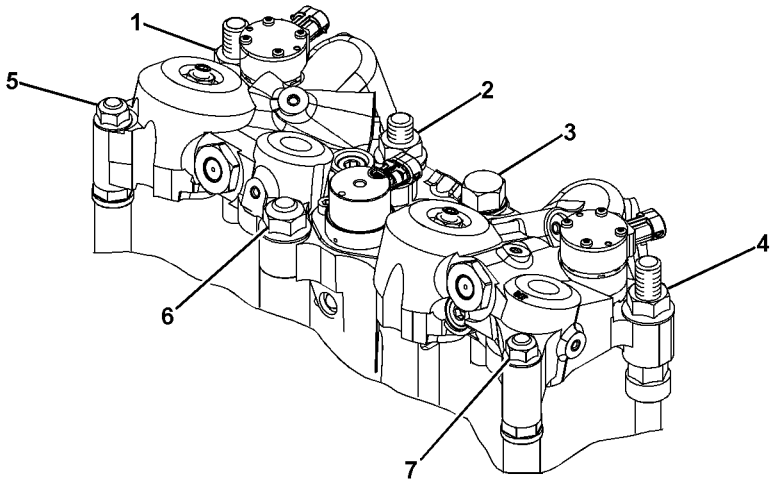


Illustration 40 g06448038

Left side view of engine

Tightening sequence for the valve actuator group

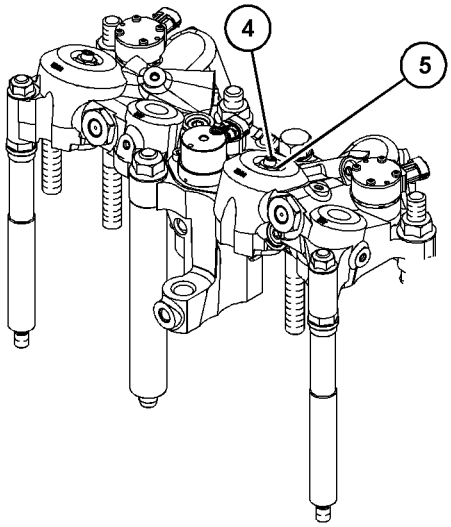


Illustration 41 g06448040

Typical example

Table 28

Item	Qty	Part	Specification Description
Note: Do not disassemble the Variable Valve Actuator. There are no components of the Variable Valve Actuator that are serviceable. If the Variable Valve Actuator is disassembled, the warranty will be void.			
1	24	235-1089 Flange Nut	Tighten the bolts and flange nuts of each valve actuator group to standard torque in the numerical sequence as shown in Illustration 39 and Illustration 40 .
2	6	234-9508 Bolt	

(continued)

(Table 28, contd)

Item	Qty	Part	Specification Description
3	6	8T-7062 Taperlock Stud	Torque to 65 ± 10 N·m (48 ± 7 lb ft).
4	-	-	Lash setting for compression brake is 0.76 ± 0.08 mm (0.030 ± 0.003 inch).
5	-	-	Tighten the locknut to 15 ± 3 N·m (133 ± 27 lb in).
-	-	-	**Note:** The lash setting for the exhaust valve to rocker arm must be completed before the lash setting of the compression brake. Refer to Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust” for procedural information.
-	-	-	**Note:** Refer to Testing and Adjusting, “Compression Brake Lash - Adjust” for procedural information that is related to the adjustment of the compression brake.

i02844244

Turbocharger

SMCS Code: 1052

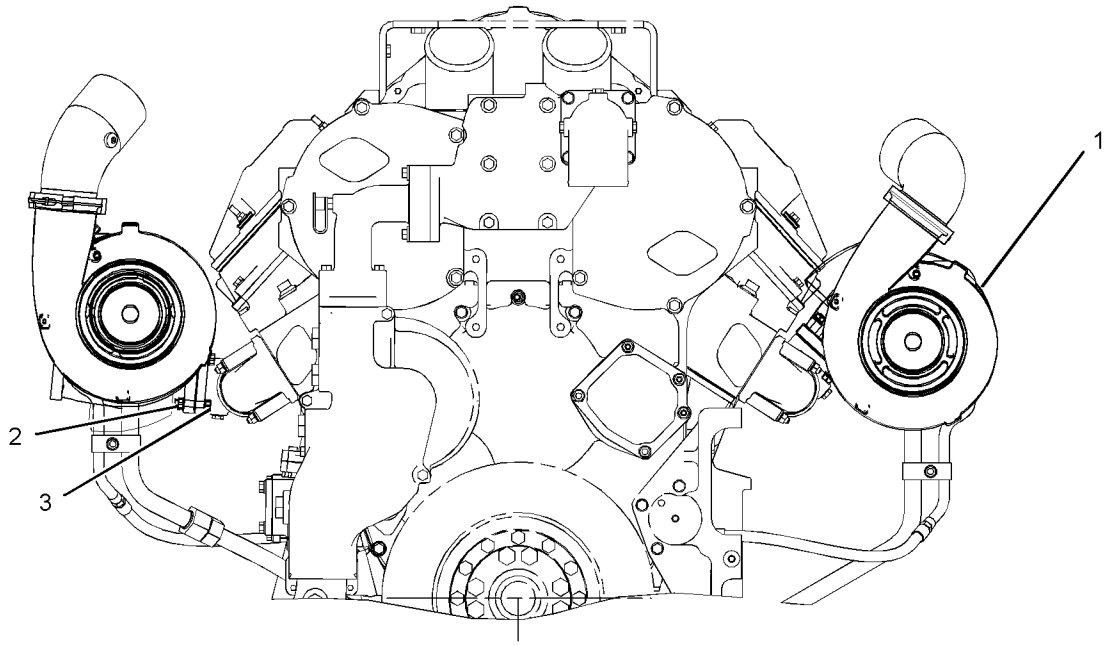


Illustration 42 g01434386

Front view of engine

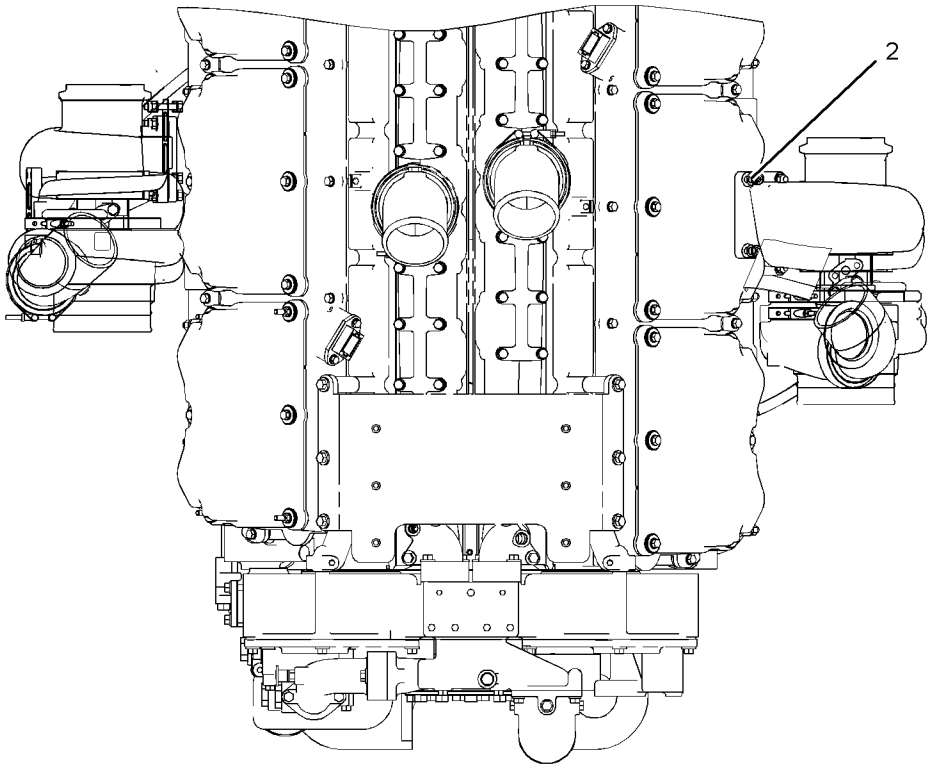


Illustration 43 g01434384

Top view of engine

Note: The oil supply and the oil drain holes should be in the vertical position with respect to the engine when the turbocharger group (1) is attached to the exhaust manifold.

Use the following procedure to tighten the compressor clamp assembly and the turbine clamp assembly for the turbocharger group:

1. Tighten the clamp assemblies to 14 ± 1 N·m (125 ± 9 lb in).

2. Lightly tap around the clamp assemblies with a soft faced hammer.

3. Again tighten the clamp assemblies to 14 ± 1 N·m (125 ± 9 lb in).

Note: Apply 4C-5599 Anti-Seize Compound on the threads of the six bolts (3).

(2) Torque for eight locknuts . . . . . 55 ± 9 N·m ((41 ± 7 lb ft))

i02844349

Turbocharger

SMCS Code: 1052

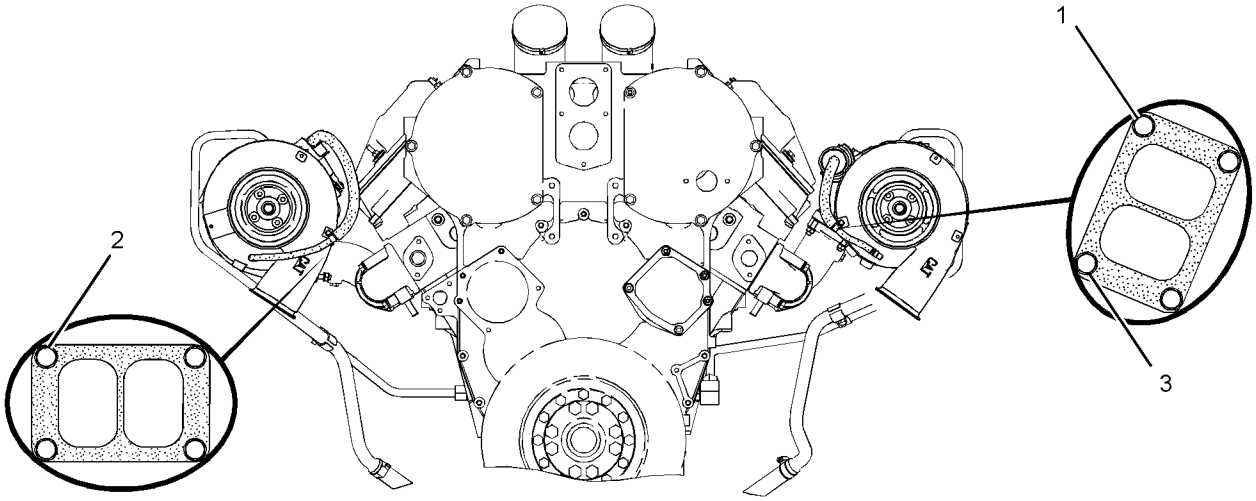


Illustration 44 g01436071

Front view

(1) Apply 4C-5599 Anti-Seize Compound to the threads of the four bolts before assembly. These bolts are 3/8-16 X 2 inches.

(2) Apply 4C-5599 Anti-Seize Compound to the threads of the four bolts before assembly. These bolts are 3/8-16 X 1 3/4 inches.

(3) Torque for the eight locknuts . . . . . 55 ± 9 N·m ((41 ± 7 lb ft))

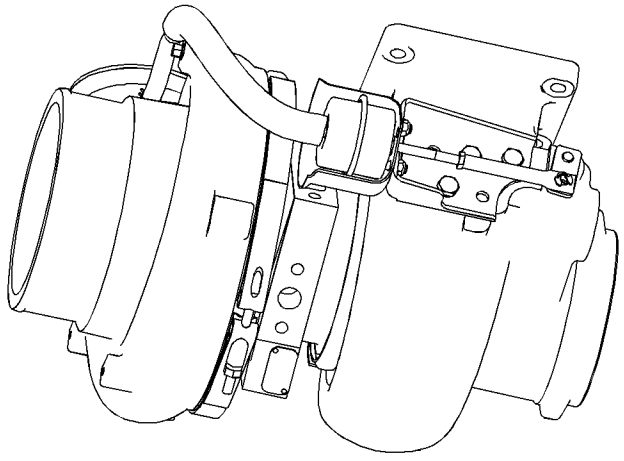


Illustration 45 g01435716

Turbocharger group

Note: The oil supply and the oil drain holes should be in the vertical position with respect to the engine when the turbocharger group is attached to the exhaust manifold.

Use the following procedure to tighten the compressor clamp assembly and the turbine clamp assembly for the turbocharger group:

1. Tighten the clamp assemblies to 14 ± 1 N·m (125 ± 9 lb in).

2. Lightly tap around the clamp assemblies with a soft faced hammer.

3. Again tighten the clamp assemblies to 14 ± 1 N·m (125 ± 9 lb in).

i02884389

Turbocharger

SMCS Code: 1052

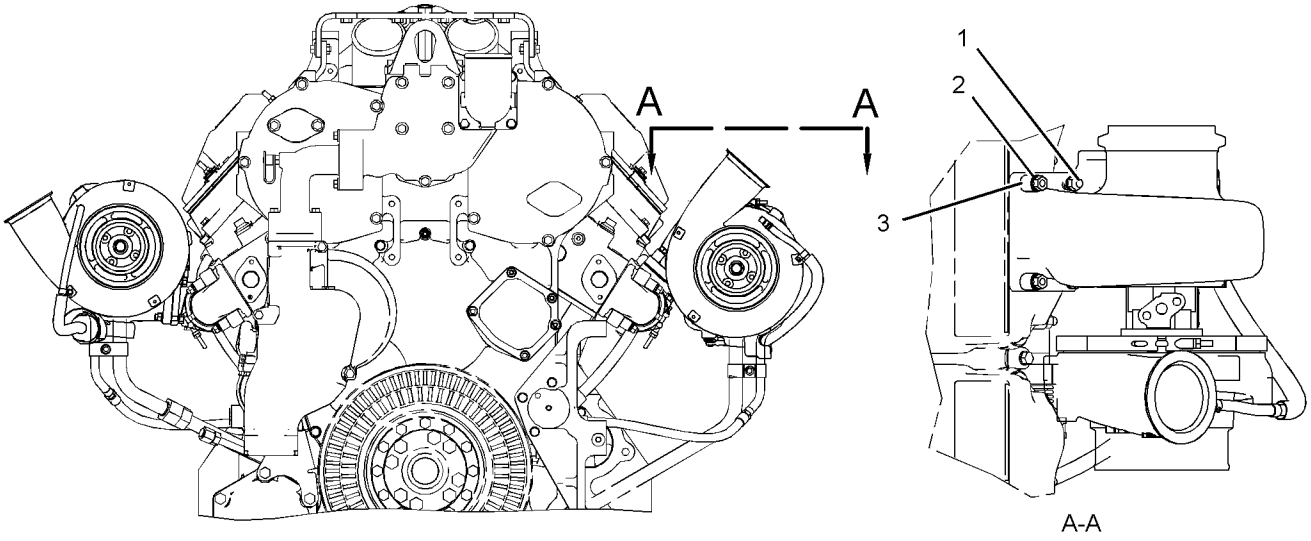


Illustration 46 g01436068

Typical example

Front view

(3) Spacer

(1) Apply 4C-5599 Anti-Seize Compound to the threads of the six bolts before assembly.

(2) Torque for the eight locknuts . . . . . 55 ± 9 N·m ((41 ± 7 lb ft))

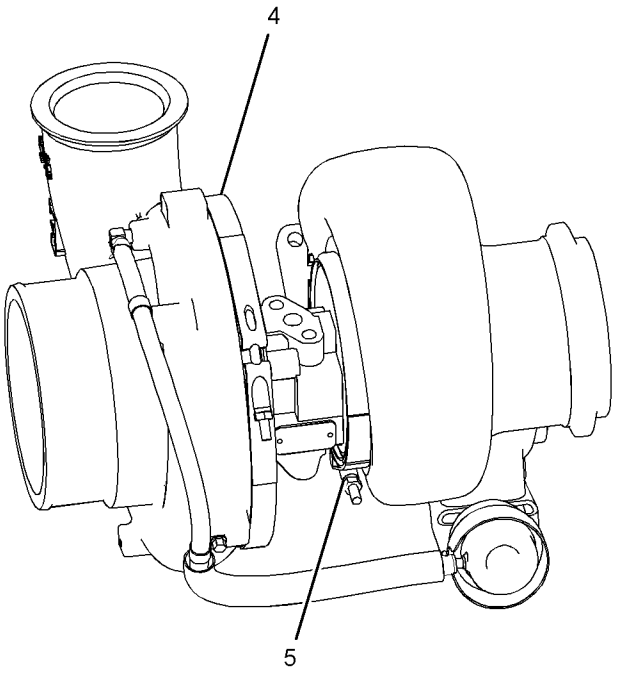


Illustration 47 g01436065
Typical example

(4) Torque for the compressor clamp assembly . . . . . 13.5 ± 1.0 N·m ((120 ± 9 lb in))

Use the following procedure to tighten the turbine clamp assembly (5) :

1. Tighten the turbine clamp assembly to 18.1 N·m (160 lb in).

2. Loosen the turbine clamp assembly to 5.6 N·m (50 lb in).

3. Again tighten the turbine clamp assembly to 13.5 ± 1.0 N·m (120 ± 9 lb in).

i02884391

Turbocharger

SMCS Code: 1052

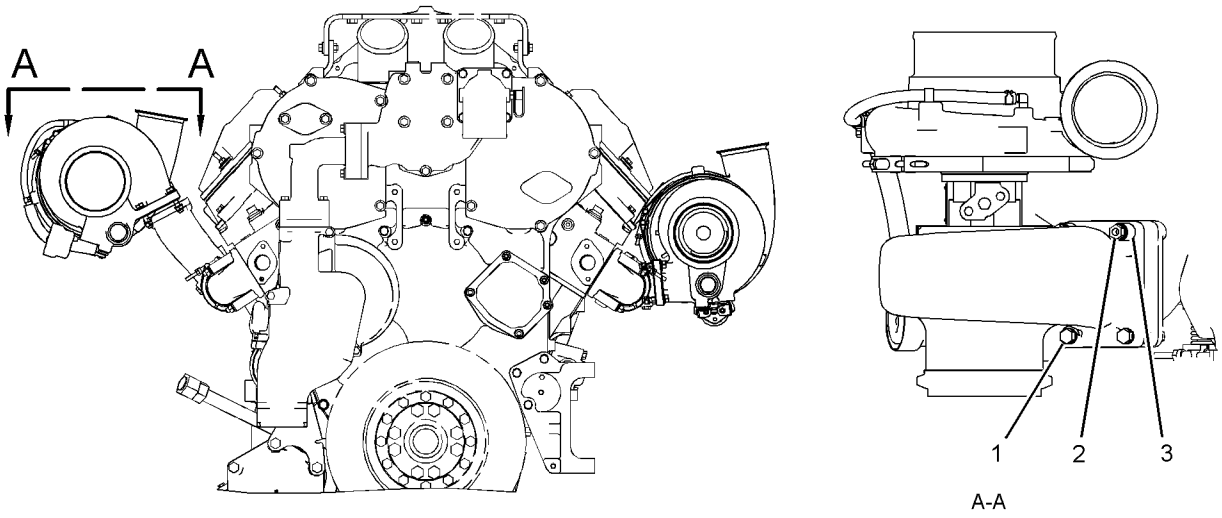


Illustration 48 g01436070

Front view

(3) Spacer

(1) Apply 4C-5599 Anti-Seize Compound to the threads of the six bolts before assembly.

(2) Torque for the eight locknuts . . . . . 55 ± 9 N·m ((41 ± 7 lb ft))

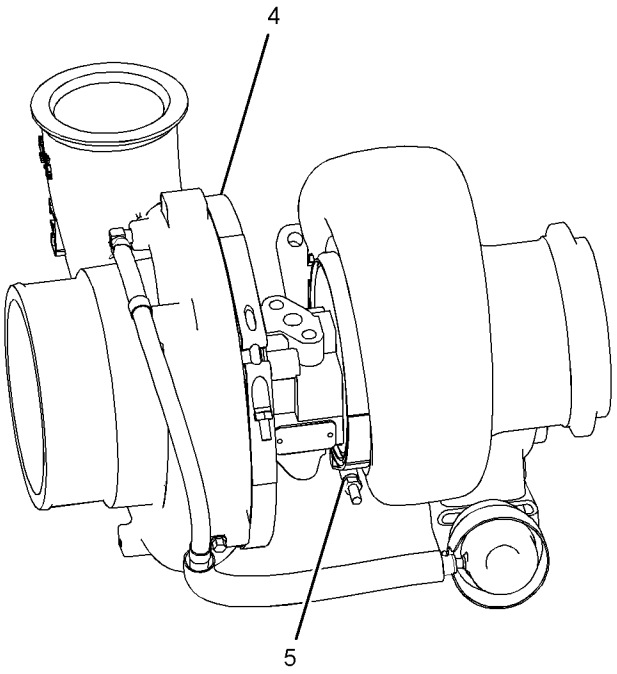


Illustration 49 g01436069

(4) Torque for the compressor clamp assembly . . . . . 13.5 ± 1.0 N·m ((120 ± 9 lb in))

Use the following procedure to tighten the turbine clamp assembly (5) :

1. Tighten the turbine clamp assembly to 18.1 N·m (160 lb in).

2. Loosen the turbine clamp assembly to 5.6 N·m (50 lb in).

3. Again tighten the turbine clamp assembly to 13.5 ± 1.0 N·m (120 ± 9 lb in).

i02884396

Turbocharger

SMCS Code: 1052

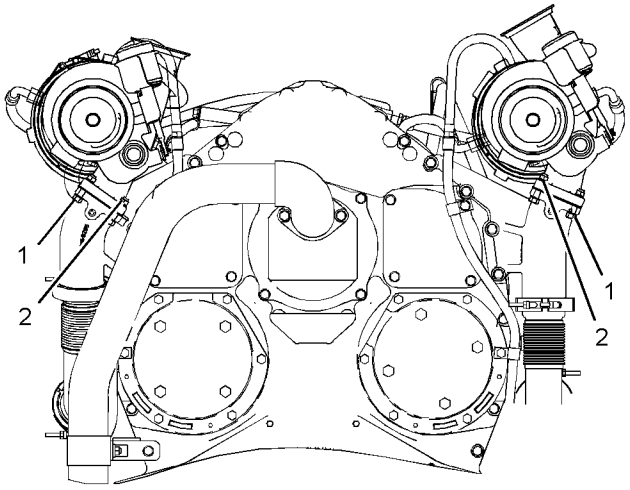


Illustration 50 g01436082

Rear view

(1) Apply 4C-5599 Anti-Seize Compound to the threads of the eight bolts before assembly.

(2) Torque for the eight locknuts . . . . . 55 ± 9 N·m ((41 ± 7 lb ft))

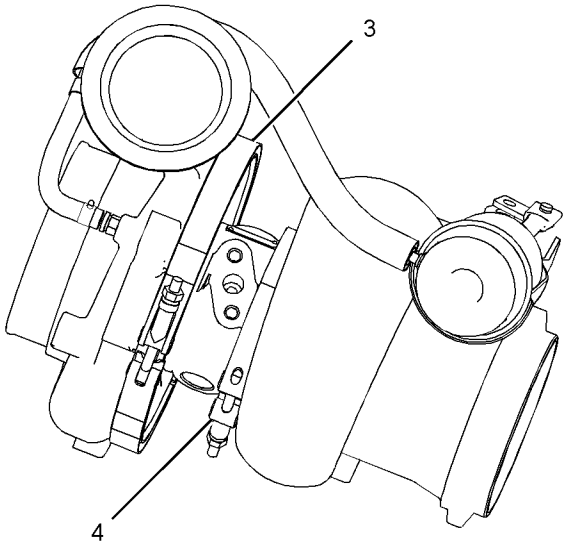


Illustration 51 g01436083

(3) Torque for the compressor clamp assembly . . . . . 13.5 ± 1.0 N·m ((120 ± 9 lb in))

Use the following procedure to tighten the turbine clamp assembly (4) :

1. Tighten the turbine clamp assembly to 18.1 N·m (160 lb in).

2. Loosen the turbine clamp assembly to 5.6 N·m (50 lb in).

3. Again tighten the turbine clamp assembly to 13.5 ± 1.0 N·m (120 ± 9 lb in).

i07321311

Turbocharger

SMCS Code: 1052

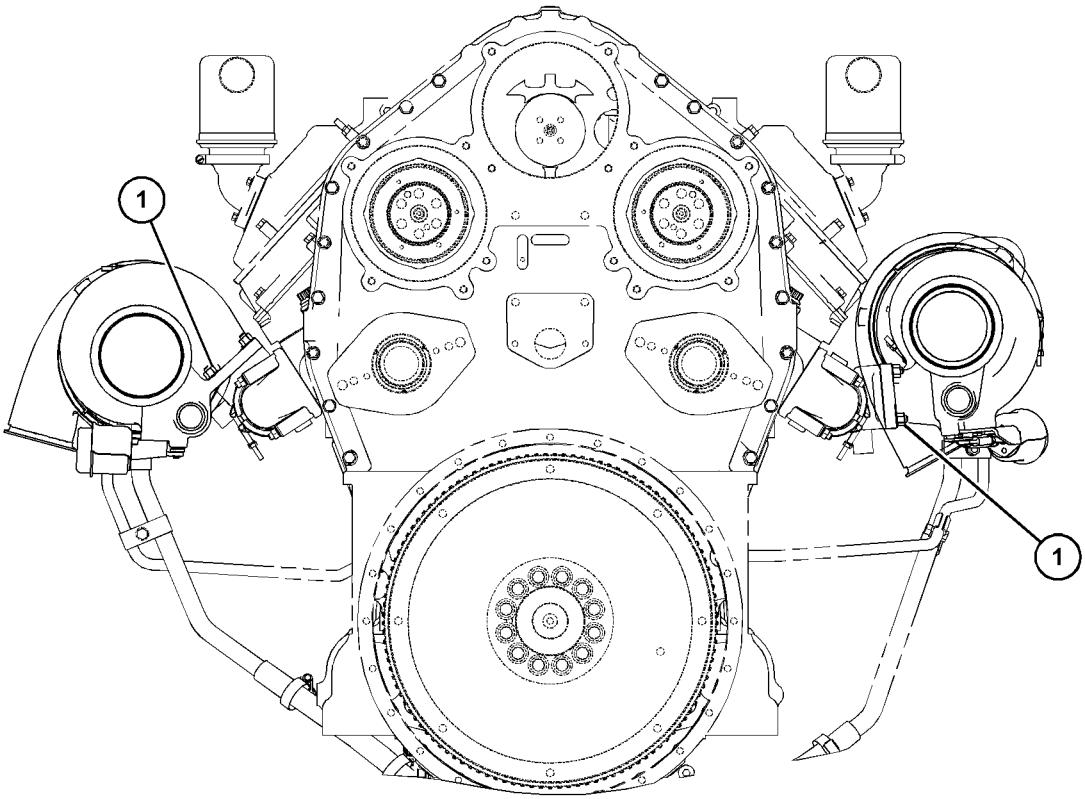


Illustration 52 g06283005

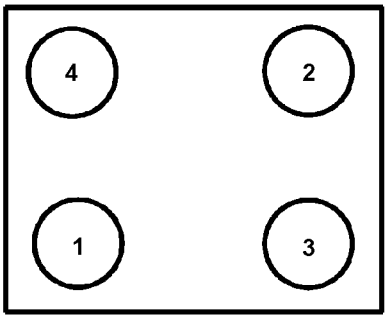


Illustration 53 g06277839

Tightening sequence

Table 29

Item	Qty	Part	Specification Description
1	8	391-2167 Flange Locknut	Before assembly, apply Loctite C5A Copper Anti-Seize to the threads and bearings. Torque to 70 ± 5 N.m (52 ± 4 lb ft) in the numerical sequence shown in illustration 53 . Do not reuse.

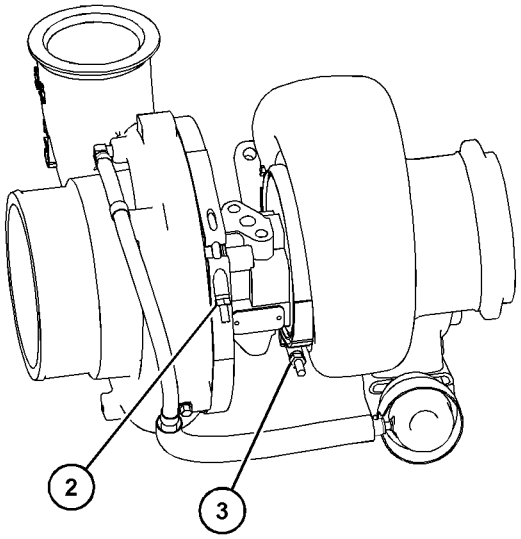


Illustration 54 g06283020

Typical example

Table 30

Item	Qty	Part	Specification Description
2	1	526-2131 Turbocharger Gp	Use the following procedure to tighten the clamp assembly: 1. Before assembly, apply Jet-Lube SS-30 Copper Anti-Seize compound to the threads. 2. Tighten the clamp assembly to 18.1 N.m (160.2 lb in). 3. Loosen clamp assembly by one to two turns. 4. Again, tighten the clamp assembly to 13.6 ± 1.2 N·m (120.4 ± 10.6 lb in).
3	1	526-2132 Turbocharger Gp	

i07390094

Turbocharger

SMCS Code: 1052

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 461-3791
S/N: E9Z1–Up

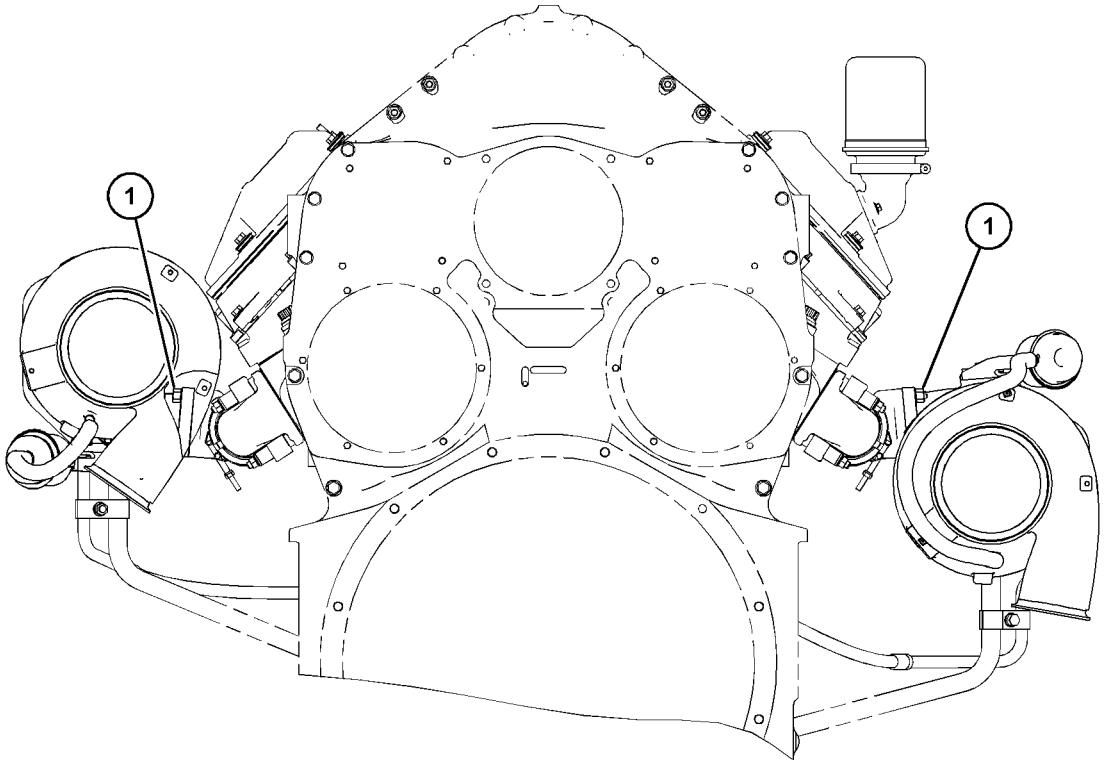


Illustration 55 g06305331

Rear view of engine

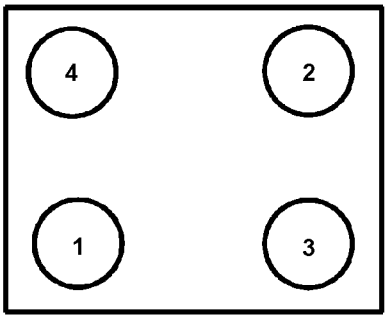


Illustration 56 g06277839

Tightening sequence

Table 31

Item	Qty	Part	Specification Description
1	8	391-2167 Flange Locknut	Use the following procedure to tighten the flange locknut: 1. Before assembly, apply Loctite C5A Copper Anti-Seize to the threads and bearings. 2. Torque to 54 ± 5 N.m (40 ± 4 lb ft) in the numerical sequence shown in illustration 56 . 3. Do not reuse.

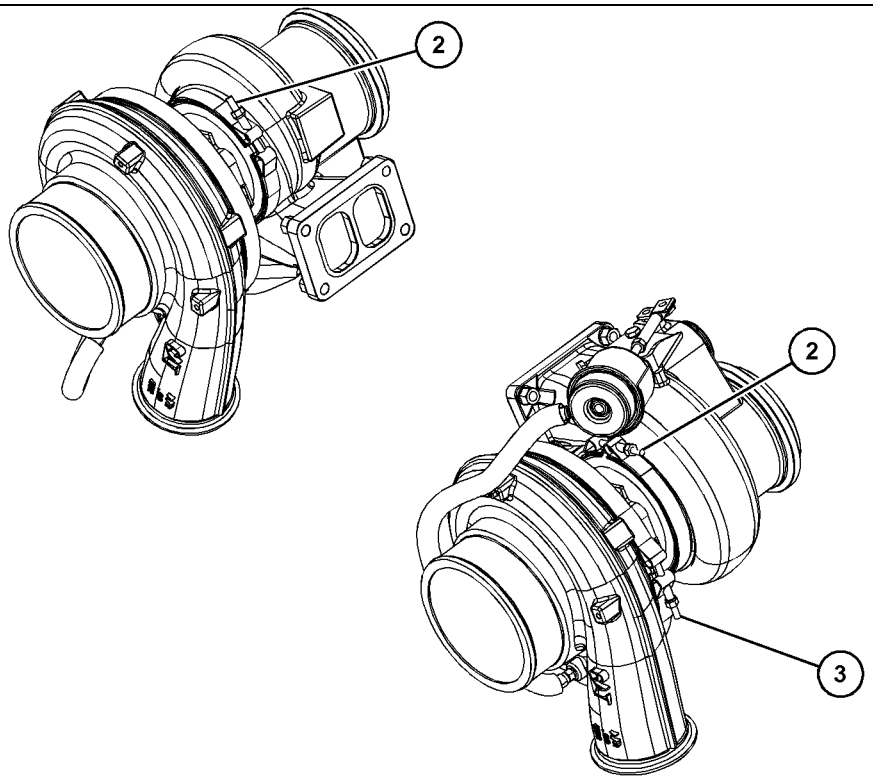


Illustration 57 g06305357

Table 32

Item	Qty	Part	Specification Description
2	-	-	Use the following procedure to tighten the turbine clamp assembly: 1. Tighten the clamp assembly to 18 N.m (160 lb in). 2. Loosen clamp assembly by one to two turns. 3. Again, tighten the clamp assembly to 13.6 ± 1.2 N·m (120.4 ± 10.6 lb in).
3	-	-	Tighten the compressor clamp assembly to 13.6 ± 1.2 N·m (120.4 ± 10.6 lb in).

i02841625

Exhaust Manifold

SMCS Code: 1059

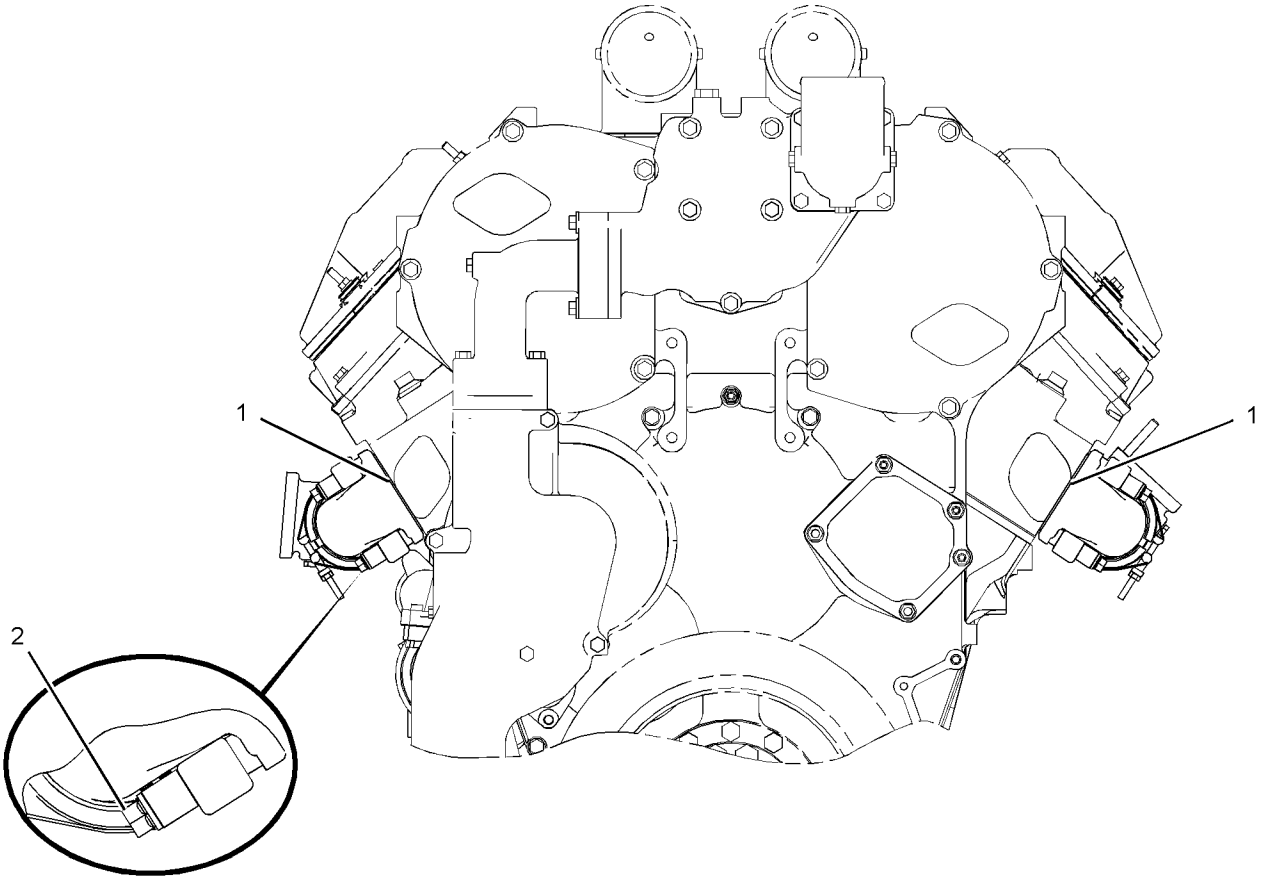


Illustration 58 g01417453

Typical example

(1) Install the gaskets so that the “MANIFOLD SIDE” marking faces away from the cylinder head.

(2) Apply 4C-5599 Anti-Seize Compound on the threads of the 24 locknuts before assembly.

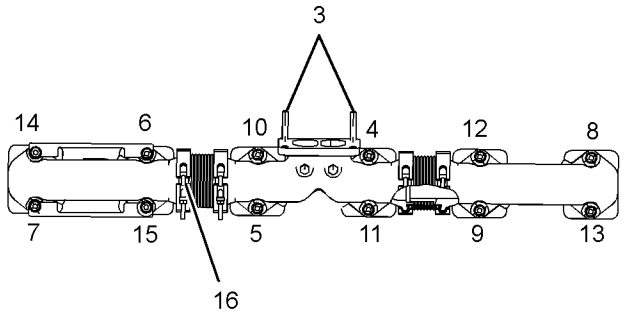


Illustration 59 g01417476

Exhaust manifold

Tightening sequence for the exhaust manifold

Note: Use a centering tool in at least one oversize hole per exhaust manifold section in order to align the exhaust manifolds. Do not remove the centering tool until removal is required to tighten the locknuts.

Use the following procedure to tighten the exhaust manifold on the cylinder head:

1. Tighten locknuts 4 through 15 in a numerical sequence to 20 ± 3 N·m (15 ± 2 lb ft).

2. Again tighten locknuts 4 through 15 in a numerical sequence to 38 ± 5 N·m (28 ± 4 lb ft).

Note: Apply 4C-5599 Anti-Seize Compound on the two taperlock studs before assembly.

(3) Torque for two taperlock studs . . . . . 35 ± 5 N·m ((26 ± 4 lb ft))

(16) Torque for eight clamps . . . . . 8.5 ± 1.0 N·m ((75 ± 9 lb in))

i02843153

Exhaust Manifold

SMCS Code: 1059

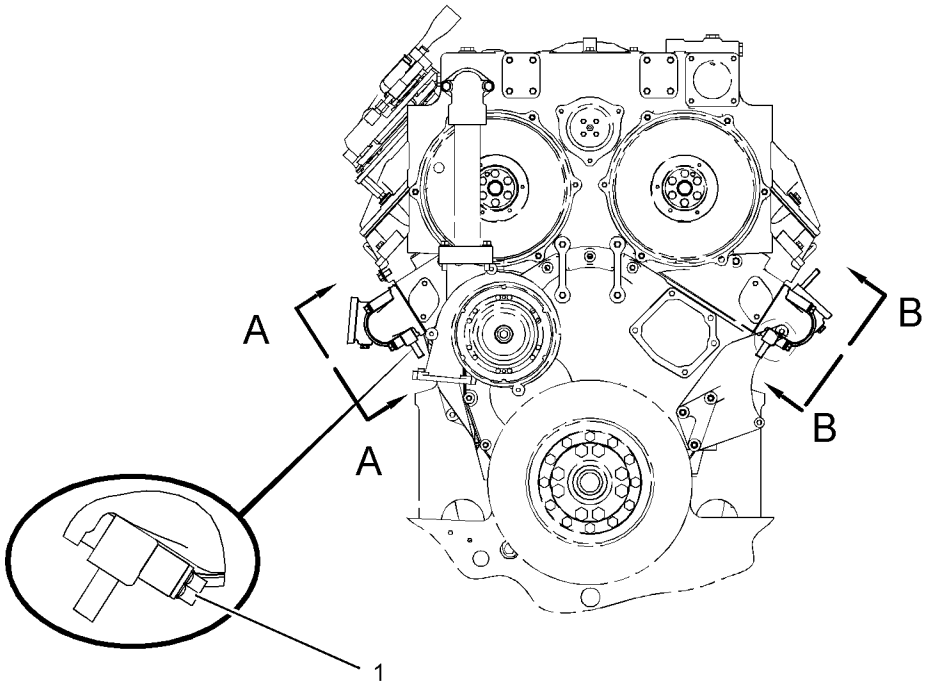


Illustration 60 g01417760

Front view

(1) Apply 4C-5599 Anti-Seize Compound on the threads of the 24 locknuts before assembly.

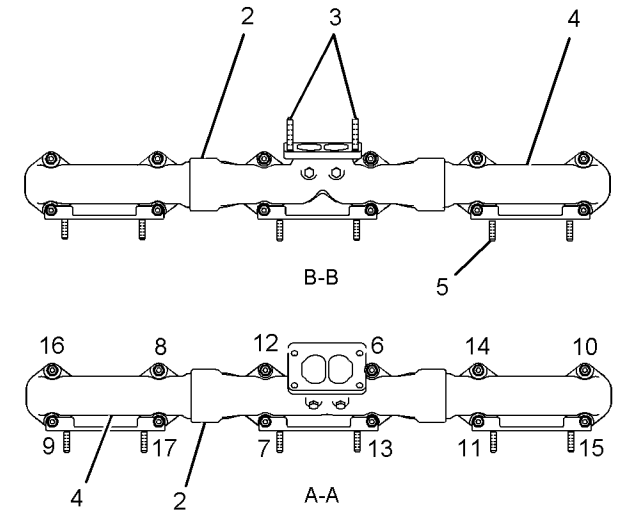


Illustration 61 g01417778

Exhaust manifold

Tightening sequence for the exhaust manifold

Note: Use a centering tool in at least one oversize hole per exhaust manifold section in order to align the exhaust manifolds. Do not remove the centering tool until removal is required to tighten the locknuts.

Use the following procedure to tighten the exhaust manifold on the cylinder head:

1. Tighten locknuts 6 through 17 in a numerical sequence to 20 ± 3 N·m (15 ± 2 lb ft).

2. Again tighten locknuts 6 through 17 in a numerical sequence to 38 ± 5 N·m (28 ± 4 lb ft).

(2) Coat the female ends of the two exhaust manifolds with clean engine oil.

Note: Apply 4C-5599 Anti-Seize Compound on the taperlock studs (3) before assembly.

(3) Torque for two taperlock studs . . . . . 35 ± 5 N·m ((26 ± 4 lb ft))

(4) Apply a thin coat of 2P-2333 High Temperature Sealer to the outside diameter of the male ends of the four exhaust manifolds prior to assembly. Remove excess sealer from the assembled joint.

(5) Torque for 12 taperlock studs . . . . . 35 ± 5 N·m ((26 ± 4 lb ft))

i02843368

Exhaust Manifold

SMCS Code: 1059

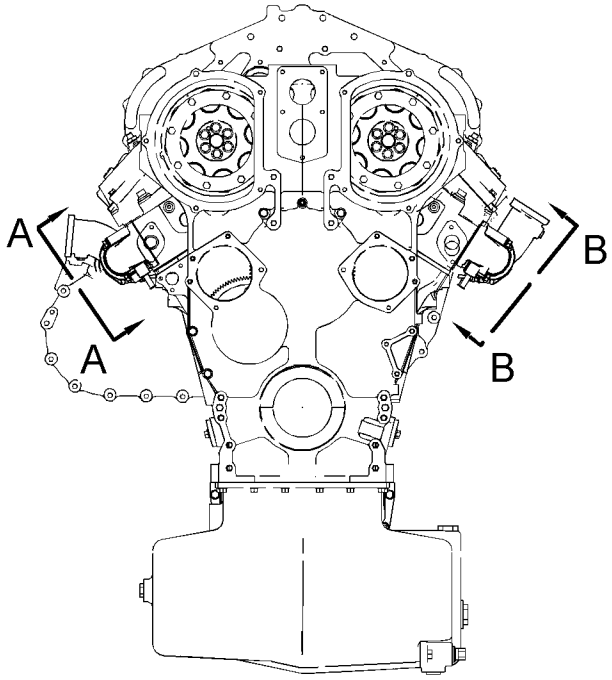


Illustration 62 g01432982

Front view

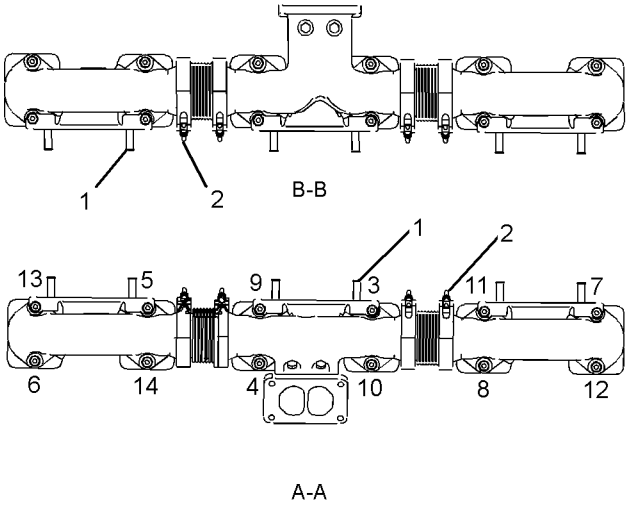


Illustration 63 g01417902

Tightening sequence for the exhaust manifold

Note: Use a centering tool in at least one oversize hole per exhaust manifold section in order to align the exhaust manifolds. Do not remove the centering tool until removal is required to tighten the locknuts.

Note: Apply 4C-5599 Anti-Seize Compound on the threads of the 24 locknuts before assembly.

Use the following procedure to tighten the exhaust manifold on the cylinder head:

1. Tighten locknuts 3 through 14 in a numerical sequence to 20 ± 3 N·m (15 ± 2 lb ft).

2. Again tighten locknuts 3 through 14 in a numerical sequence to 38 ± 5 N·m (28 ± 4 lb ft).

(1) Torque for 12 taperlock studs . . . . . 35 ± 5 N·m ((26 ± 4 lb ft))

(2) Torque for eight clamps . . . . . 8.5 ± 1.0 N·m ((75 ± 9 lb in))

i02866063

Exhaust Manifold

SMCS Code: 1059

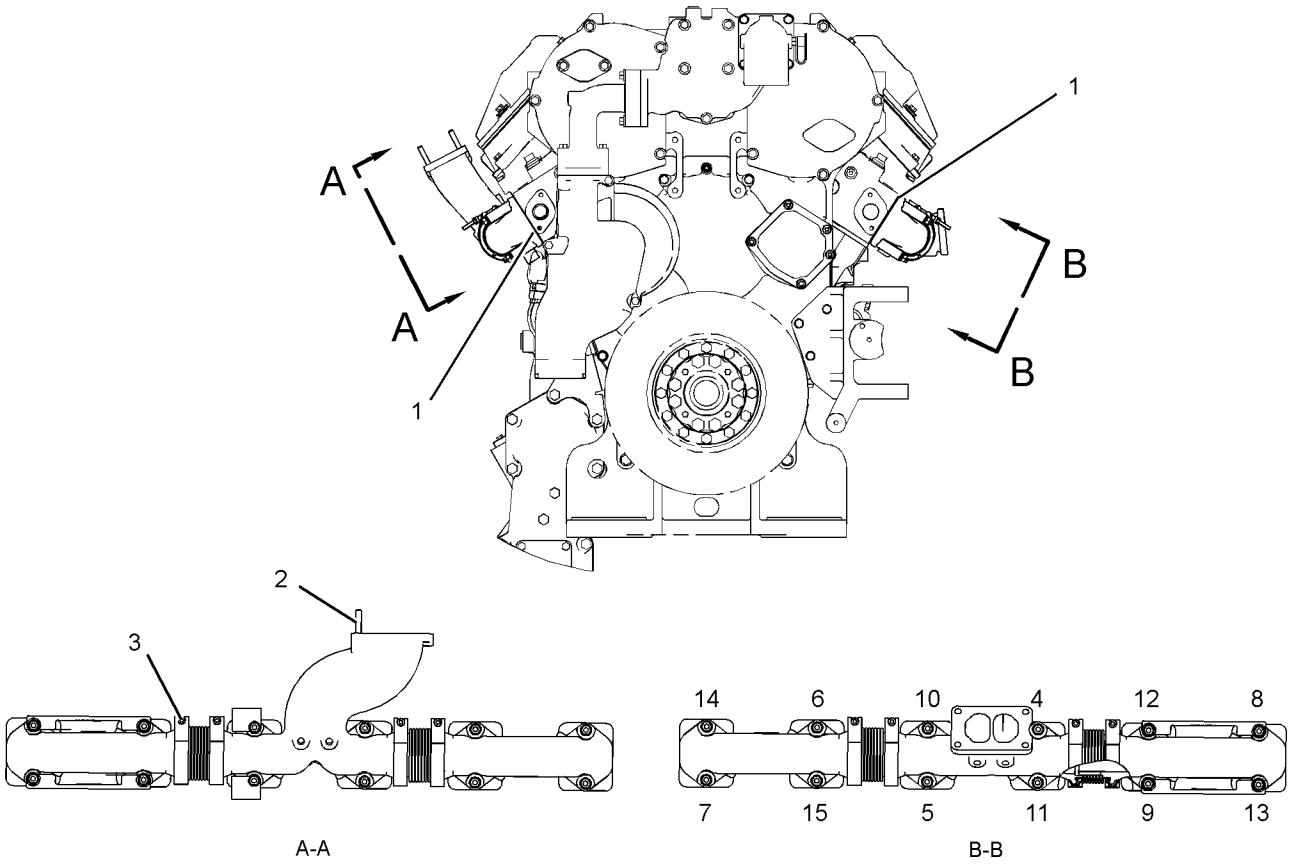


Illustration 64 g01427800

Front view

(1) Install the 12 gaskets so that the “MANIFOLD SIDE” marking faces away from the cylinder head.

(2) Torque for the two taperlock studs . . . 35 ± 5 N·m ((26 ± 4 lb ft))

(3) Torque for the eight clamps . . . . . 8.5 ± 1.0 N·m ((75 ± 9 lb in))

Note: Use a centering tool in at least one oversize hole per exhaust manifold section in order to align the exhaust manifolds. Do not remove the centering tool until removal is required to tighten the locknuts.

Use the following procedure to tighten locknut 4 through locknut 15:

Note: Apply 4C-5599 Anti-Seize Compound to the threads of the 24 locknuts.

1. Tighten the locknuts in a numerical sequence to 20 ± 3 N·m (15 ± 2 lb ft).
2. Again tighten the locknuts in a numerical sequence to 38 ± 5 N·m (28 ± 4 lb ft).

i03350880

Exhaust Manifold

SMCS Code: 1059

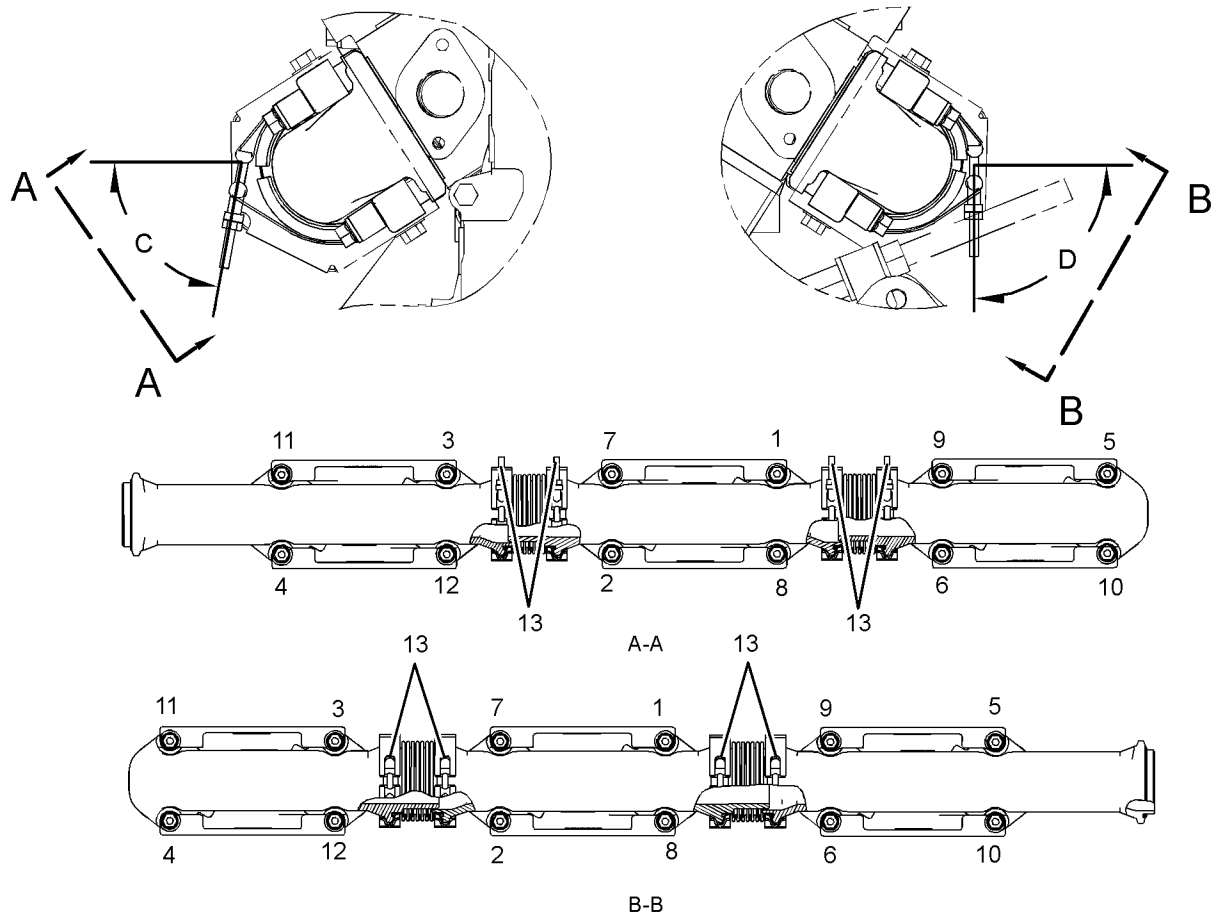


Illustration 65 g01417806

Orientation of clamps from front view of engine

Tightening sequence for the exhaust manifold

(C) Orientation for four clamps . . . . . 78 ± 5 degrees

(D) Orientation for four clamps . . . . . 90 ± 5 degrees

(13) Torque for eight clamps . . . . . 8.5 ± 1.0 N·m ((75 ± 9 lb in))

Note: Use a centering tool in at least one oversize hole per exhaust manifold section in order to align the exhaust manifolds. Do not remove the centering tools until removal is required to tighten the locknuts.

Use the following procedure to tighten the locknuts:

Note: Apply 4C-5599 Anti-Seize Compound to the threads of locknuts and to the bearing surface of the locknuts and the spacers and the washers before assembly.

1. Tighten locknut 1 through locknut 12 in a numerical sequence to 20 ± 3 N·m (15 ± 2 lb ft).
2. Again, tighten locknut 1 through locknut 12 in a numerical sequence to 38 ± 5 N·m (28 ± 4 lb ft).

i04961289

Exhaust Manifold

SMCS Code: 1059

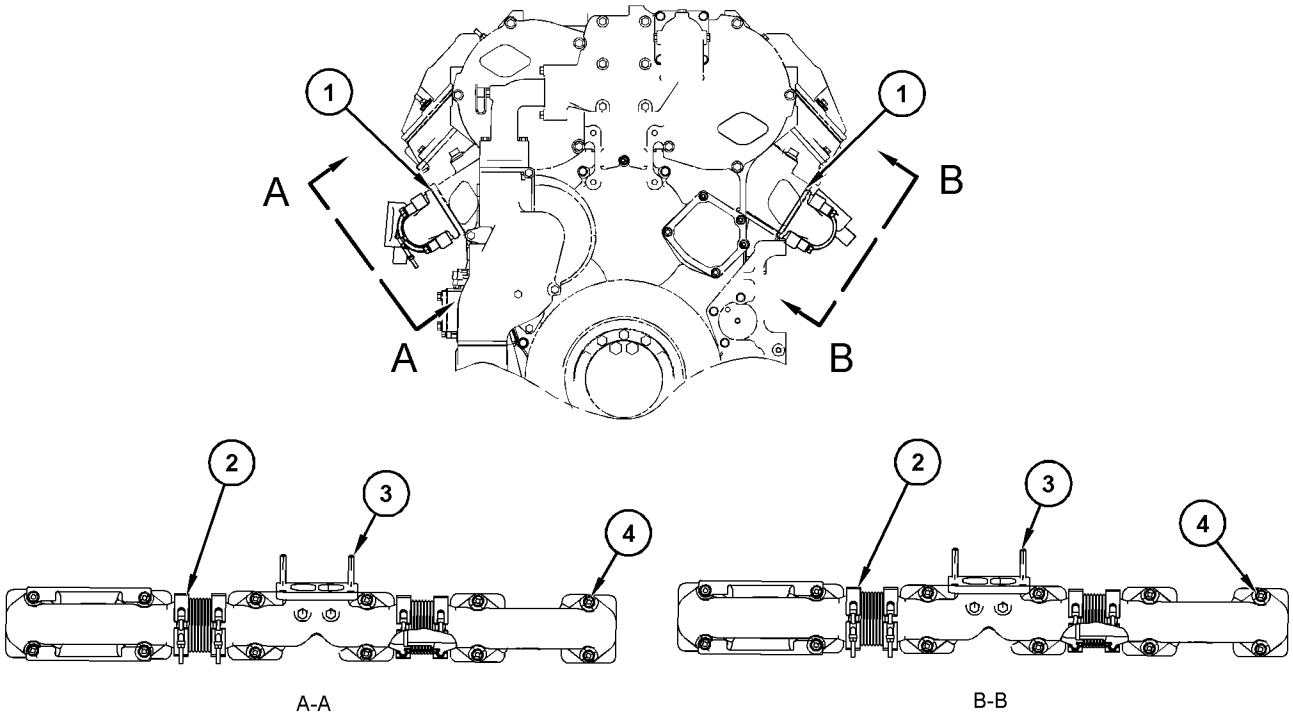


Illustration 66 g03145896

Typical example

Front view of engine

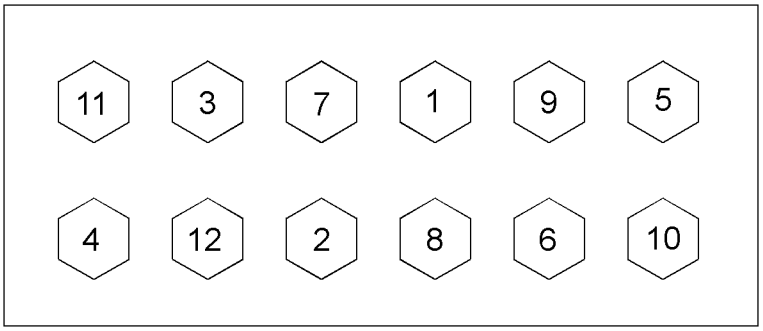


Illustration 67 g03145897

Tightening sequence for exhaust manifold

Table 33

Specification for 343-8976 Exhaust Manifold Gp and 348-2768 Exhaust Manifold Gp			
Item	**Qty**	**Part**	**Specification Description**
1	12	239-1388 Gasket	Install the gasket so that the “MANIFOLD SIDE” marking faces away from the cylinder head.
2	8	8N-0879 Clamp	Torque to 7.5 ± 1.0 N·m (66.4 ± 8.9 lb in). Do not reuse the clamp.
3	8	393-5115 Taperlock Stud	Torque to 35 ± 5 N·m (26 ± 4 lb ft).
4	24	2N-2766 Locknut	Use the following procedure in order to tighten the locknut: Use a centering tool in at least one oversize hole per manifold section in order to align the manifolds. Do not remove the centering tools until locknuts are tightened. 1. Before assembly, apply Loctite C5A copper anti-seize to the threads. 2. Tighten the locknut in a numerical sequence as shown in Illustration 67 to 20 ± 3 N·m (15 ± 2 lb ft). 3. Again, tighten the locknut in a numerical sequence as shown in Illustration 67 to 38 ± 5 N·m (28 ± 4 lb ft).

i07390200

Exhaust Manifold

SMCS Code: 1059

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 463-6097
S/N: E9Z1–Up

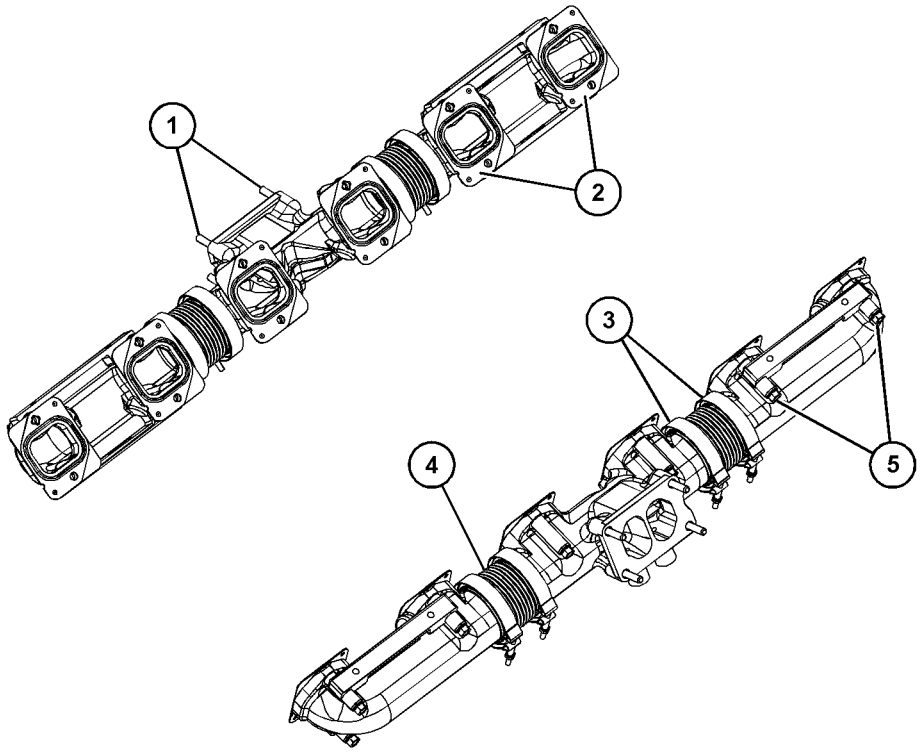


Illustration 68 g06305511

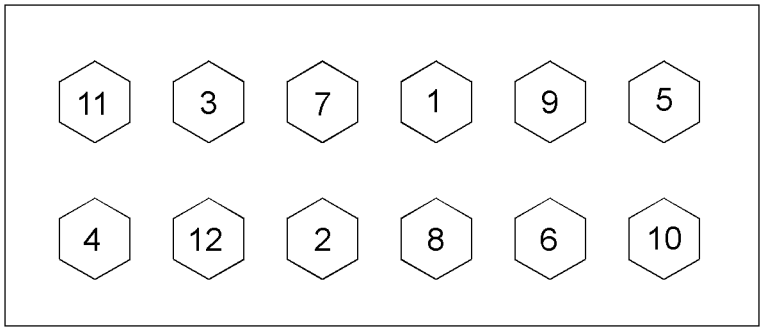


Illustration 69 g03145897

Tightening sequence for exhaust manifold

Table 34

Item	Qty	Part	Specification Description
1	8	393-5115 Taperlock Stud	Torque to 35 ± 5 N·m (26 ± 4 lb ft). Torque tool speed should not exceed 100 rpm.
2	12	239-1388 Gasket	Install the gasket so that the “manifold side” marking faces away from the cylinder head.
3	8	8N-0879 Clamp	Torque to 7.5 ± 1.0 N·m (66.4 ± 8.9 lb in). Do not reuse the clamp.
4	4	243-3566 Bellows As	Do not reuse.
5	24	2N-2766 Locknut	Use the following procedure to tighten the locknut: Use a centering tool in at least one oversize hole per manifold section to align the manifolds. Do not remove the centering tools until locknuts are tightened. 1. Before assembly, apply Loctite C5A copper anti-seize to the threads. 2. Tighten the locknut in a numerical sequence as shown in Illustration 69 to 20 ± 3 N·m (177 ± 27 lb in). 3. Again, tighten the locknut in a numerical sequence as shown in Illustration 69 to 38 ± 5 N·m (28 ± 4 lb ft).

i07109981

Camshaft

SMCS Code: 1210

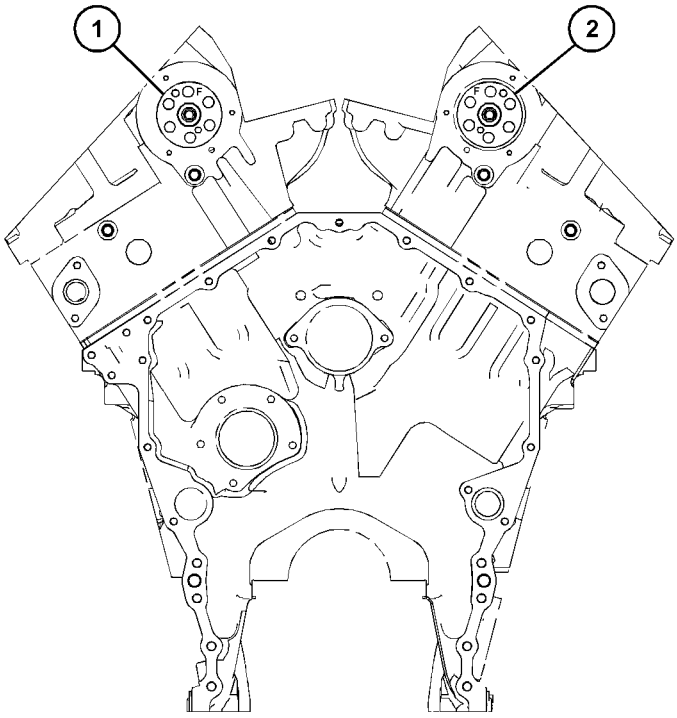


Illustration 70 g06226355

Front of engine

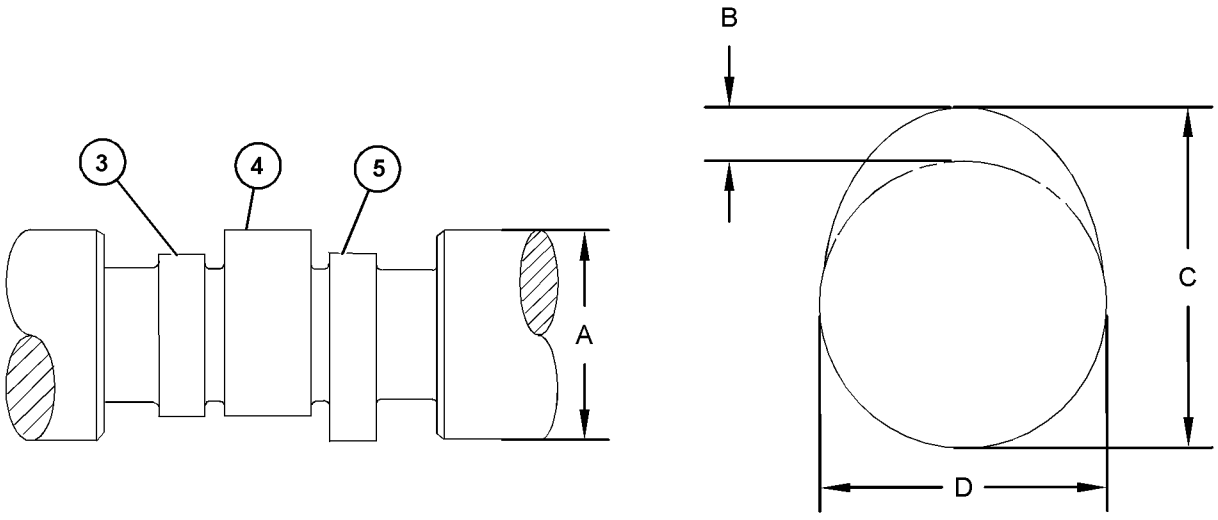


Illustration 71 g06228165

(3) Exhaust lobe (4) Injector lobe (5) Inlet lobe

Table 35

Item	Qty	Part	Specification Description
1	1	421-0049 Camshaft	Lubricate the camshaft bearings, the journals, and the lobes with a 50/50 mixture of 8T-2998 Lubricant and clean engine oil. The end of the camshaft that is marked “F” must be placed at the front of the engine.
2	1	421-0071 Camshaft	
A	-	-	Diameter of camshaft journal is 84.85 ± 0.02 mm (3.341 ± 0.001 inch).
Use the following procedure in order to determine the camshaft lobe lift: 1. Measure the camshaft lobe height (C). 2. Measure the base circle (D). 3. Subtract the base circle measurement in Step 2 from the camshaft lobe height in Step 1. The difference is the actual camshaft lobe lift (B). Specified camshaft lobe lift: For inlet lobe is 9.61850 mm (0.378681 inch) For exhaust lobe is 8.51520 mm (0.335244 inch) For injector lobe (right blank) is 10.33685 mm (0.406963 inch). For injector lobe (left blank) is 10.34660 mm (0.407356 inch). The maximum permissible difference between the actual camshaft lobe lift in Step 3 and the specified camshaft lobe lift is 0.13 mm (0.005 inch).			

i07397672

Camshaft

SMCS Code: 1210

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 260-9306
S/N: E9Z1–Up

S/N: KDZ1–Up

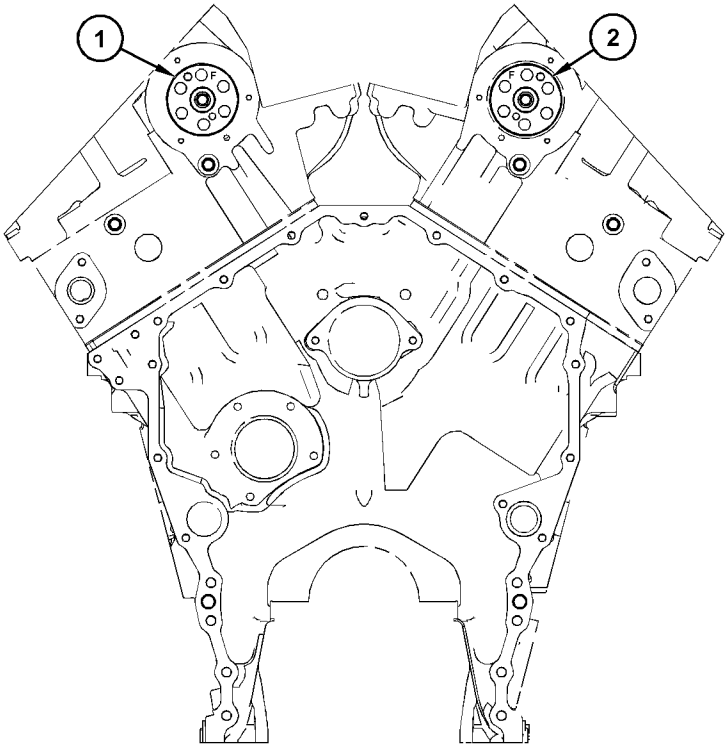


Illustration 72 g03146238

Front view of engine

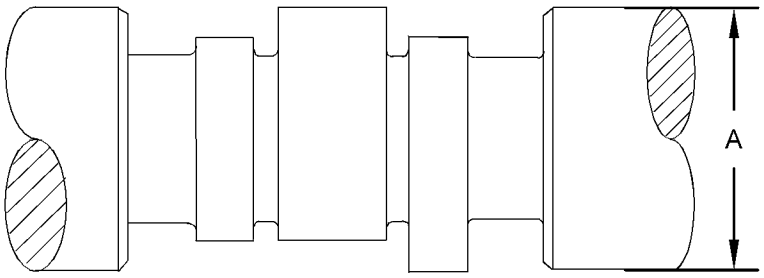


Illustration 73 g03146239

Table 36

Item	Qty	Part	Specification Description
Before assembly, lubricate the camshaft bearings, the journals, and the lobes with a 50/50 mixture of green 8T-2998 Lubricant and clean engine oil.			
1	1	421-0087 Camshaft	The end of the camshaft that is marked “F” must be placed at the front of the engine.
2	1	421-0097 Camshaft	The end of the camshaft that is marked “F” must be placed at the front of the engine.
A	-	-	Diameter of camshaft journal is 84.85 ± 0.02 mm (3.341 ± 0.001 inch).

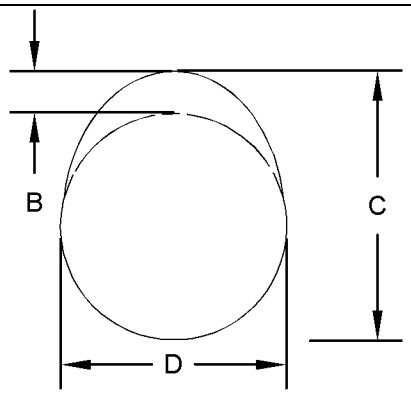


Illustration 74 g03146256

Table 37

Item	Qty	Part	Specification Description
-	-	-	Use the following procedure to determine the actual camshaft lobe lift: 1. Measure camshaft lobe height (C). 2. Measure the base circle (D). 3. Subtract the base circle (D) from the camshaft lobe height (C). The difference is the actual camshaft lobe lift (B).
-	-	-	Specified camshaft lobe lift (B) for:
			Inlet lobe is 9.6185 mm (0.37868 inch).
			Exhaust lobe is 8.5152 mm (0.33524 inch).
			Injector lobe (right blank) is 10.3372 mm (0.40698 inch).
			Injector lobe (left blank) is 10.3381 mm (0.40701 inch).

i02847540

Engine Oil Filter Base

SMCS Code: 1306

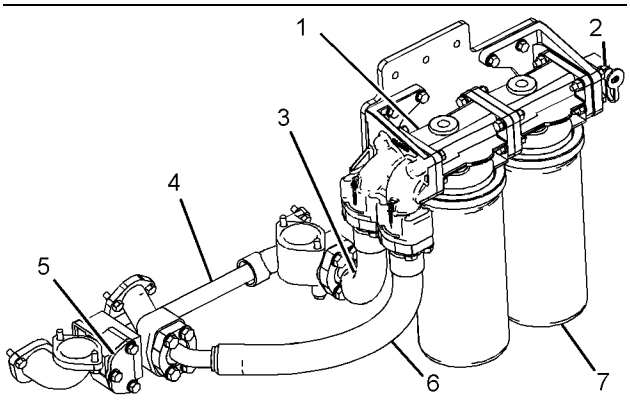


Illustration 75 g01419688

(1) Oil filter base assembly
(2) Fluid sampling valve
(3) Oil supply line (unfiltered oil)
(5) Oil cooler bypass valves
(6) Oil return line (filtered oil)

(4) Lightly lubricate the bore and the O-ring seals for the cooler bypass tube with clean engine oil.

(7) Lubricate the seal of the engine oil filter element assembly with clean engine oil.

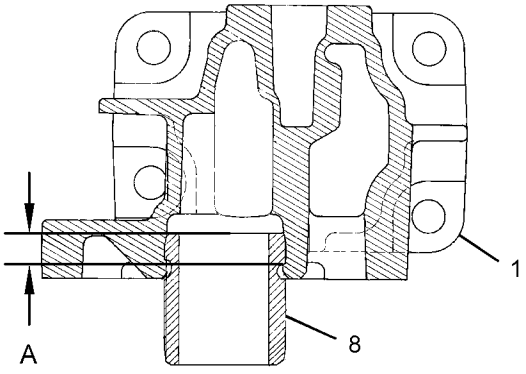


Illustration 76 g01419678

(A) Length for applying 154 - 9731 Thread Lock Compound to the threads of the hollow stud . . . . . 10.2 ± 1.5 mm ((0.40 ± 0.06 inch))

(8) Torque for the hollow stud . . . . . 80 ± 14 N·m ((60 ± 10 lb ft))

i02848619

Engine Oil Filter Base

SMCS Code: 1306

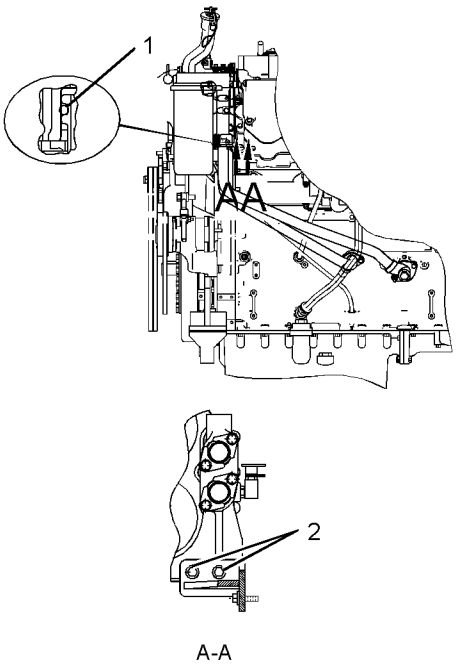


Illustration 77 g01432945

Left side view of engine

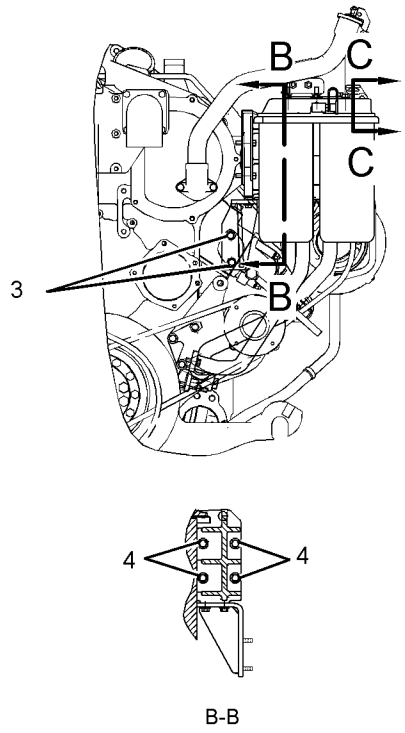


Illustration 78 g01432946

Front view of engine

(1) Lubricate the bore of the O-ring seal lightly with lubricant that is being sealed.

Use the following procedure to tighten the bolts:

1. Torque bolts (4) to 47 ± 9 N·m (35 ± 7 lb ft).

2. Torque bolts (2) to 5 ± 3 N·m (45 ± 27 lb in).

3. Torque bolts (3) to 47 ± 9 N·m (35 ± 7 lb ft).

4. Again torque bolts (2) to 47 ± 9 N·m (35 ± 7 lb ft).

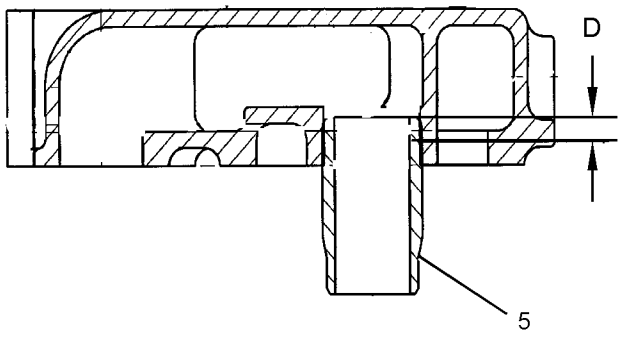


Illustration 79 g01420429

Section C-C

(D) Length for applying 154-9731 Thread Lock Compound on the two taperlock studs . . . . . 8 mm ((0.3 inch))

(5) Torque for two taperlock studs . . . . . 80 ± 15 N·m ((60 ± 11 lb ft))

i07199944

Engine Oil Filter Base

SMCS Code: 1306

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 350-2547
S/N: E9Z1–Up

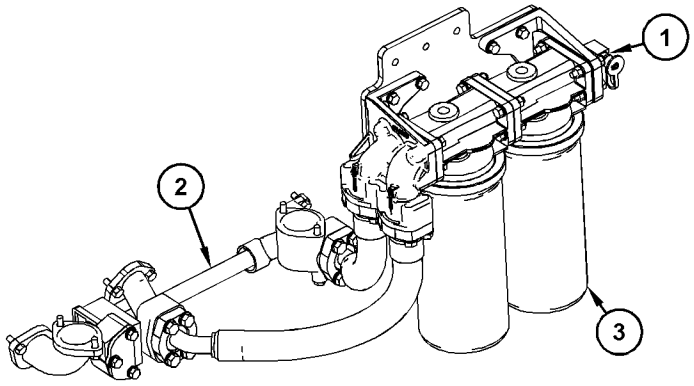


Illustration 80 g03143957

Table 38

Item	Qty	Part	Specification Description
1	1	8C-3446 Fluid Sampling Valve	Torque to 19 ± 3 N.m (168 ± 27 lb in).
2	-	-	Lightly lubricate the bore and the O-ring seals for the cooler bypass tube with clean engine oil.
3	2	1R-1808 Engine Oil Filter	Lubricate the seal of the engine oil filter element assembly with clean engine oil. Tighten the filter for one complete turn after the oil filter contacts the oil filter base.

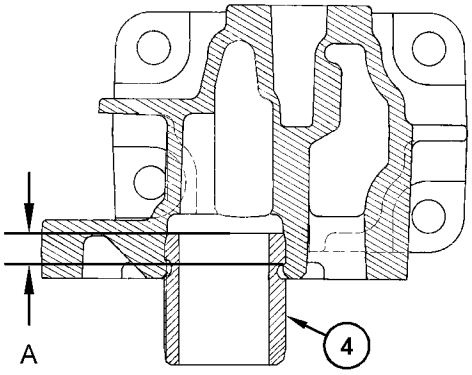


Illustration 81 g03143976

Table 39

Item	Qty	Part	Specification Description
A	-	-	Before assembly, apply red Loctite271 to the hollow stud length 10.2 ± 1.5 mm (0.4 ± 0.06 inch).
4	2	2P-4304 Hollow Stud	Torque to 80 ± 14 N·m (59 ± 10 lb ft).

i07317747

Engine Oil Filter Base

SMCS Code: 1306

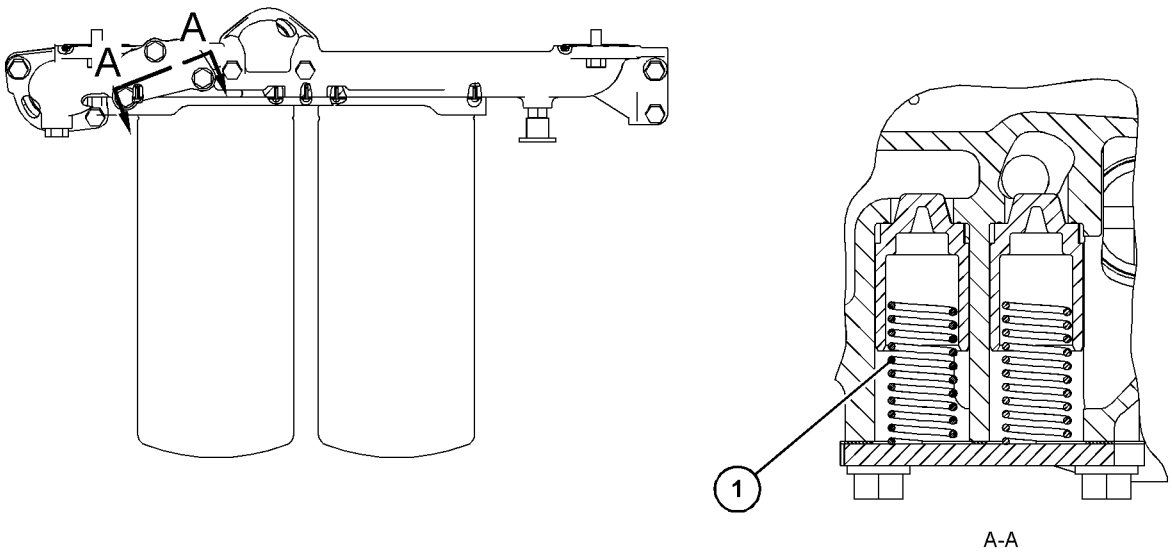


Illustration 82 g06281160

Table 40

Item	Qty	Part	Specification Description
1	2	4N-8150 Spring	Length under test force is 55.24 mm (2.175 inch). Test force is 75.619 ± 5.800 N (17.0 ± 1.3 lb). Free length after test is 93.726 mm (3.6900 inch).

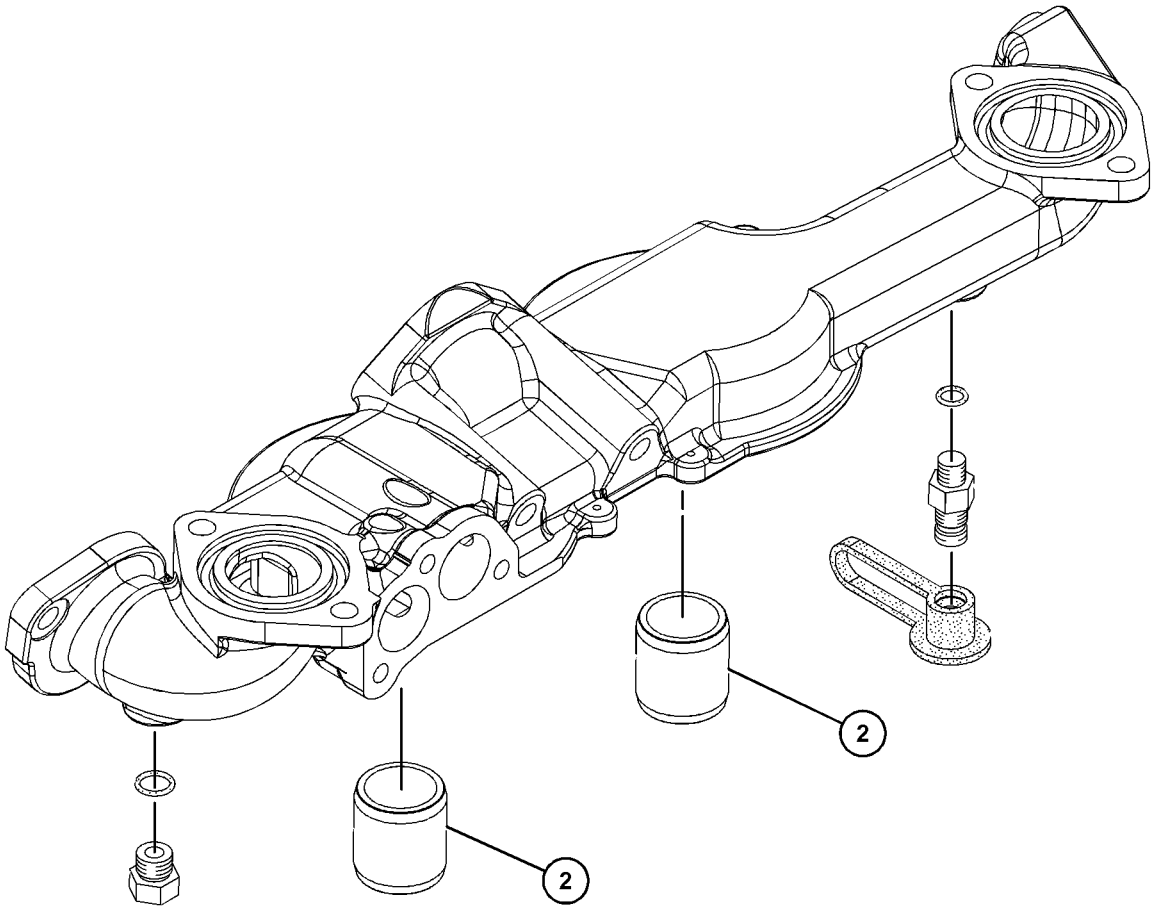


Illustration 83 g06281165

264-1491 Oil Filter Base As

Table 41

Item	Qty	Part	Specification Description
2	2	2P-4304 Hollow Stud	Apply red Loctite 263 to the threads on 7.6 mm (0.30 inch) from tapered end. Torque to 81 ± 14 N·m (60 ± 10 lb ft).

i04962092

Engine Oil Pump

SMCS Code: 1304

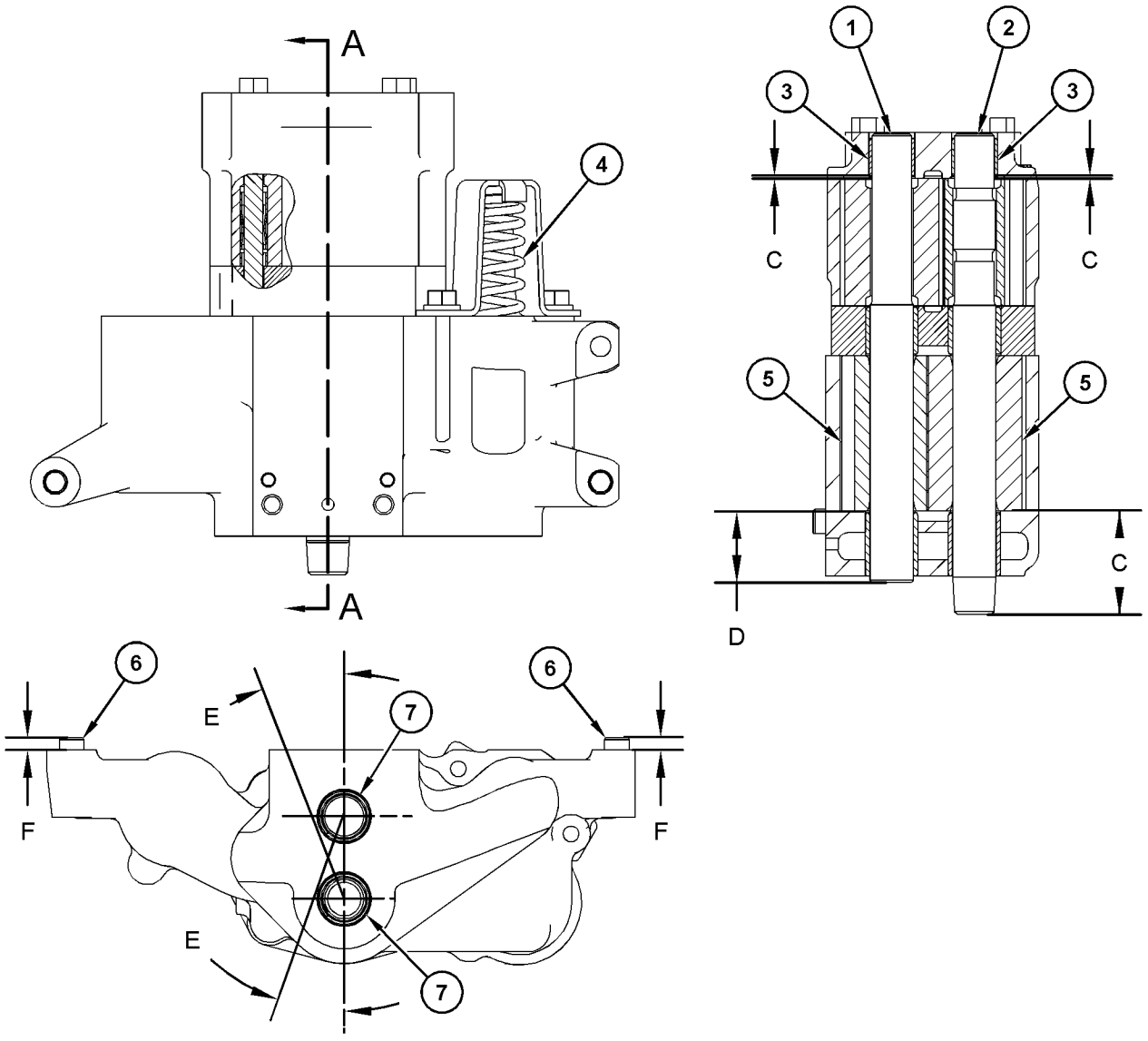


Illustration 84 g03146776

Table 42

Specification for 7C-1772 Engine Oil Pump Gp			
Item	**Qty**	**Part**	**Specification Description**
Before you install the pump, lubricate the moving parts with clean engine oil. Rotate the pump by hand in order to ensure that the pump rotates freely.			
1	1	145-8503 Idler Shaft Assembly	Diameter of the new shaft over bushing (3) end is 20.320 ± 0.005 mm (0.8000 ± 0.0002 inch).

(continued)

(Table 42, contd)

			Diameter of the new shaft over gear (5) end is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
			Bore in the bushing for the new shaft is 20.361 ± 0.008 mm (0.8016 ± 0.0003 inch).
			Installation depth (B) of the bushing is 1.52 mm (0.060 inch).
			Distance (D) from the end of the shaft to the gear (5) face is 36.50 ± 0.25 mm (1.437 ± 0.010 inch).
2	1	202-3572 Drive Shaft As	Diameter of the new shaft over bushing (3) end is 20.320 ± 0.005 mm (0.8000 ± 0.0002 inch).
			Diameter of the new shaft over gear (5) end is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
			Bore in the bushing for the new shaft is 20.361 ± 0.008 mm (0.8016 ± 0.0003 inch).
			Installation depth (B) of the bushing is 1.52 mm (0.060 inch).
			Distance (C) from the end of the shaft to the gear (5) face is 53.00 ± 0.25 mm (2.087 ± 0.010 inch).
4	1	236-6733 Spring	Length under test force is 82.87 mm (3.263 inch).
			Test force is 709 ± 35 N (159 ± 8 lb).
			Free length after test is 130.0 mm (5.12 inch).
5	2	1W-7240 Gear	Length of the new gear is 79.375 ± 0.025 mm (3.1250 ± 0.0010 inch).
			Depth of the bore in the oil pump body for the new gear is 79.502 ± 0.020 mm (3.1300 ± 0.0008 inch).
6	2	8M-8489 Dowel	Protrusion (F) is 6.4 ± 0.5 mm (0.25 ± 0.02 inch).
7	2	7N-2156 Bushing	Installation depth is 0.30 ± 0.25 mm (0.012 ± 0.010 inch).
			Position (E) of bushing joints from the centerline through the bearing bores is 30 ± 15 degrees.

i06682456

Engine Oil Pump

SMCS Code: 1304

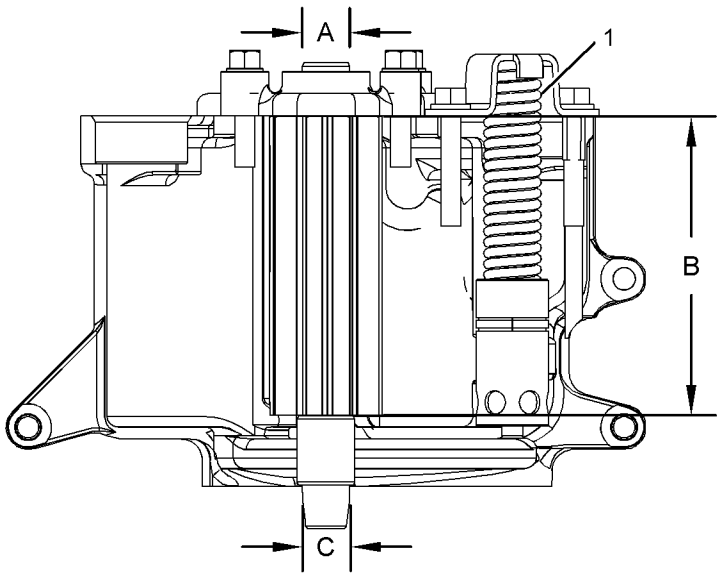


Illustration 85 g02589961

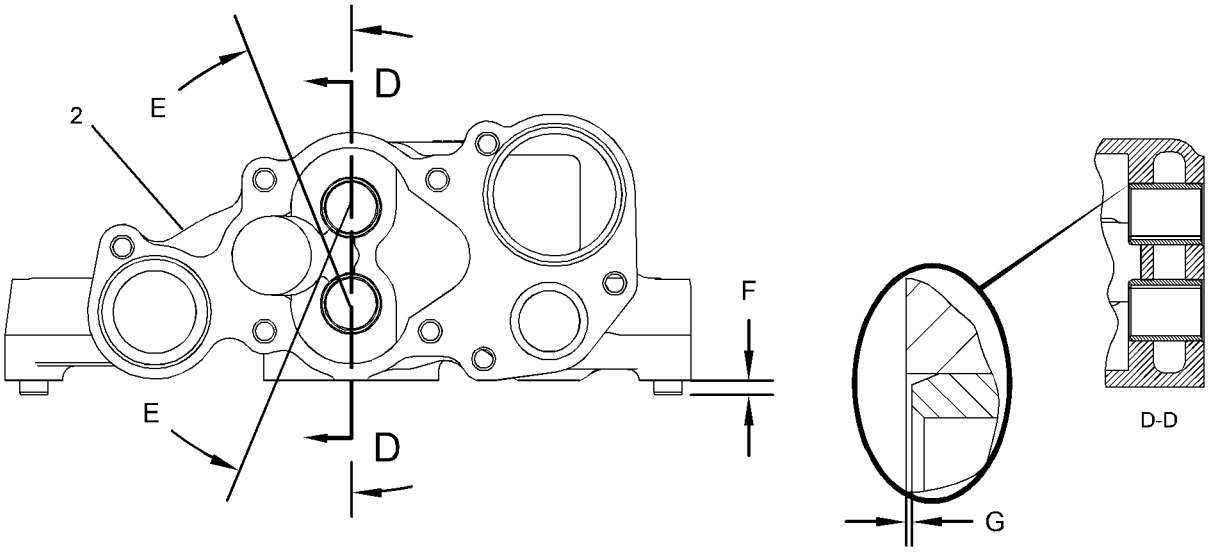


Illustration 86 g06073261

(2) Oil pump body

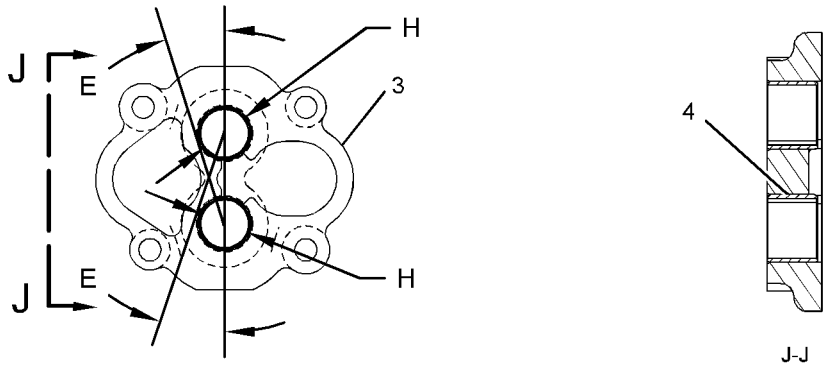


Illustration 87 g06073272

(3) Oil pump cover

Table 43

Specification for 116-1980 Engine Oil Pump Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	2S-2760 Spring	Length under test force is 117.14 mm (4.612 inch).
			Test force is 499 ± 24 N (112 ± 5 lb).
			Approximate free length after test is 152.91 mm (6.020 inch).
A	1	105-4929 Oil Pump Drive Shaft	Diameter of the oil pump drive shaft is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
B	2	107-7372 Gear	Length of the gear is 140.000 ± 0.025 mm (5.5118 ± 0.0010 inch).
			Depth of bores in oil pump body (2) for gear is 140.127 ± 0.020 mm (5.5168 ± 0.0008 inch).
C	1	105-1485 Oil Pump Drive Shaft	Diameter of the oil pump drive shaft is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
E	-	-	Position of bushing joint from the centerline through bushing bores is 30 ± 15 degrees.
F	2	8M-8489 Dowel	Extension of dowel from the oil pump body (2) is 6.4 ± 0.5 mm (0.25 ± 0.02 inch).
G	2	7N-2156 Bushing	The bushings should be installed so that the edge of the bushing is flush with the outside of the oil pump body (2).
			Installation depth of the bushing into the oil pump body is 0.30 ± 0.25 mm (0.012 ± 0.010 inch).
H	2	8S-6511 Bushing	The bushings should be installed so that the edge of the bushing is flush with face (4).
			Bore in oil pump cover (3) for bushing for pump drive shaft is 25.400 ± 0.013 mm (1.0000 ± 0.0005 inch).

i07317784

Engine Oil Pump

SMCS Code: 1304

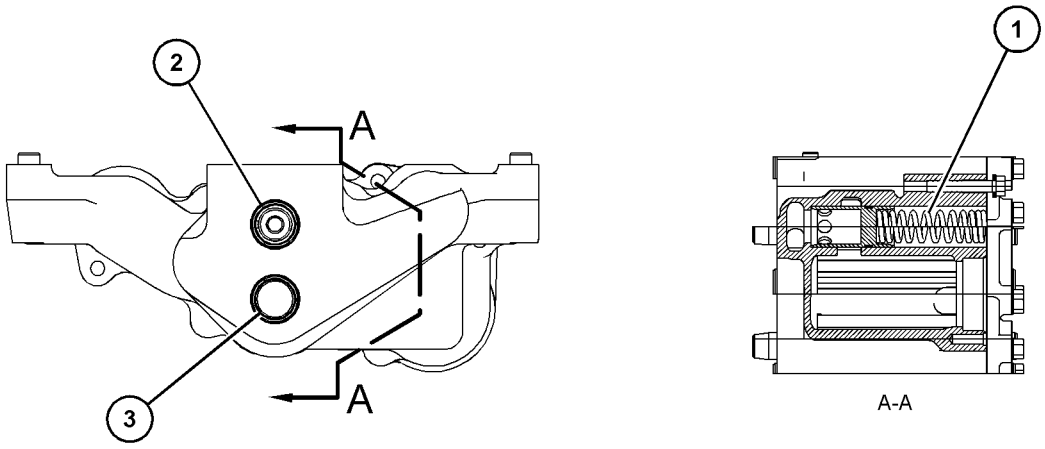


Illustration 88 g06281270

Table 44

Item	Qty	Part	Specification Description
Before you install the pump, lubricate the moving parts with clean engine oil. Rotate the pump by hand in order to ensure that the pump rotates freely.			
1	1	2S-2760 Spring	Length under test force is 117.14 mm (4.612 inch).
			Test force is 499 ± 24 N (112 ± 5 lb).
			Free length after test is 152.91 mm (6.020 inch).
2	1	516-6890 Drive	Diameter of the new shaft is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
			Distance from the end of the shaft to the gear face is 53.00 ± 0.25 mm (2.087 ± 0.010 inch).
3	1	516-6891 Shaft Idler	Diameter of the new shaft is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
			Distance from the end of the shaft to the gear face is 36.50 ± 0.25 mm (1.437 ± 0.010 inch).

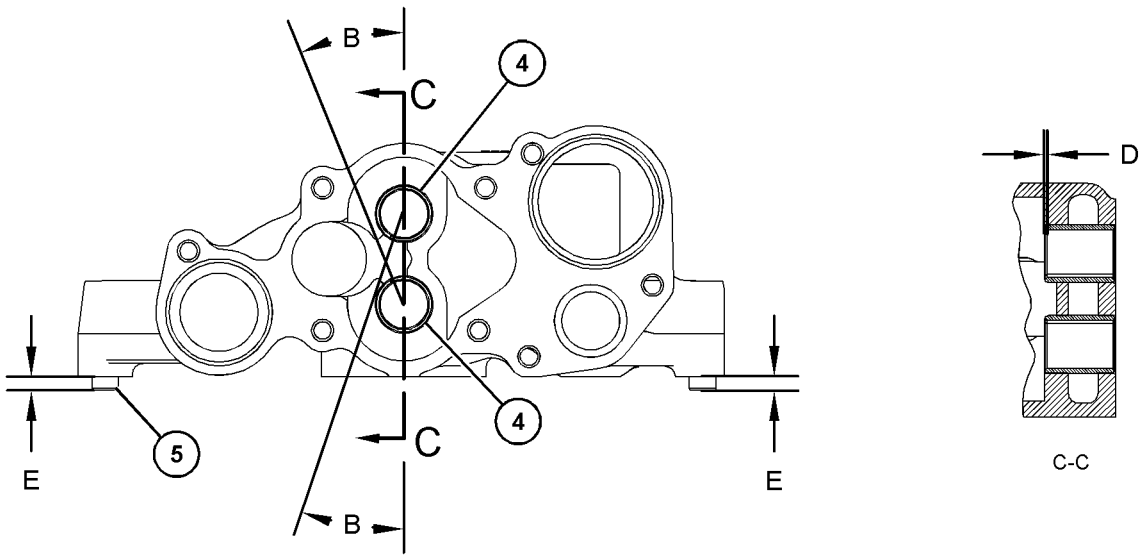


Illustration 89 g06281275

116-1979 Oil Pump Body As

Table 45

Item	Qty	Part	Specification Description
4	2	7N-2156 Bushing	Installation depth (D) is 0.30 ± 0.25 mm (0.012 ± 0.010 inch).
			Position (B) of bushing joints from the centerline through the bearing bores is 30 ± 15 degrees.
5	2	8M-8489 Dowel	Protrusion (E) is 6.4 ± 0.5 mm (0.25 ± 0.02 inch).

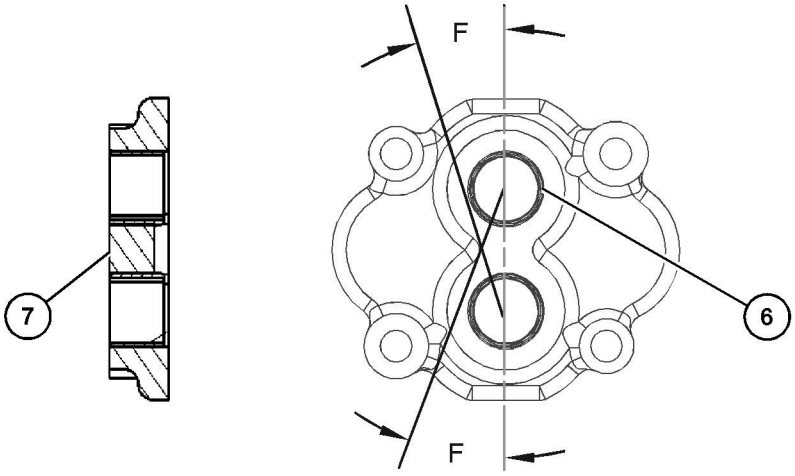


Illustration 90 g06281284

127-6356 Pump Cover

Table 46

Item	Qty	Part	Specification Description
6	2	8S-6511 Bushing	Install the bushing flush with face (7).
			Position (F) of bushing joints from the centerline through the bearing bores is 30 ± 15 degrees.

i07330527

Engine Oil Pump

SMCS Code: 1304

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 520-2923
S/N: E9Z1–Up

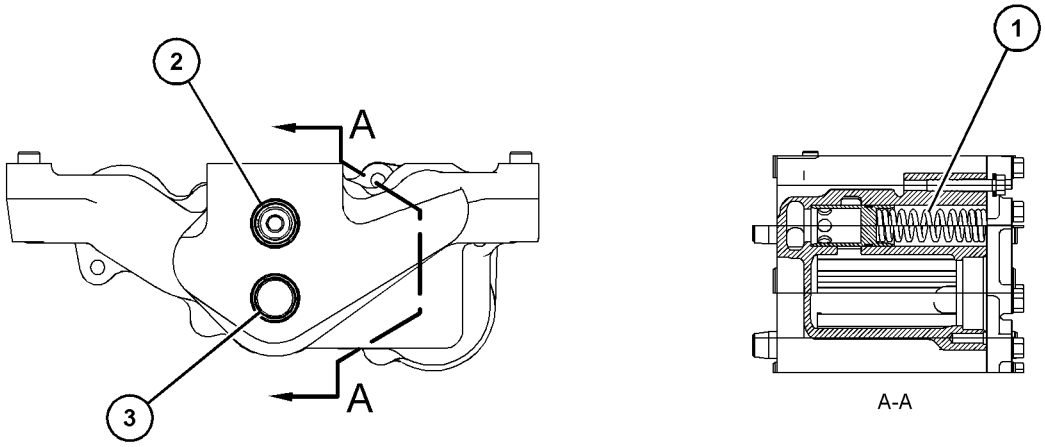


Illustration 91 g06281270

Table 47

Item	Qty	Part	Specification Description
Before you install the pump, lubricate the moving parts with clean engine oil. Rotate the pump by hand to ensure that the pump rotates freely.			
1	1	236-6733 Spring	Length under test force is 82.87 mm (3.263 inch).
			Test force is 709 ± 35 N (160 ± 8 lb).
			Free length after test is 130 mm (5 inch).
2	1	516-6890 Drive	Diameter of the new shaft is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
			Distance from the end of the shaft to the gear face is 53.00 ± 0.25 mm (2.087 ± 0.010 inch).
3	1	516-6891 Shaft Idler	Diameter of the new shaft is 22.217 ± 0.005 mm (0.8747 ± 0.0002 inch).
			Distance from the end of the shaft to the gear face is 36.50 ± 0.25 mm (1.437 ± 0.010 inch).

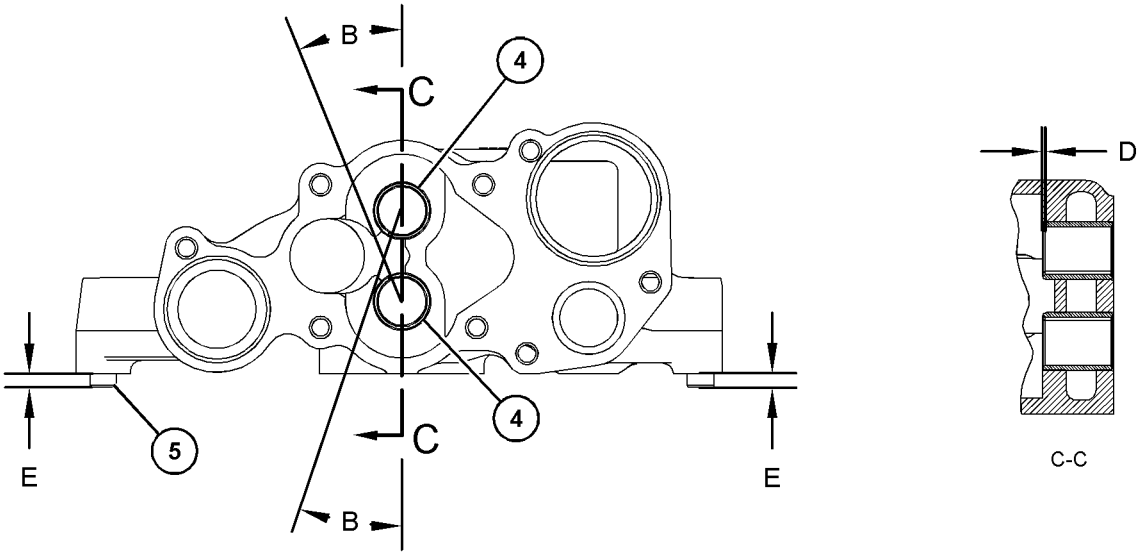


Illustration 92 g06281275

116-1979 Oil Pump Body As

Table 48

Item	Qty	Part	Specification Description
4	2	7N-2156 Bushing	Installation depth (D) is 0.30 ± 0.25 mm (0.012 ± 0.010 inch).
			Position (B) of bushing joints from the centerline through the bearing bores is 30 ± 15 degrees.
5	2	8M-8489 Dowel	Protrusion (E) is 6.4 ± 0.5 mm (0.25 ± 0.02 inch).

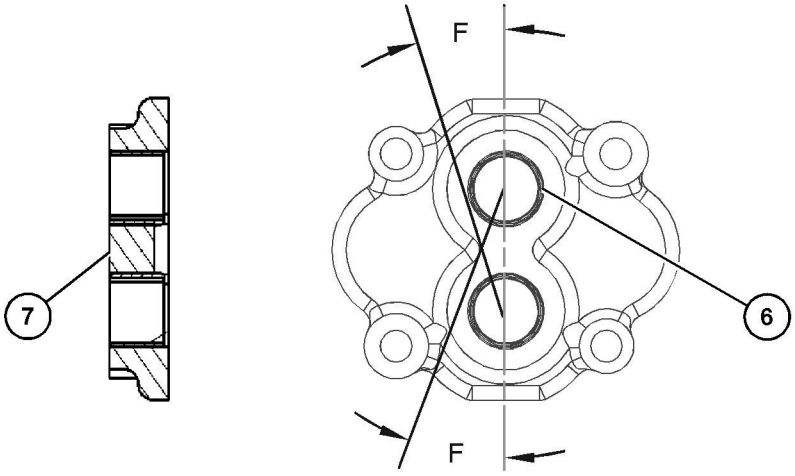


Illustration 93 g06281284

127-6356 Pump Cover

Table 49

Item	Qty	Part	Specification Description
6	2	8S-6511 Bushing	Install the bushing flush with face (7).
			Position (F) of bushing joints from the centerline through the bearing bores is 30 ± 15 degrees.

i02865980

Engine Oil Bypass Valve

SMCS Code: 1306-BV

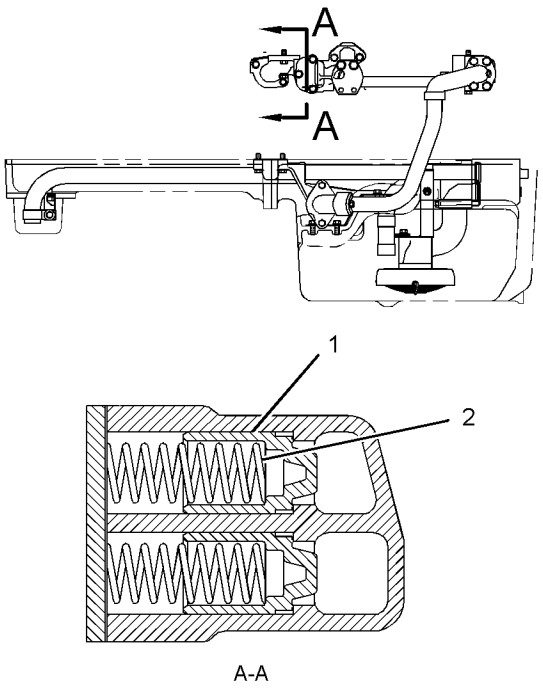


Illustration 94 g01427688

Typical example

Right side view

Note: Check the valve and the valve seat for abnormal contact patterns.

(1) The 9M-0853 Valve Plunger is for the oil filter bypass valve.

(2) The 9F-6304 Spring is for the oil filter bypass valve.

Length under test force . . . . . 53.98 mm ((2.125 inch))
Test force . . . . . 145 to 160 N ((32.3 to 35.7 lb))
Free length after test . . . . . 105.56 mm ((4.156 inch))
Outside diameter . . . . . 20.65 mm ((0.813 inch))

i02865988

Engine Oil Bypass Valve

SMCS Code: 1306-BV

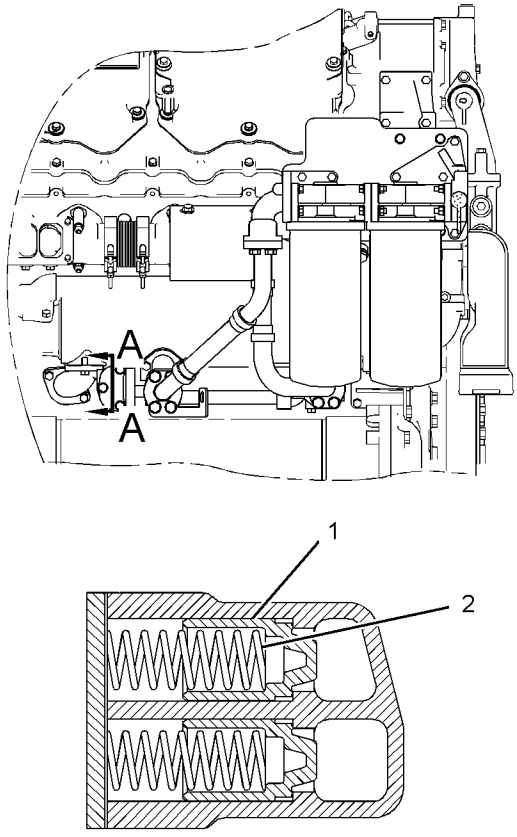


Illustration 95 g01427693

Typical example

Right side view of engine

Note: Check the valve and the valve seat for abnormal contact patterns.

(1) The 9M-0853 Valve Plunger is for the oil filter bypass valve.

(2) The 9F-6304 Spring is for the oil filter bypass valve.

Length under test force . . . . . 53.98 mm ((2.125 inch))
Test force . . . . . 145 to 160 N ((32.3 to 35.7 lb))
Free length after test . . . . . 105.56 mm ((4.156 inch))
Outside diameter . . . . . 20.65 mm ((0.813 inch))

i02857775

Engine Oil Pan

SMCS Code: 1302

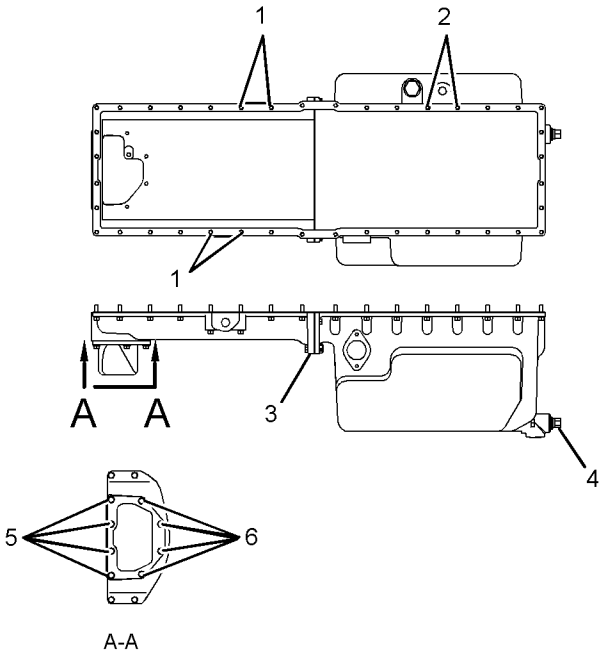


Illustration 96 g01433353

(3) After assembly, trim off excess gasket material from outside of assembled joint.

Note: Lubricate the threads of the drain plug lightly with clean engine oil before assembly.

(4) Torque for the drain plug . . . . . 70 ± 10 N·m ((50 ± 7 lb ft))

Bolts (1) are 3/8-16 X 2 3/4 inches.

Bolts (2) are 3/8-16 X 1 1/2 inches.

Bolts (5) are 3/8-16 X 4 1/4 inches.

Bolts (6) are 3/8-16 X 1 3/8 inches.

The remaining oil pan bolts are 3/8-16 X 1 1/4 inches.

i02879916

Engine Oil Pan

SMCS Code: 1302

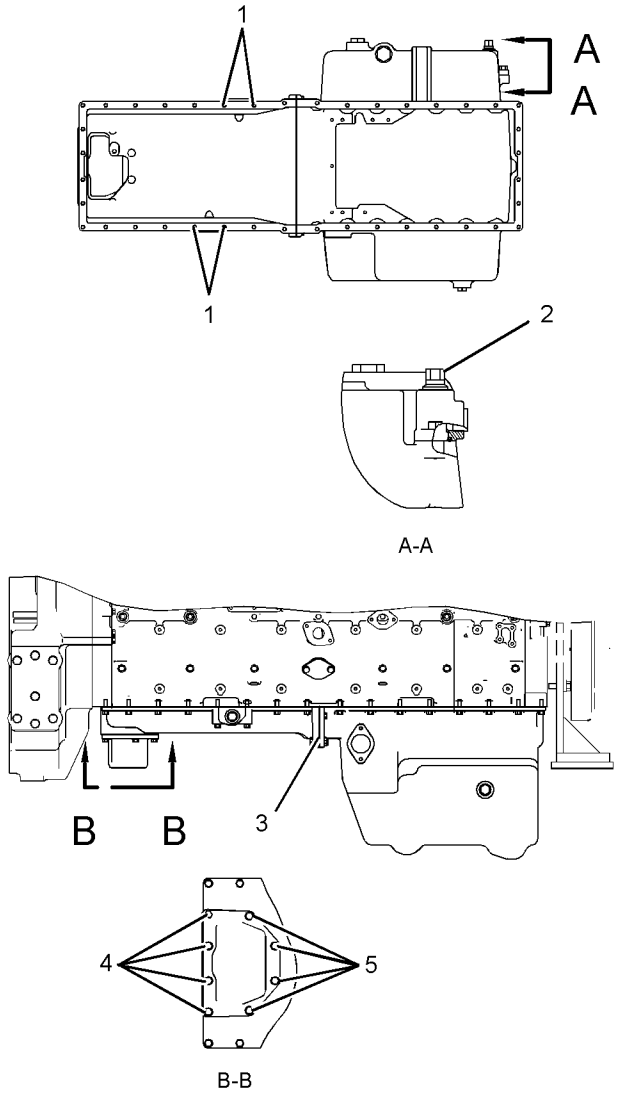


Illustration 97 g01433751

Note: Lubricate the threads of the drain plug lightly with clean engine oil before assembly.

(2) Torque for the drain plug . . . . . 70 ± 10 N·m ((50 ± 7 lb ft))

(3) After assembly, trim off excess gasket material from outside of assembled joint.

Bolts (1) are 3/8-16 X 2 3/4 inches.

Bolts (4) are 3/8-16 X 4 1/4 inches.

Bolts (5) are 3/8-16 X 1 3/8 inches.

The remaining oil pan bolts are 3/8-16 X 1 1/4 inches.

i06171375

Engine Oil Pan

SMCS Code: 1302

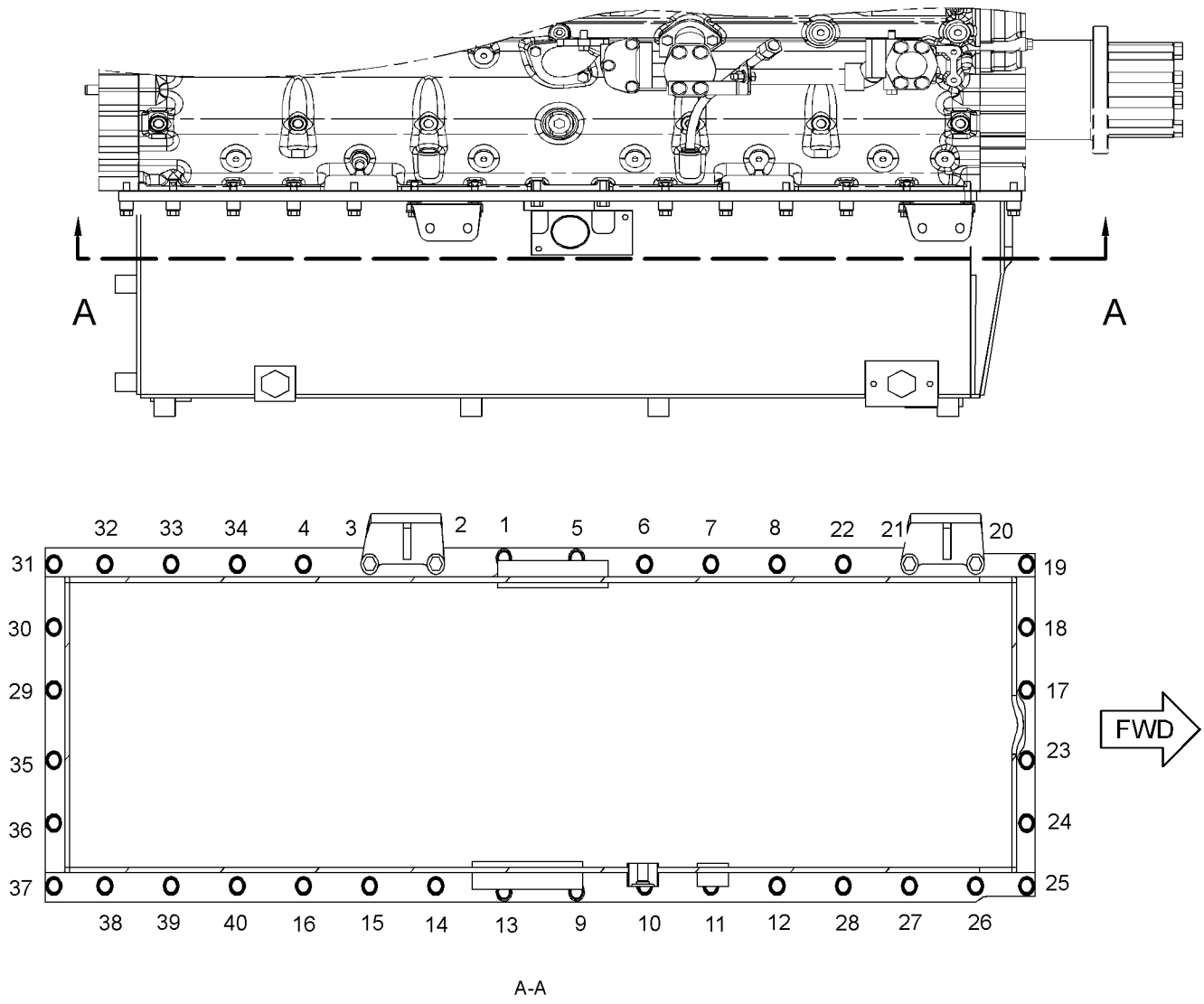


Illustration 98 g01422063

Typical example

Right side view

Use the following procedure to tighten the bolts for the oil pan:

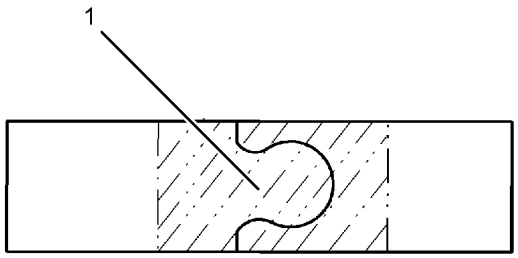


Illustration 99 g03836039

Detail of the oil pan gasket joint

(1) Ball and socket joint

1. Apply sealant under and on top of the four ball and socket joints (1) of the oil pan gasket.

2. Tighten the bolts in the numerical sequence to 47 ± 9 N·m (35 ± 7 lb ft).

3. Again tighten the bolts in the numerical sequence to 47 ± 9 N·m (35 ± 7 lb ft).

i07306228

Engine Oil Pan

SMCS Code: 1302

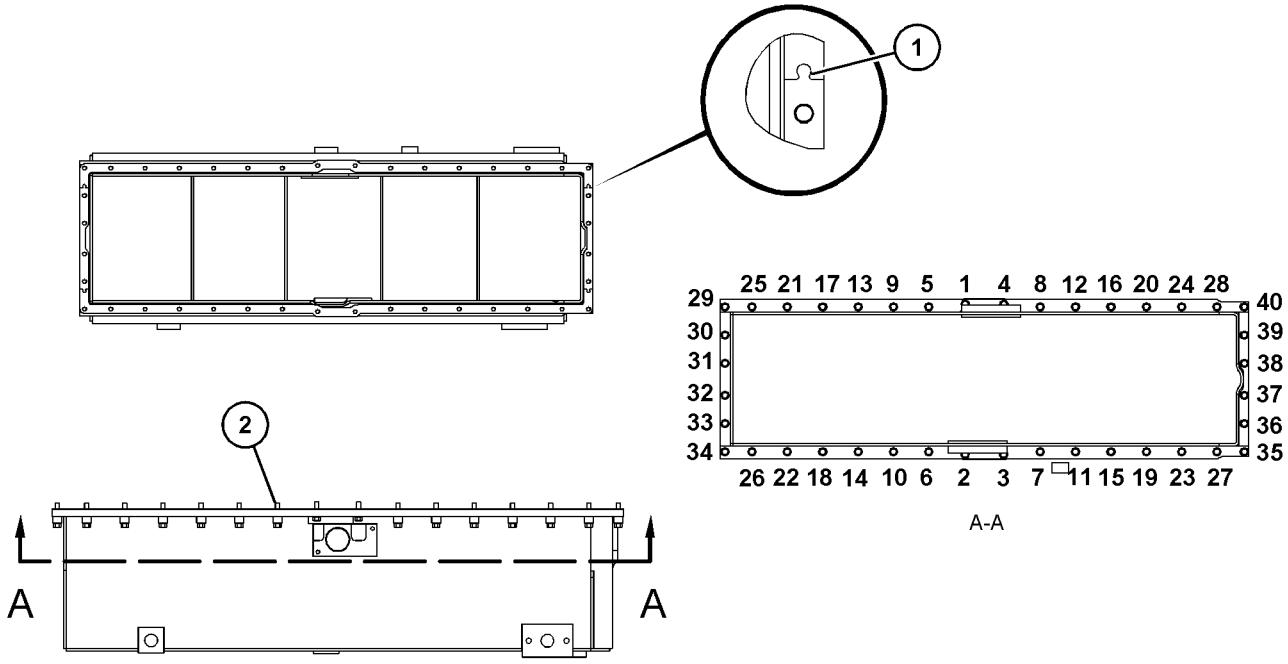


Illustration 100 g06277447

Typical example

Table 50

Item	Qty	Part	Specification Description
1	-	-	Before assembly, apply Loctite ® 598 black, high-performance RTV silicone gasket maker below and over the ball and socket joints of the oil pan gasket.
2	40	2P-3205 Bolt	Use the tightening sequence as shown in illustration 100 . 1. Perform the tightening sequence twice. 2. Tighten the oil pan bolts in the numerical sequence 1 to 40 to 47 ± 9 N·m (35 ± 7 lb ft).

i04907651

Water Temperature Regulator

SMCS Code: 1355

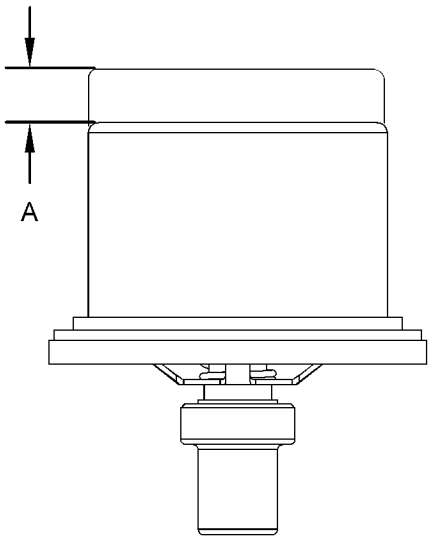


Illustration 101 g02545979

Table 51

Specification for 248-5513 Temperature Regulator			
Item	**Qty**	**Part**	**Specification Description**
A	-	-	Minimum opening distance at fully open temperature is 10.4 mm (0.41 inch).
-	-	-	Opening temperature is 81 to 84 °C (178 to 183 °F).
-	-	-	Fully open temperature is 92 °C (198 °F).
-	-	-	Leakage at the seat and sleeve shall not exceed minimum 10.0 cc (0.6 cubic inch) at 207 kPa (30 psi).
-	-	-	Force required to separate valve from seat is 165 ± 9 N (37 ± 2 lb), measured at temperature 75 °C (167 °F).

i04403086

Water Pump

SMCS Code: 1361

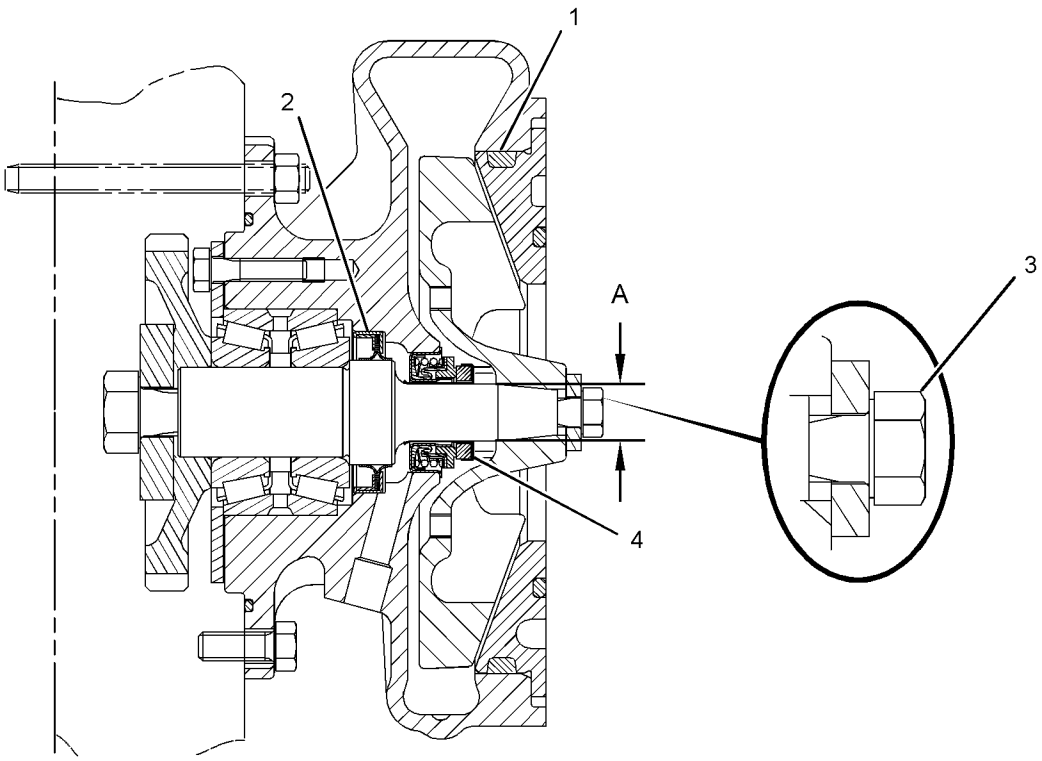


Illustration 102 g02589697

Table 52

Specification for 4N-5837 Water Pump Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	112-1579 O-Ring Seal	Lubricate the bore of the O-ring seal lightly with glycerine or an approved equivalent.
2	1	153-1256 Lip Type Seal	Do not install the lip type seal by hand. Use the installation tool and a press to install the lip type seal. Make sure that the primary lip is towards the water pump drive gear. Press the lip type seal until the lip type seal is flush into the counterbore.
3	1	0S-1591 Bolt	Torque to 39 ± 3 N·m (29 ± 2 lb ft).
4	1	349-2654 Water Pump Seal	Use the installation tool to install the seal group. Press the seal group onto the shaft until the stationary cup of the seal group is fully seated in the pump housing.
A	1	135-4928 Water Pump Shaft	Diameter of the water pump shaft is 19.100 ± 0.010 mm (0.7520 ± 0.0004 inch).

i07317779

Water Pump

SMCS Code: 1361

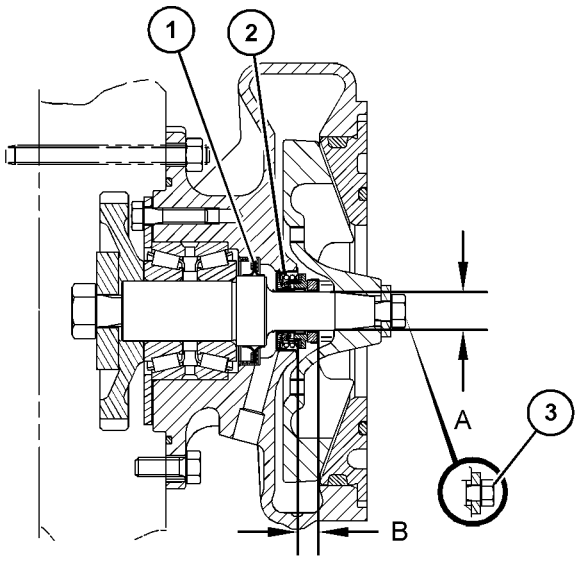


Illustration 103 g06281930

Table 53

Item	Qty	Part	Specification Description
Note: Do not install the lip type seal (1) by hand. Use the installation tool and a press to install the lip type seal. Make sure that the primary lip is towards the water pump drive gear. Press the lip type seal is flush into the counterbore. Use the installation tool to install the seal group(2). Press the seal group onto the shaft until the stationary cup of the seal group is fully seated in the pump housing.			
3	1	0S-1591 Bolt	Torque to 39 ± 3 N.m (29 ± 2 lb ft).
A	1	135-4928 Water Pump Shaft	Diameter of the water pump shaft is 19.100 ± 0.010 mm (0.752 ± 0.0004 inch).
B	-	-	Installation height is 10.92 ± 0.13 mm (0.43 ± 0.005 inch).
-	-	-	Maximum air leakage per minute with an air pressure test of 140 kPa (20 psi). Water side not to exceed 10 cc (0.6 cu in). Oil side not to exceed 24 cc (1.5 cu in).

i07396742

Water Pump

SMCS Code: 1361

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 355-7389
S/N: E9Z1–Up

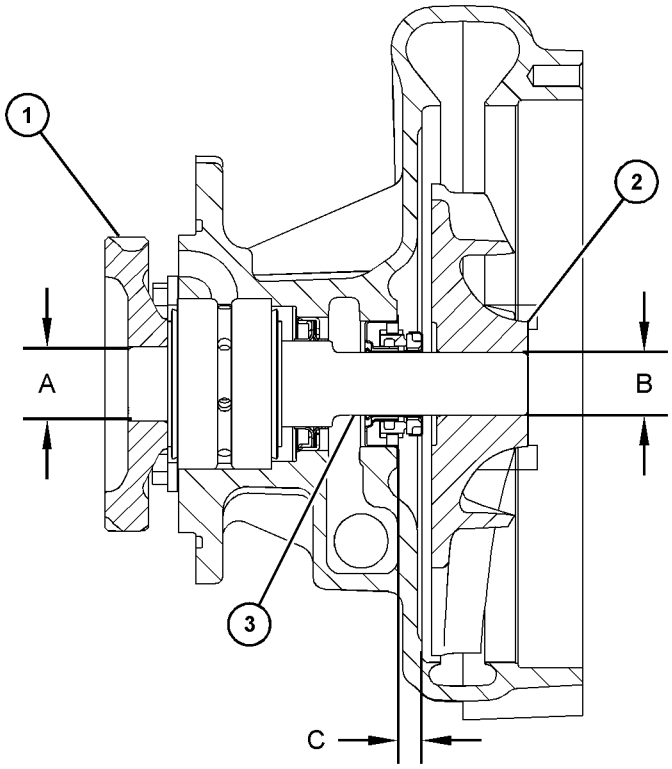


Illustration 104 g06308220

Table 54

Item	Qty	Part	Specification Description
A	1	331-5207 Water Pump Shaft	Diameter of the water pump shaft is 30.022 ± 0.008 mm (1.1820 ± 0.0003 inch).
B	-	331-5207 Water Pump Shaft	Diameter of the water pump shaft is 25.400 to 25.413 mm (1.0000 to 1.0005 inch).
C	1	336-2212 Water Pump Seal As	Installed height of the seal is 9.90 ± 0.38 mm (0.390 ± 0.015 inch).
-	-	-	Gear (1) must be pressed against the bearing.
-	-	-	Pump impeller (2) must be flush with water pump shaft (3).

i07675858

Cylinder Block

SMCS Code: 1201

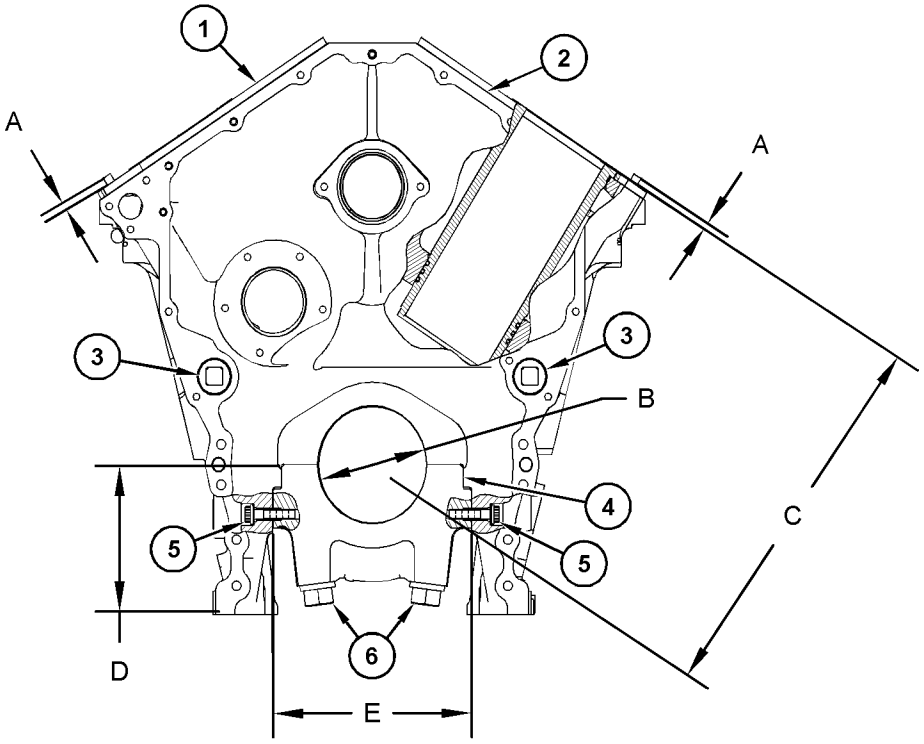


Illustration 105 g03347646
Front view of the engine
Typical example

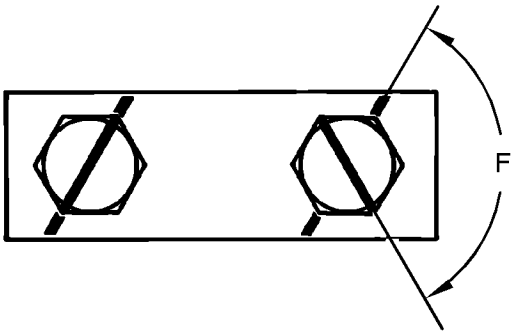


Illustration 106 g03347647
Marks for tightening main bearings
Typical example

Table 55

Item	Qty	Part	Specification Description
The top face of the cylinder block, bottom surface of spacer plate (1) and both sides of plate gasket (2) must be free of fuel, oil, water, gasket adhesives, assembly compounds and any other contaminants during assembly.			
1	2	225-3100 Spacer Plate	Thickness is 8.585 ± 0.025 mm (0.3380 ± 0.0010 inch).
2	2	354-8484 Plate Gasket	Apply adhesive to block side of gasket-plate only, no adhesive should be on opposing side of gasket-plate. Adhesive to be applied as an even, minimal coat(Skim coat). Minimal to zero material should squeeze out of joint after assembly has been torqued. No adhesive should contact water ferrule or liner lip. Thickness of plate gasket that is between cylinder block and spacer plate is 0.20 ± 0.02 mm (0.008 ± 0.001 inch).
3	4	7C-9614 Taperlock Plug	Before assembly, apply Loctite low breakloose PST on the threads.
			Torque to 80 ± 15 N·m (60 ± 11 lb ft).
A	4	4N-1650 Dowel	Extension of the dowels on the left bank and right bank from the cylinder block is 18.5 ± 0.5 mm (0.73 ± 0.02 inch).
4	7	232-7607 Crankshaft Cap	The crankshaft caps must be installed with the identifying marks toward the front of the engine. The number of the main bearing cap must also match the cast number on the left side of each main bearing saddle.
B	-	-	Bore in cylinder block for main bearing is 129.891 ± 0.013 mm (5.1138 ± 0.0005 inch).
C	-	-	The distance from the centerline of the crankshaft bearing bore to the top of the cylinder block is 419.10 ± 0.15 mm (16.500 ± 0.006 inch).
D	-	-	The distance from the centerline of the crankshaft bearing bore to the bottom of the cylinder block is 165.10 ± 0.10 mm (6.500 ± 0.004 inch).
E	-	-	The width of the slot for the crankshaft cap (4) is 236.00 ± 0.05 mm (9.291 ± 0.002 inch).
			Width of crankshaft cap (4) is 235.500 ± 0.025 mm (9.2716 ± 0.0010 inch).
5	14	365-4307 Bolt	Use the following procedure to install the crankshaft cap:
6	14	3P-1323 Bearing Cap Bolt	1. Apply clean engine oil on the threads of the bolts (6). Loosely install the bolts (6).
			2. Apply clean engine oil on the threads of the side bearing cap bolts (5) and the washers. Loosely install the side bearing cap bolts (5) and the washers.
			3. Tighten tab end of the main bearing cap bolt (6) to 258 ± 14 N·m (190 ± 10 lb ft).
			4. Tighten opposite end of the main bearing cap bolt (6) to 258 ± 14 N·m (190 ± 10 lb ft).
			5. Put a mark on each bolt (6) and each crankshaft cap (4). See Illustration 106 .
			6. Again, tighten opposite end of the main bearing cap bolt from the mark to an additional angle (F) of 120 ± 5 degrees.
			7. Again, tighten tab end of the main bearing cap bolt from the mark to an additional angle (F) of 120 ± 5 degrees.
			8. Tighten the side bearing cap bolts (5) that are at the opposite end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft).
			9. Tighten the side bearing cap bolts (5) that are at the tab end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft).
			10. Again, tighten the side bearing cap bolts (5) that are at the opposite end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft).
			11. Again, tighten the side bearing cap bolts (5) that are at the tab end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft).

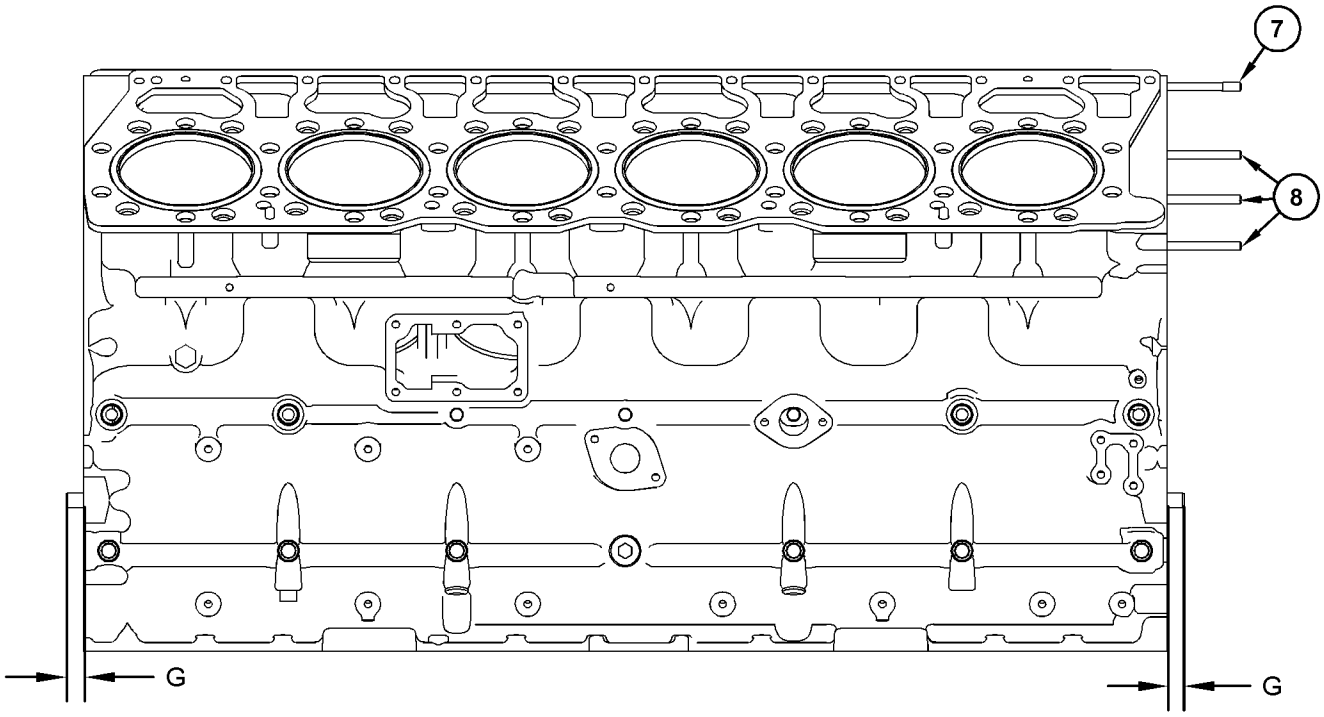


Illustration 107 g03347648

Right side of the engine

Typical example

Table 56

Specification for 350-5438 Cylinder Block Gp and 349-2859 Cylinder Block Gp			
Item	**Qty**	**Part**	**Specification Description**
7	1	214-1728 Stud	Apply blue Loctite 540 to the pipe threads of stud. Tighten the stud with the coated pipe threads into the cylinder block.
8	3	6L-4428 Taperlock Stud	Torque to 35 ± 5 N·m (26 ± 4 lb ft).
G	4	4N-0683 Dowel	Extension of dowels from the rear face of the cylinder block and from the front face of the cylinder block is 19.0 ± 0.5 mm (0.75 ± 0.02 inch).

i07675924

Cylinder Block

SMCS Code: 1201

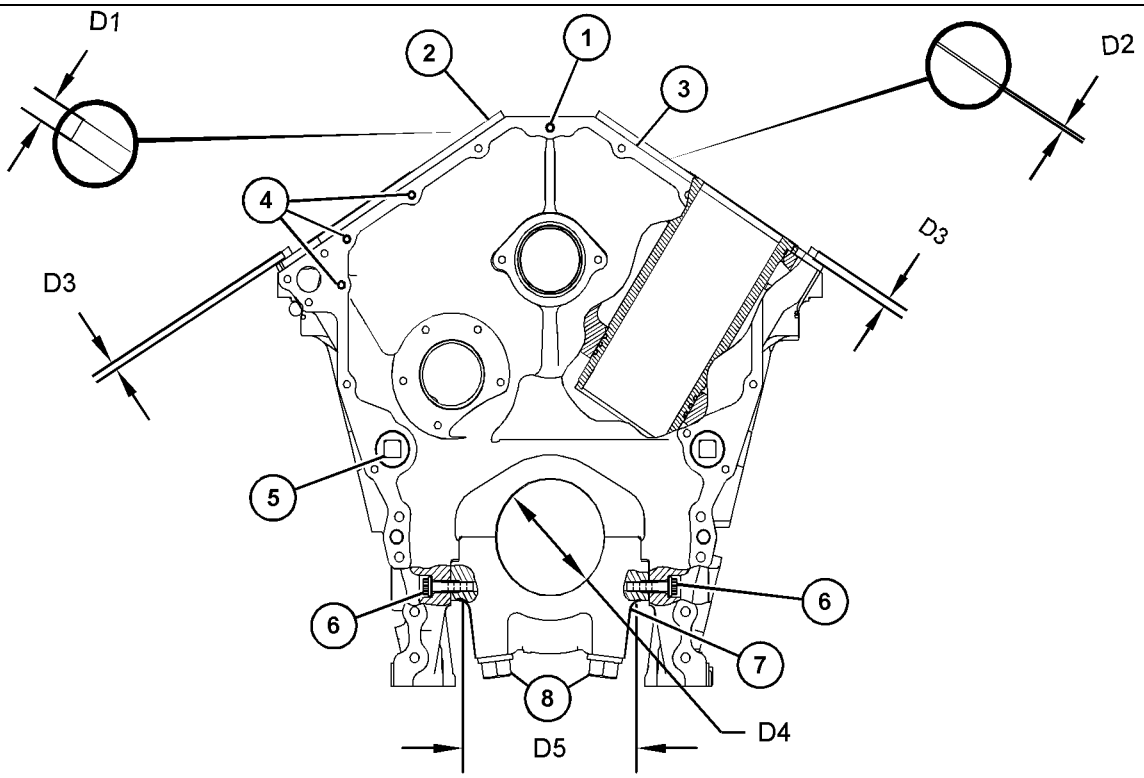


Illustration 108 g06391426
Front of the engine

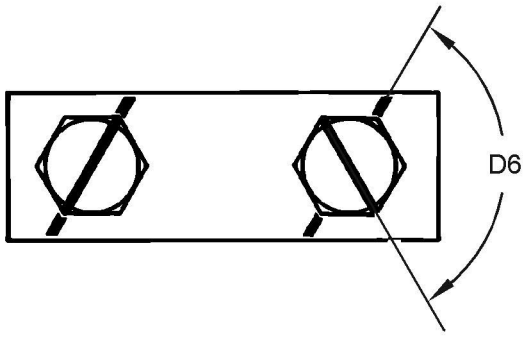


Illustration 109 g06391460
Marks for tightening main bearings

Table 57

Item	Qty	Part	Specification Description
1	-	-	Use the following procedure to tighten the studs: 1. Apply Loctite ® Hi-Temp flange sealant. 2. Tighten the stud with coated pipe threads into the cylinder block.
2	-	-	During assembly, the top of face of the cylinder block, both sides of plate gasket and bottom surface of spacer plate must be free of fuel, oil, water, gasket adhesives, assembly compounds, and any other contaminants.
3	-	-	
4	3	-	Tighten the taperlock studs to 35 ± 5 N·m (26 ± 4 lb ft).
5-	4	-	Use the following procedure to tighten the taperlock studs: 1. Before assembly, apply Loctite ® 536 pipe sealant on the threads of the taperlock studs. 2. Tighten the taperlock plugs to 80 ± 15 N·m (59 ± 11 lb ft).
6	-	-	Use the following procedure to install the crankshaft cap: 1. Apply clean engine oil on the threads of the bolts (8). Loosely install the bolts (8). 2. Apply clean engine oil on the threads of the side bearing cap bolts (6) and the washers. Loosely install the side bearing cap bolts (6) and the washers. 3. Tighten tab end of the main bearing cap bolt (8) to 258 ± 14 N·m (190 ± 10 lb ft). 4. Tighten opposite end of the main bearing cap bolt (8) to 258 ± 14 N·m (190 ± 10 lb ft). 5. Put a mark on each bolt (8) and each crankshaft cap (7). as shown in Illustration 109 . 6. Again, tighten opposite end of the main bearing cap bolt from the mark to an additional angle (D6) of 120 ± 5 degrees. 7. Again, tighten tab end of the main bearing cap bolt from the mark to an additional angle (D6) of 120 ± 5 degrees. 8. Tighten the side bearing cap bolts (6) that are at the opposite end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft). 9. Tighten the side bearing cap bolts (6) that are at the tab end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft). 10. Again, tighten the side bearing cap bolts (6) that are at the opposite end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft). 11. Again, tighten the side bearing cap bolts (6) that are at the tab end of the main bearing cap to 80 ± 10 N·m (60 ± 7 lb ft).
7	-	-	
8	-	-	
D1	-	-	Thickness of the spacer plate is 8.585 ± 0.025 mm (0.3380 ± 0.0010 inch).
D2	-	-	Thickness of plate gasket that is between cylinder block and spacer plate is 0.195 ± 0.028 mm (0.0077 ± 0.0011 inch).
D3	-	-	Extension of the dowels on the left bank and right bank from the cylinder block is 18.5 ± 0.5 mm (0.73 ± 0.02 inch).
D4	-	-	Bore in the cylinder block for main bearing is 236.00 ± 0.05 mm (9.291 ± 0.002 inch).
D5	-	-	The width of the slot for the main bearing caps is 236.00 ± 0.05 mm (9.291 ± 0.002 inch).
			Width of main bearing cap is 235.500 ± 0.025 mm (9.2716 ± 0.0010 inch).

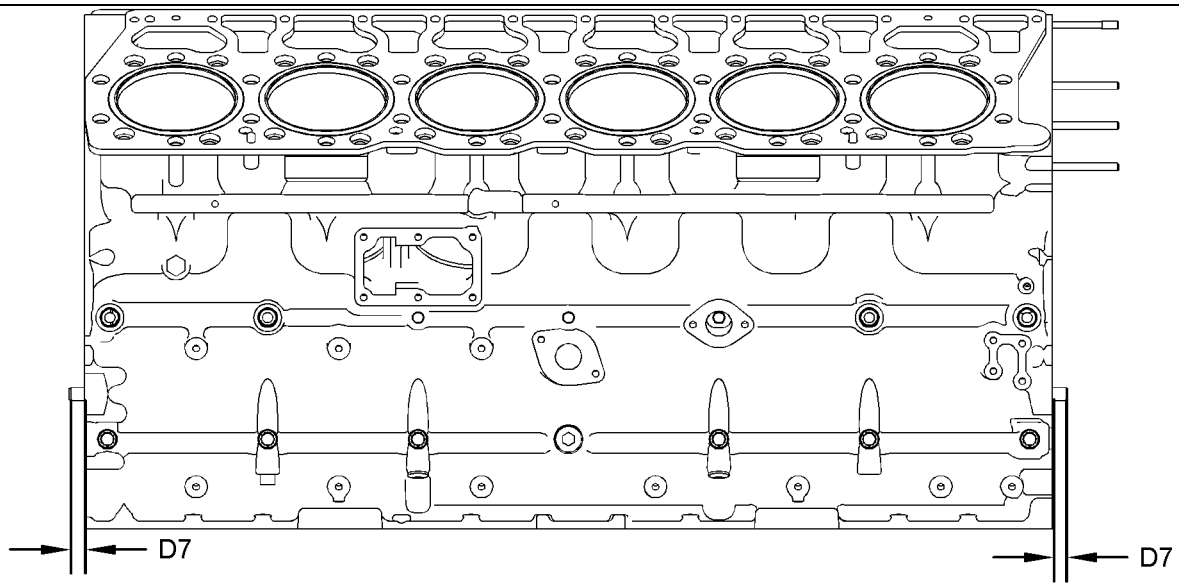


Illustration 110 g06391476

Right side of the engine

Table 58

Item	Qty	Part	Specification Description
D7	-	-	Extension of dowels from the rear face of the cylinder block and from the front face of the cylinder block is 19.0 ± 0.5 mm (0.75 ± 0.02 inch).

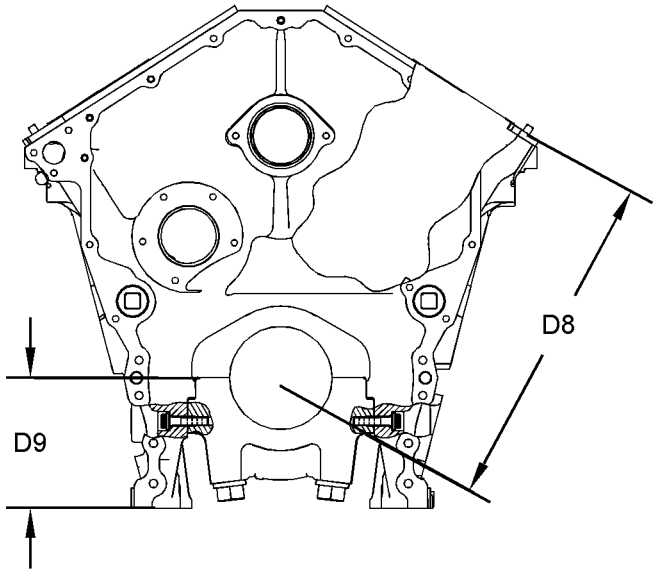


Illustration 111 g06391484

Table 59

Item	Qty	Part	Specification Description
D8	-	-	The distance from the centerline of the crankshaft bearing bore to the top of the cylinder block is 419.10 ± 0.15 mm (16.500 ± 0.006 inch).
D9	-	-	The distance from the centerline of the crankshaft bearing bore to the bottom of the cylinder block is 165.10 ± 0.10 mm (6.500 ± 0.004 inch).

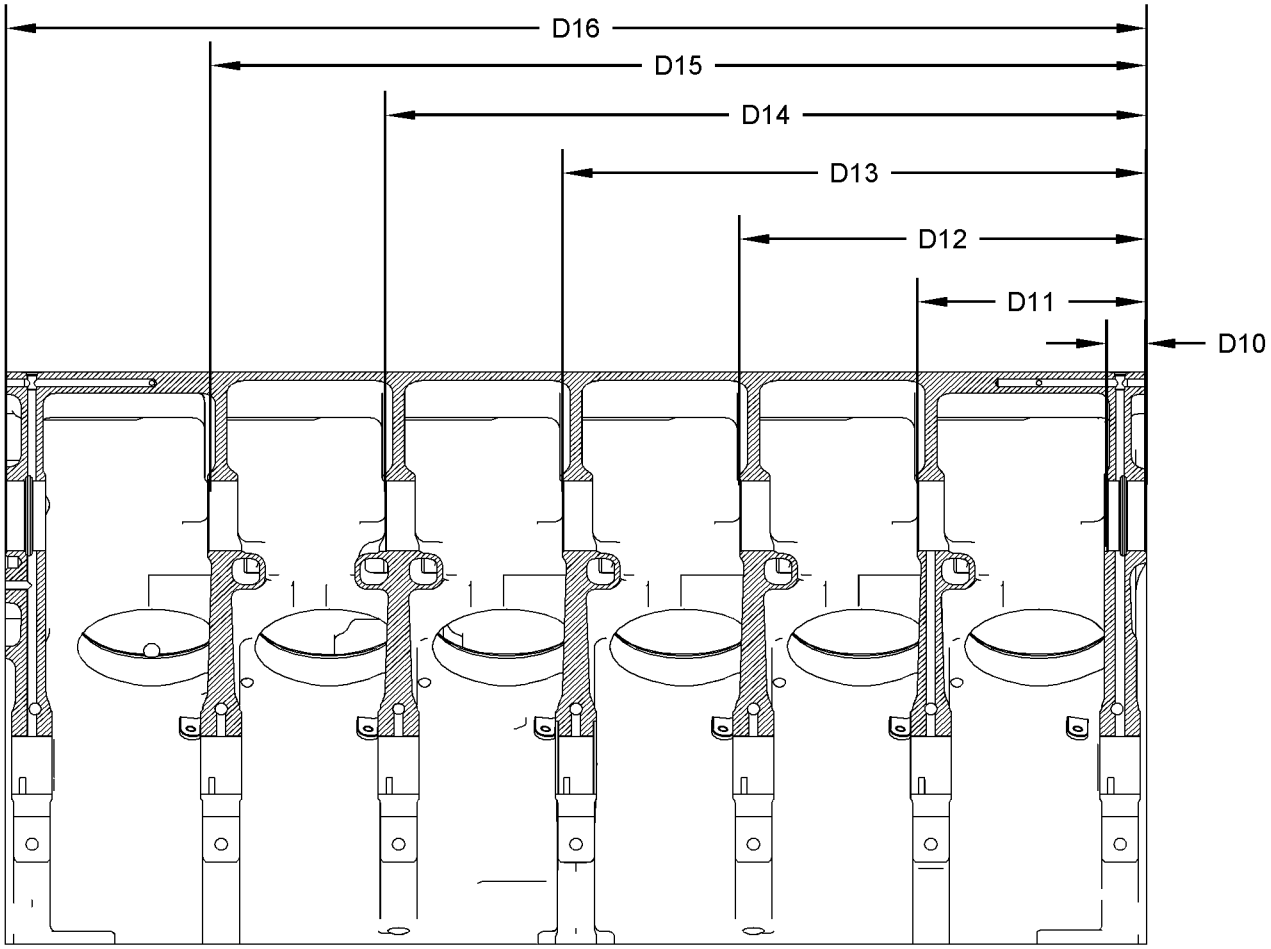


Illustration 112 g06391492

Table 60

Item	Qty	Part	Specification Description
Install camshaft bearings into the cylinder block at the following locations:			
D10	-	-	Position of the camshaft bearing is 7.4 ± 0.5 mm (0.29 ± 0.02 inch).
D11	-	-	Position of the camshaft bearing is 211.3 ± 0.5 mm (8.32 ± 0.02 inch).
D12	-	-	Position of the camshaft bearing is 395.5 ± 0.5 mm (15.57 ± 0.02 inch).
D13	-	-	Position of the camshaft bearing is 579.6 ± 0.5 mm (22.82 ± 0.02 inch).
D14	-	-	Position of the camshaft bearing is 763.8 ± 0.5 mm (30.07 ± 0.02 inch).
D15	-	-	Position of the camshaft bearing is 947.9 ± 0.5 mm (37.32 ± 0.02 inch).
D16	-	-	Position of the camshaft bearing is 1144.3 ± 0.5 mm (45.05 ± 0.02 inch).

i07700135

Cylinder Block

SMCS Code: 1201

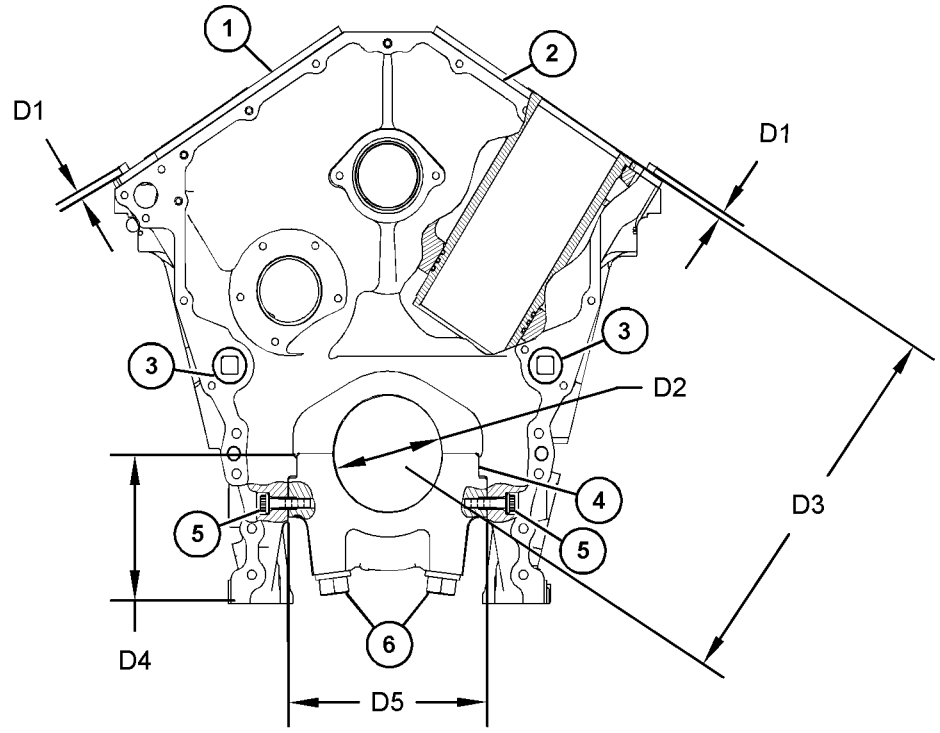


Illustration 113 g06391335

Front view of the engine

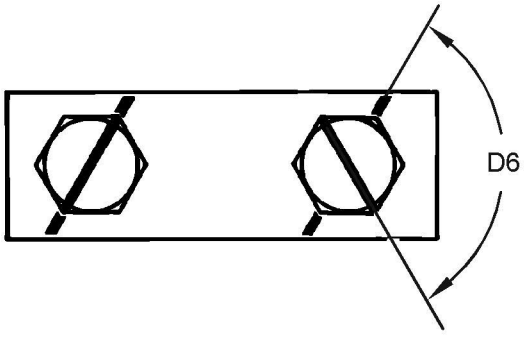


Illustration 114 g06391351

Marks for tightening main bearings

Table 61

Specification for 253-9882 Cylinder Block Gp and 273-7595 Cylinder Block Gp			
Item	**Qty**	**Part**	**Specification Description**
The top face of the cylinder block, bottom surface of spacer plate (1) and both sides of plate gasket (2) must be free of fuel, oil, water, gasket adhesives, assembly compounds and any other contaminants during assembly.			
1	2	225-3100 Spacer Plate	Thickness is 8.585 ± 0.025 mm (0.3380 ± 0.0010 inch).
2	2	225-3101 Plate Gasket	Thickness of plate gasket that is between cylinder block and spacer plate is 0.208 ± 0.025 mm (0.0082 ± 0.0010 inch).
3	4	7C-9614 Taper-lock Plug	Before assembly, apply Loctite low breakloose PST on the threads.
			Torque to 80 ± 15 N·m (60 ± 11 lb ft).
A	4	4N-1650 Dowel	Extension of the dowels on the left bank and right bank from the cylinder block is 18.5 ± 0.5 mm (0.73 ± 0.02 inch).
4	7	232-7607 Crank-shaft Cap	The crankshaft caps must be installed with the identifying marks toward the front of the engine. The number of the main bearing cap must also match the cast number on the left side of each main bearing saddle.
B	-	-	Bore in cylinder block for main bearing is 129.891 ± 0.013 mm (5.1138 ± 0.0005 inch).
C	-	-	The distance from the centerline of the crankshaft bearing bore to the top of the cylinder block is 419.10 ± 0.15 mm (16.500 ± 0.006 inch).
D	-	-	The distance from the centerline of the crankshaft bearing bore to the bottom of the cylinder block is 165.10 ± 0.10 mm (6.500 ± 0.004 inch).
E	-	-	The width of the slot for the crankshaft cap (4) is 236.00 ± 0.05 mm (9.291 ± 0.002 inch).
			Width of crankshaft cap (4) is 235.500 ± 0.025 mm (9.2716 ± 0.0010 inch).
5	14	3P-1323 Bearing Cap Bolt	Use the following procedure to install the crankshaft cap: 1. Apply clean engine oil on the threads of the bolts (6). Loosely install the bolts (6). 2. Apply clean engine oil on the threads of the side bearing cap bolts (5) and the washers. Loosely install the side bearing cap bolts (5) and the washers. 3. Tighten the bolts (6) first on the main bearing tab side of the crankshaft cap (4) to 258 ± 14 N·m (190 ± 10 lb ft). 4. Tighten the bolts (6) that are opposite the main bearing tab side of the crankshaft cap (4) to 258 ± 14 N·m (190 ± 10 lb ft). 5. Put a mark on each bolt (6) and each crankshaft cap (4). See Illustration 114 . 6. Tighten the bolts (6) that are placed opposite the main bearing tab side of the crankshaft cap (4) from the mark by angle (F) of 120 ± 5 degrees. 7. Tighten the bolts (6) that are placed on the main bearing tab side of the crankshaft cap (4) from the mark by angle (F) of 120 ± 5 degrees. 8. Tighten the side bearing cap bolts (5) that are opposite the main bearing tab side of the crankshaft cap (4) to 80 ± 10 N·m (60 ± 7 lb ft). 9. Tighten the side bearing cap bolts (5) that are placed on the main bearing tab side of the crankshaft cap (4) to 80 ± 10 N·m (60 ± 7 lb ft).
6	14	234-6902 Bolt	

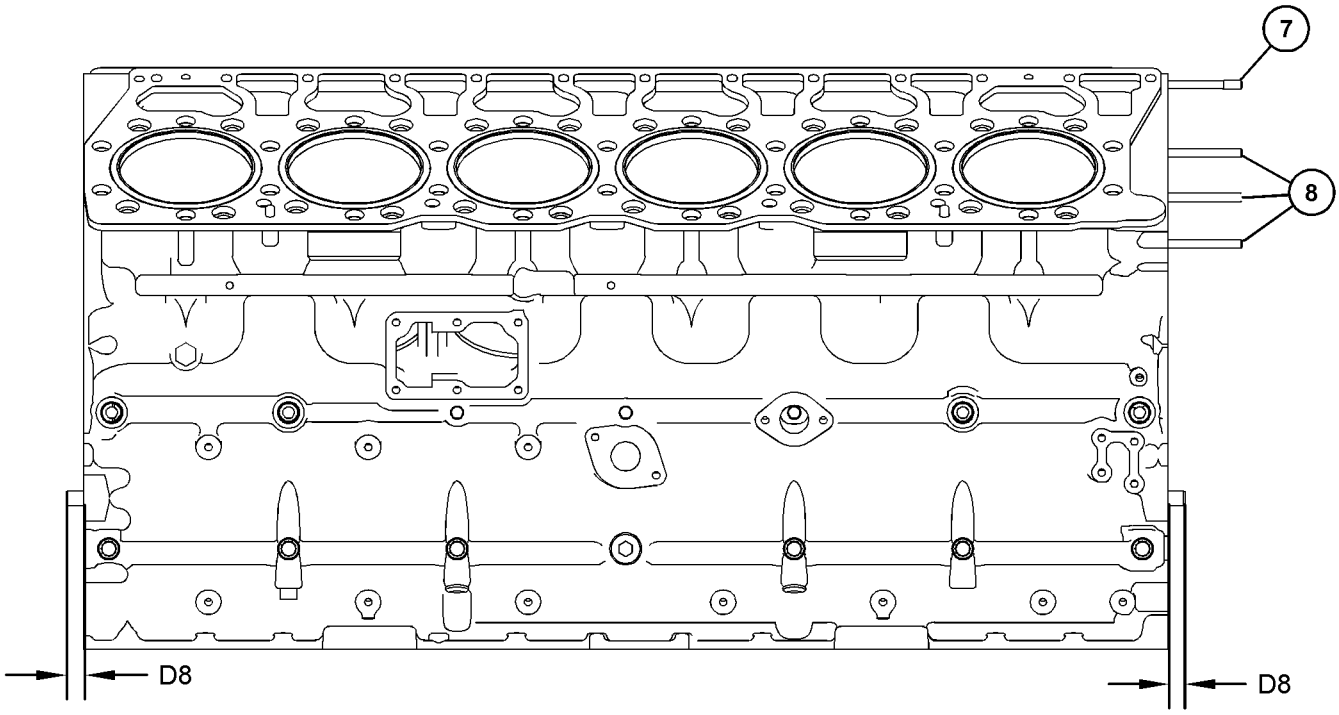


Illustration 115 g06391357

Right side of the engine

Table 62

Item	Qty	Part	Specification Description
7	1	214-1728 Stud	Apply blue Loctite 540 to the pipe threads of stud. Tighten the stud with the coated pipe threads into the cylinder block.
8	3	6L-4428 Taperlock Stud	Torque to 35 ± 5 N·m (26 ± 4 lb ft).
G	4	4N-0683 Dowel	Extension of dowels from the rear face of the cylinder block and from the front face of the cylinder block is 19.0 ± 0.5 mm (0.75 ± 0.02 inch).

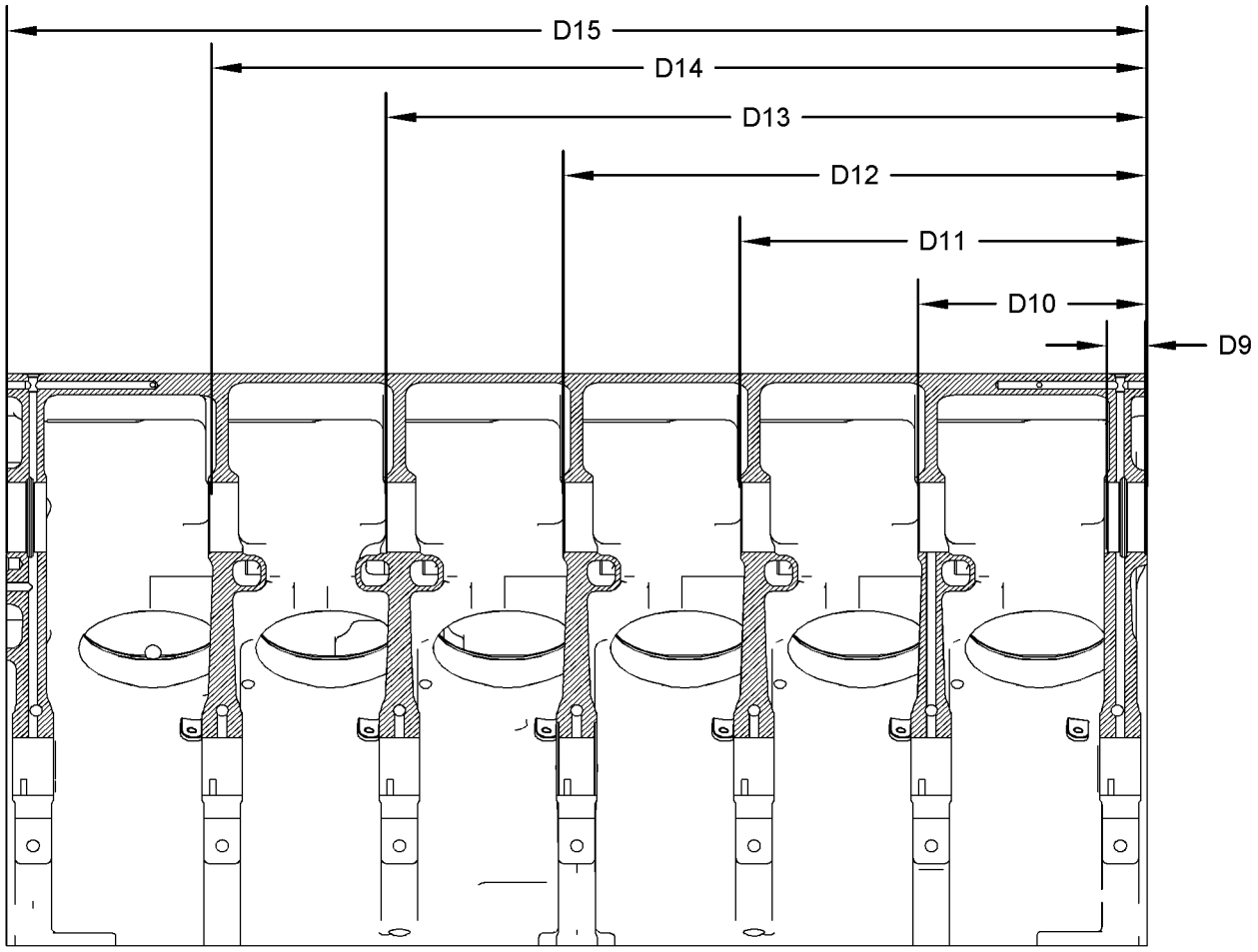


Illustration 116 g06391414

Table 63

Item	Qty	Part	Specification Description
Install the camshaft bearings into the cylinder block at the location specified. The distance that is listed below is measured from the front face of the cylinder block.			
-	-	-	Dimension (D9) is 40.39 ± 1 mm (1.590 ± 0 inch).
-	-	-	Dimension (D10) is 236.73 ± 1 mm (9.320 ± 0 inch).
-	-	-	Dimension (D11) is 420.9 ± 1 mm (16.57 ± 0 inch).
-	-	-	Dimension (D12) is 605.04 ± 1 mm (23.820 ± 0 inch).
-	-	-	Dimension (D13) is 789.18 ± 1 mm (31.070 ± 0 inch).
-	-	-	Dimension (D14) is 973.33 ± 1 mm (38.320 ± 0 inch).
-	-	-	Dimension (D15) is 1183.46 ± 1 mm (46.593 ± 0 inch).

i07724166

Cylinder Block

SMCS Code: 1201

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 349-2528
S/N: E9Z1–Up

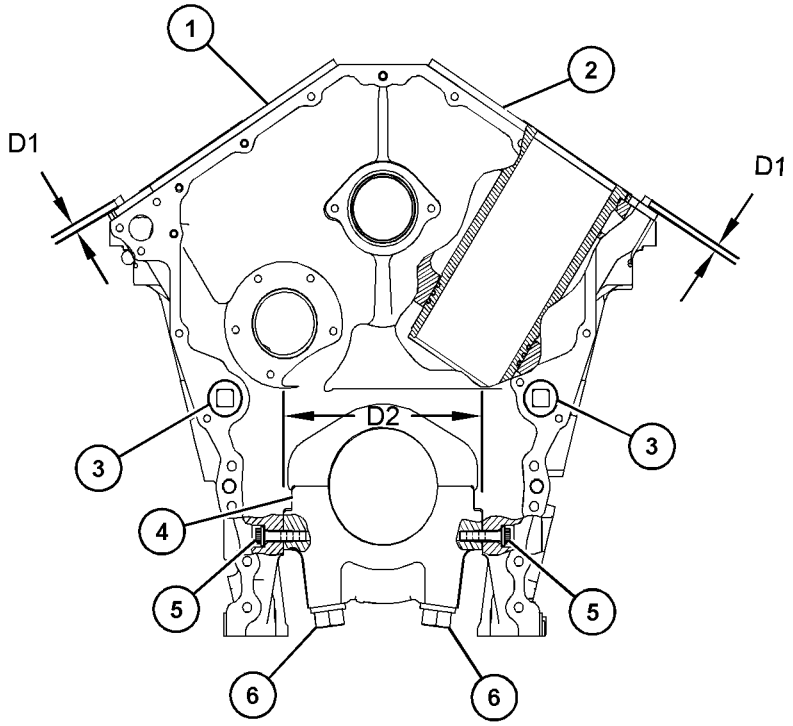


Illustration 117 g06411817

Front view of the engine

Table 64

Specification for 349-2528 Cylinder Block Gp			
Item	**Qty**	**Part**	**Specification Description**
The top face of the cylinder block, bottom surface of spacer plate (1) and both sides of plate gasket (2) must be free of fuel, oil, water, gasket adhesives, assembly compounds and any other contaminants during assembly.			
1	2	225-3100 Spacer Plate	Thickness is 8.585 ± 0.025 mm (0.3380 ± 0.0010 inch).
2	2	354-8484 Plate Gasket	Thickness of plate gasket that is between cylinder block and spacer plate is 0.20 ± 0.02 mm (0.008 ± 0.001 inch).

(continued)

(Table 64, contd)

3	4	7C-9614 Taper-lock Plug	Before assembly, apply white Loctite Low Breakloose PST to the threads.
			Torque to 80 ± 15 N·m (60 ± 11 lb ft).
D1	4	4N-1650 Dowel	Protrusion is 18.5 ± 0.5 mm (0.73 ± 0.02 inch).
4	7	232-7607 Crank-shaft Cap	The crankshaft caps must be installed with the identifying marks toward the front of the engine. The number of the main bearing cap must also match the cast number on the left side of each main bearing saddle.
			Width in the cylinder block for the crankshaft cap is 236.00 ± 0.05 mm (9.291 ± 0.002 inch).
			Width (D2) is 235.500 ± 0.025 mm (9.2716 ± 0.0010 inch).
5	14	234-6902 Bolt	Use the following procedure in order to install the crankshaft cap: 1. Install bolt (6). 2. Lubricate the threads of side bolt (5) and seal washers with clean engine oil. Install side bolt (5) and seal washers. 3. Tighten bolt (6) on the tab end of the crankshaft cap to 258 ± 14 N·m (190 ± 10 lb ft). 4. Tighten bolt (6) on the opposite end to the tab end bolt of the crankshaft cap to 258 ± 14 N·m (190 ± 10 lb ft). 5. Turn bolt (6) on the opposite end to the tab end bolt of the crankshaft cap to an angle of 120 ± 5 degrees. 6. Turn bolt (6) on the tab end of the crankshaft cap to an angle of 120 ± 5 degrees. 7. Tighten side bolt (5) on the opposite end to the tab end bolt of the crankshaft cap to 80 ± 10 N·m (59 ± 7 lb ft). 8. Tighten side bolt (5) on the tab end of the crankshaft cap to 80 ± 10 N·m (59 ± 7 lb ft). 9. Repeat Step 7 and Step 8.
6	14	3P-1323 Bearing Cap Bolt	

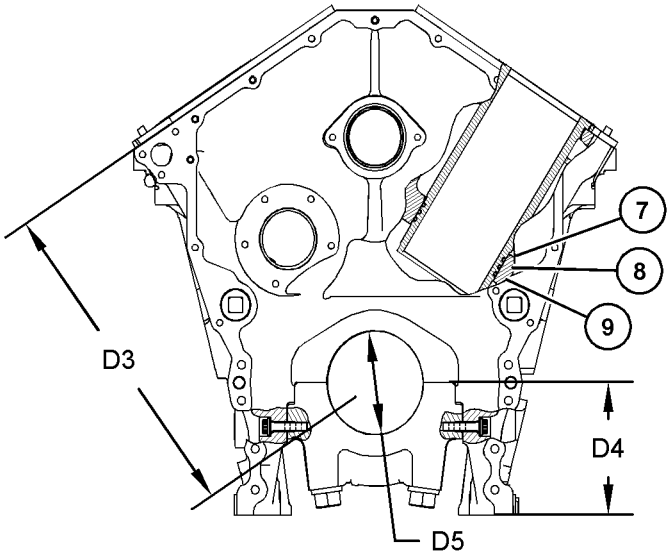


Illustration 118 g06411823

Table 65

Item	Qty	Part	Specification Description
7	12	142-7072 Liner Seal	Immediately before inserting liners, cover the liner bore surfaces and seals with 5P-3975 Rubber Lubricant

(continued)

(Table 65, contd)

8	12	110-2220 Liner Seal	Immediately before inserting liners, cover the liner bore surfaces and seals with 5P-3975 Rubber Lubricant
9	12	142-6217 O-Ring Seal	Immediately before inserting liners, cover the liner bore surfaces and seals with 5P-3975 Rubber Lubricant
D3	-	-	The distance from the centerline of the crankshaft bearing bore to the top of the cylinder block is 419.10 mm (16.500 inch).
D4	-	-	The distance from the centerline of the crankshaft bearing bore to the bottom of the cylinder block is 165.10 mm (6.500 inch).
D5	-	-	Bore in cylinder block for main bearing is 129.891 ± 0.013 mm (5.1138 ± 0.0005 inch).

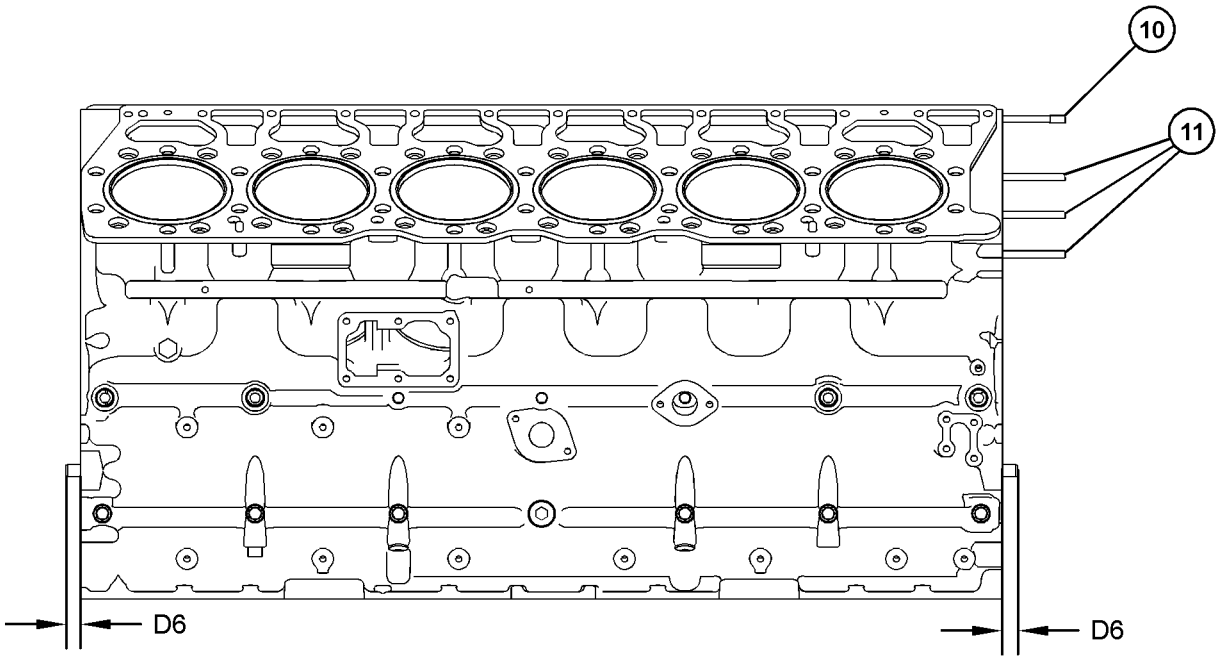


Illustration 119 g06411827

Right side of the engine

Table 66

Item	Qty	Part	Specification Description
10	1	214-1728 Stud	Before assembly, apply blue Loctite 540 to the pipe threads of stud.
11	3	6L-4428 Taperlock Stud	Torque to 35 ± 5 N·m (26 ± 4 lb ft).
D6	4	4N-0683 Dowel	Protrusion is 19.0 ± 0.5 mm (0.75 ± 0.02 inch).

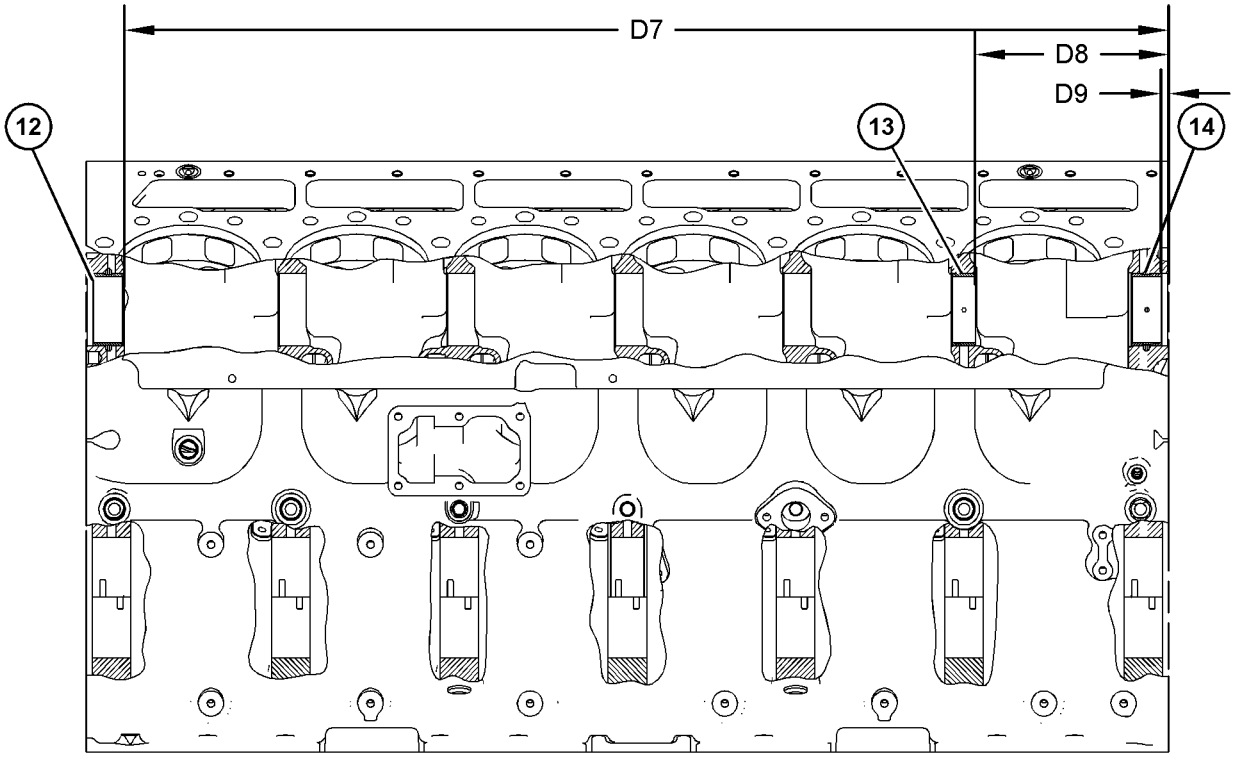


Illustration 120 g06411832

Table 67

Item	Qty	Part	Specification Description
Install the bearing in position as shown in Illustration 120 .			
12	1	225-5966 Sleeve	Installation distance (D7) is 1177.3 ± 0.5 mm (46.35 ± 0.02 inch).
13	1	4N-0685 Bushing	Installation distance (D8) is 236.7 ± 0.5 mm (9.32 ± 0.02 inch).
14	1	4N-6658 Bushing	Installation distance (D9) is 40.4 ± 0.5 mm (1.59 ± 0.02 inch).

i04384050

Cylinder Liner

SMCS Code: 1216

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 197-9322
S/N: E9Z1–Up

S/N: KDZ1–Up

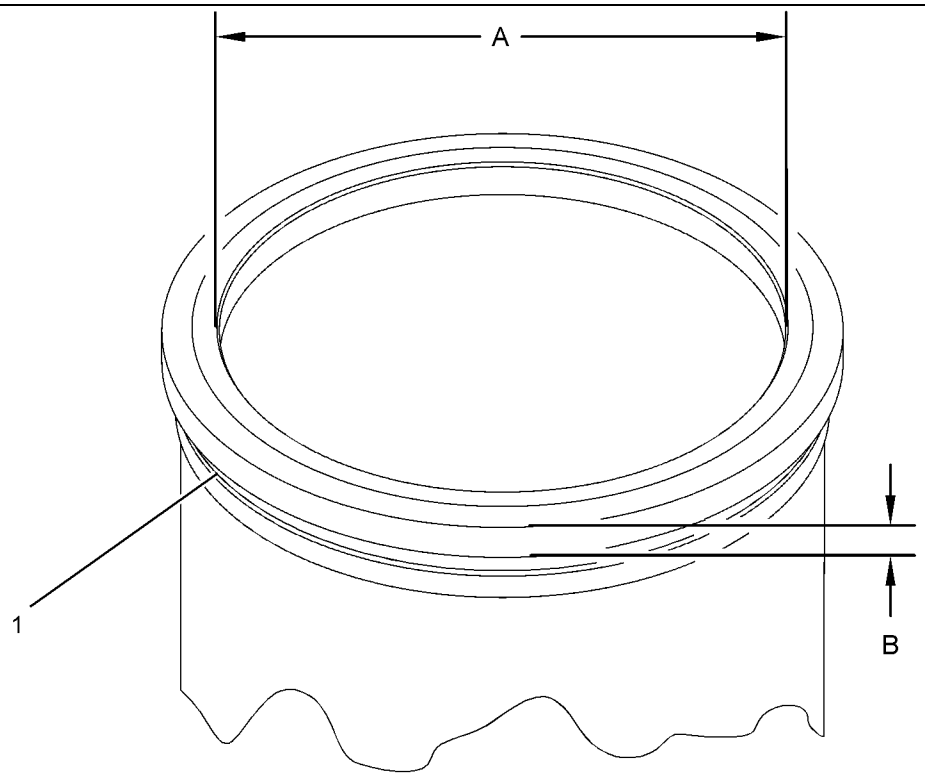


Illustration 121 g02551321

Table 68

Specification for the 197-9322 Cylinder Block Liner, 238-2700 Cylinder Block Liner, and 2W-6000 Cylinder Block Liner			
Item	**Qty**	**Part**	**Specification Description**
A	-	-	New cylinder liner bore is 137.185 ± 0.025 mm (5.4010 ± 0.0010 inch).
B	-	-	Flange Thickness is 8.890 ± 0.020 mm (0.3500 ± 0.0008 inch). Minimum thickness is 8.870 mm (0.3492 inch).
Use the following procedure to install the cylinder liner: 1. Put liquid soap on the cylinder block liner bore surfaces and the rubber seals that are on the lower end of the cylinder liner. 2. Dip the filler band (1) completely in clean engine oil. 3. Immediately install the filler band (1) in the groove that is under the cylinder liner flange. 4. Install the cylinder liner into the cylinder block before the expansion of the filler band.			
Refer to Guideline For Reusable Parts and Salvage Operations, SEBF8068, “Cylinder Liners” for more information. Also, refer to Reuse And Salvage Guidelines, SEBF8049, “Visual Inspection of the Piston” for more information.			

i05391826

Cylinder Liner

SMCS Code: 1216

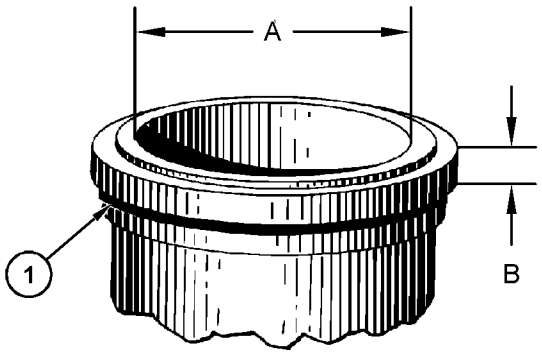


Illustration 122 g03408783

Table 69

Specification for the 253-8766 Cylinder Block Liner, 215-2985 Cylinder Block Liner, and 322-1126 Cylinder Block Liner			
Item	**Qty**	**Part**	**Specification Description**
A	-	-	New liner bore is 145.000 ± 0.025 mm (5.7086 ± 0.0010 inch).
B	-	-	Thickness of flange on liner is 8.890 ± 0.020 mm (0.3500 ± 0.0008 inch). The minimum thickness of the part that can be used again is 8.870 mm (0.3492 inch).
Use the following procedure for installing the cylinder liner into the cylinder block: 1. Apply 5P-3975 Rubber Lubricant on the surfaces of the cylinder liner bore. Apply 5P-3975 Rubber Lubricant on the rubber seals on the lower part of the cylinder liner. 2. Put filler band (1) completely in clean engine oil for a moment. 3. Install the filler band in the groove under the liner flange without delay. 4. Install the liner in the bore immediately, before the filler band expands.			
Refer to Guideline For Reusable Parts, SEBF8068, “Cylinder Liners” for more information. Also, refer to Testing and Adjusting, “Cylinder Liner Projection - Inspect” for the procedure for inspecting the projection of the cylinder liners.			

i07319773

Cylinder Liner

SMCS Code: 1216

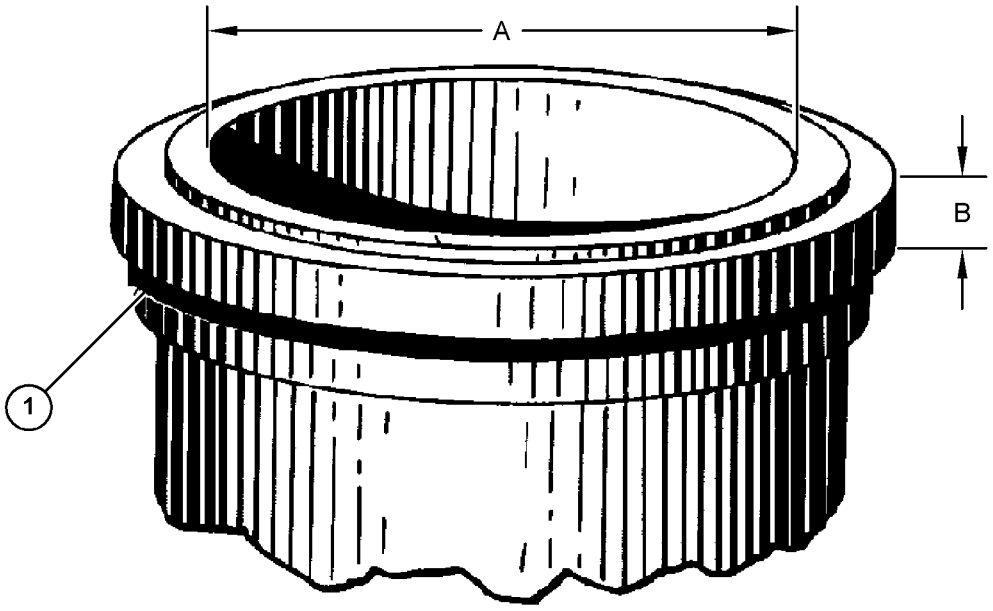


Illustration 123 g06218275

Table 70

Item	Qty	Part	Specification Description
A	-	-	New liner bore is 145.000 ± 0.025 mm (5.7086 ± 0.0010 inch).
B	-	-	Thickness of flange on liner is 8.890 ± 0.020 mm (0.3500 ± 0.0008 inch). The minimum thickness of the part that can be used again is 8.870 mm (0.3492 inch).
Use the following procedure for installing the cylinder liner into the cylinder block: 1. Apply 5P-3975 Rubber Lubricant on the surfaces of the cylinder liner bore. Apply 5P-3975 Rubber Lubricant on the rubber seals on the lower part of the cylinder liner. 2. Put filler band (1) completely in clean engine oil for a moment. 3. Install the filler band in the groove under the liner flange without delay. 4. Install the liner in the bore immediately, before the filler band expands.			

i04399215

Crankshaft

SMCS Code: 1202

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 225-6052
S/N: E9Z1–Up

S/N: KDZ1–Up

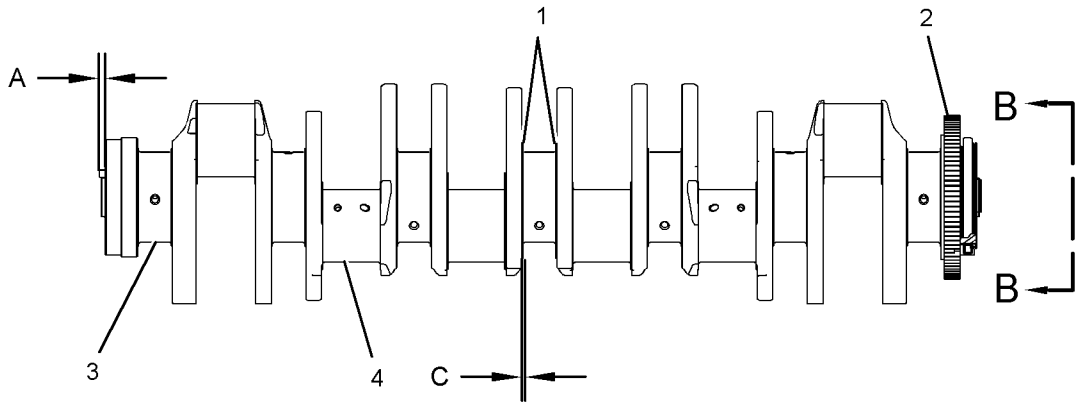


Illustration 124 g01584474

Typical example

(3) Main bearing journal (4) Connecting rod bearing journal

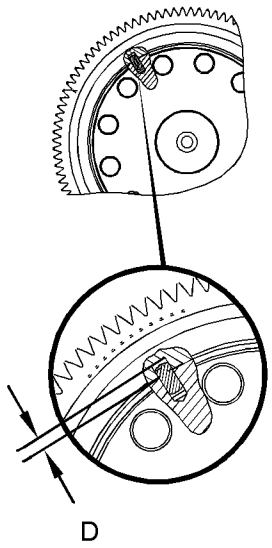


Illustration 125 g01585653

View B-B

Table 71

Specification for 224-3250 Crankshaft Gp and 225-6052 Crankshaft Gp			
Item	**Qty**	**Part**	**Specification Description**
Refer to Specifications, “Connecting Rod and Main Bearing Journals” for more information about the crankshaft journals.			
For the correct procedure of measuring for a bent crankshaft, refer to the Guideline for Reusable Parts and Salvage Operations, SEBF8054, “Procedure to Measure and Straighten Bent Crankshafts”.			

(continued)

(Table 71, contd)

1	2	253-1752 Thrust Plate	Install the thrust plates (1) on the center main bearing journal of the crankshaft only.
			Thickness is 5.74 ± 0.04 mm (0.226 ± 0.002 inch).
2	1	223-9135 Crankshaft Gear	The crankshaft gear must be installed on the crankshaft with the timing mark “V” on the outside of the crankshaft gear.
A	1	4N-0684 Dowel	Maximum protrusion of the dowel from the face of the crankshaft is 8.4 mm (0.33 inch).
C	End play with new thrust plates is 0.10 to 0.60 mm (0.004 to 0.024 inch). Maximum end play with used thrust plates is 0.89 mm (0.035 inch).		
D	1	7S-5005 Dowel	Protrusion of the dowel from the surface of the crankshaft is 4.1 ± 0.5 mm (0.16 ± 0.02 inch).

i07714496

Crankshaft Seals

SMCS Code: 1160; 1161

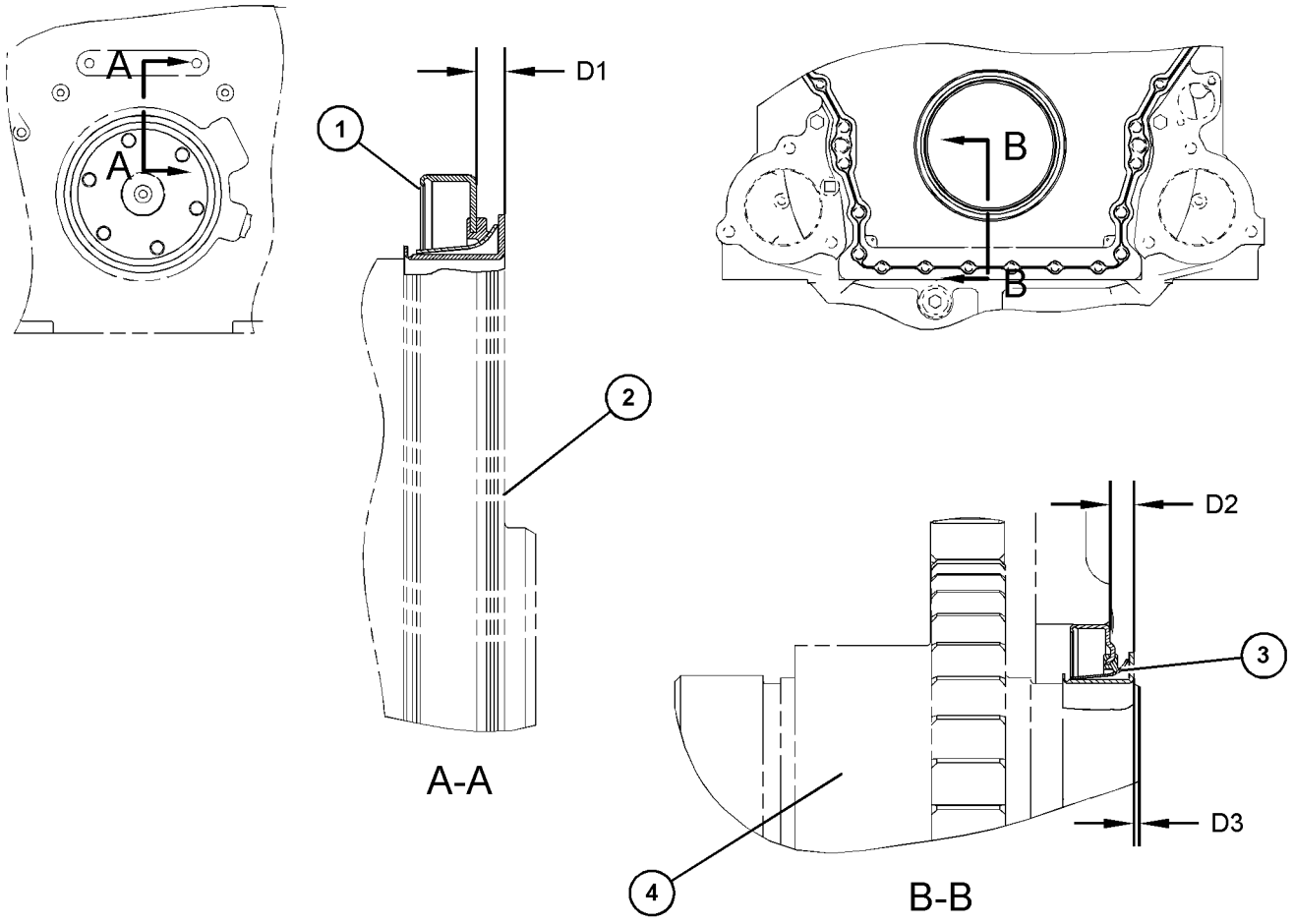


Illustration 126 g06405993

(2) Front end of crankshaft (4) Rear end of crankshaft

Table 72

Item	Qty	Part	Specification Description
1	1	142-5867 Crankshaft Seal	Do not separate the seal from the sleeve. Replace the seal if the seal is separated from the sleeve.
			The sleeve of the front crankshaft seal should be flush with front face of crankshaft.
			The seal driver should not contact the crankshaft seal inside diameter is 177.80 ± 0.25 mm (7.000 ± 0.010 inch).
D1	-	-	The assembled installation depth should be checked with the crankshaft at maximum forward position is 5.03 to 5.43 mm (0.198 to 0.214 inch).
3	1	142-5868 Crankshaft Seal	Do not separate the seal from the sleeve. Replace the seal if the seal is separated from the sleeve.

(continued)

(Table 72, contd)

Item	Qty	Part	Specification Description
			The seal driver should not contact the crankshaft seal inside diameter is 177.80 ± 0.25 mm (7.000 ± 0.010 inch).
D2	-	-	The assembled installation depth should be checked with the crankshaft at maximum rearward position is 6.15 to 6.55 mm (0.242 to 0.258 inch).
D3	-	-	Installation depth of the rear crankshaft seal is 1.5 ± 0.5 mm (0.06 ± 0.020 inch).

i02856619

Vibration Damper

SMCS Code: 1205

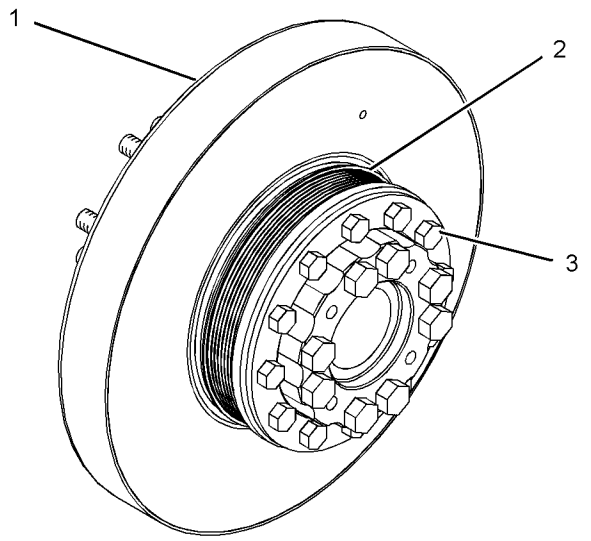


Illustration 127 g01248941

(1) Damper
(2) Crankshaft pulley

(3) Torque for 12 bolts . . . . . 135 ± 20 N·m ((100 ± 15 lb ft))

i02866018

Vibration Damper

SMCS Code: 1205

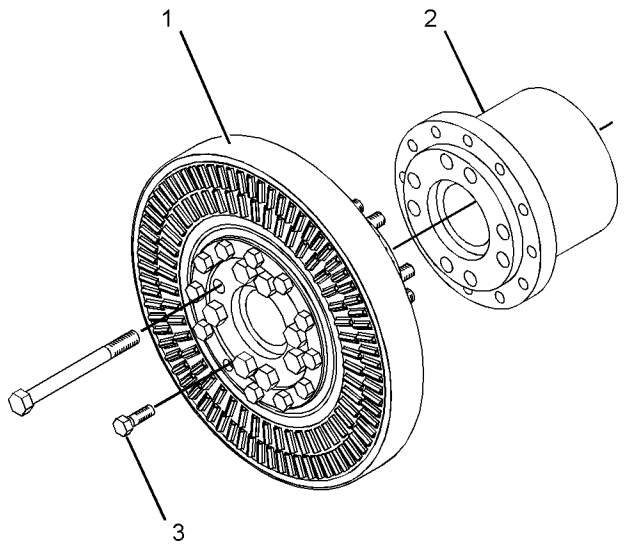


Illustration 128 g01427740

(1) Damper
(2) Damper adapter

(3) Torque for 12 bolts . . . . . 135 ± 20 N·m ((100 ± 15 lb ft))

i02866033

Vibration Damper

SMCS Code: 1205

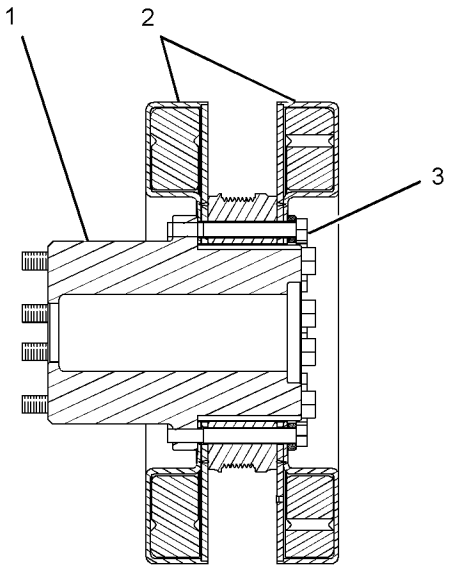


Illustration 129 g01427752

(1) Damper adapter
(2) Dampers

(3) Torque for 12 bolts . . . . . 135 ± 20 N·m ((100 ± 15 lb ft))

i02866067

Vibration Damper

SMCS Code: 1205

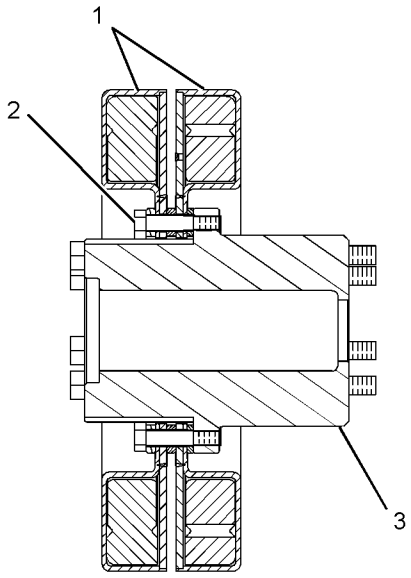


Illustration 130 g01427778

(1) Dampers
(3) Damper adapter

(2) Torque for 12 bolts . . . . . 135 ± 20 N·m ((100 ± 15 lb ft))

i06215880

Vibration Damper

SMCS Code: 1205

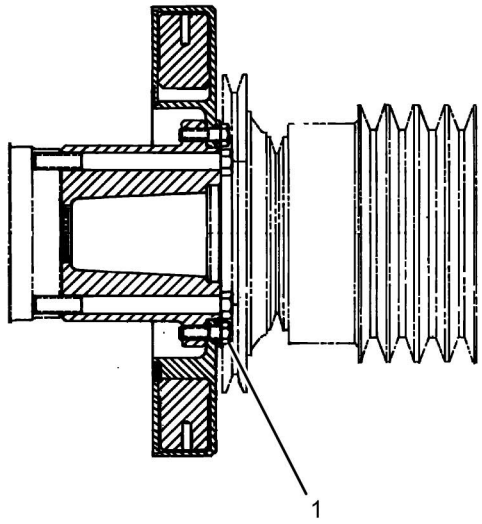


Illustration 131 g03857658

Table 73

Specification for 6N-2229 Damper Gp			
Item	**Qty**	**Part**	**Specification Description**
1	12	0S-1585 Bolt	Torque to 135 ± 20 N·m (100 ± 15 lb ft).

i07317060

Vibration Damper

SMCS Code: 1205

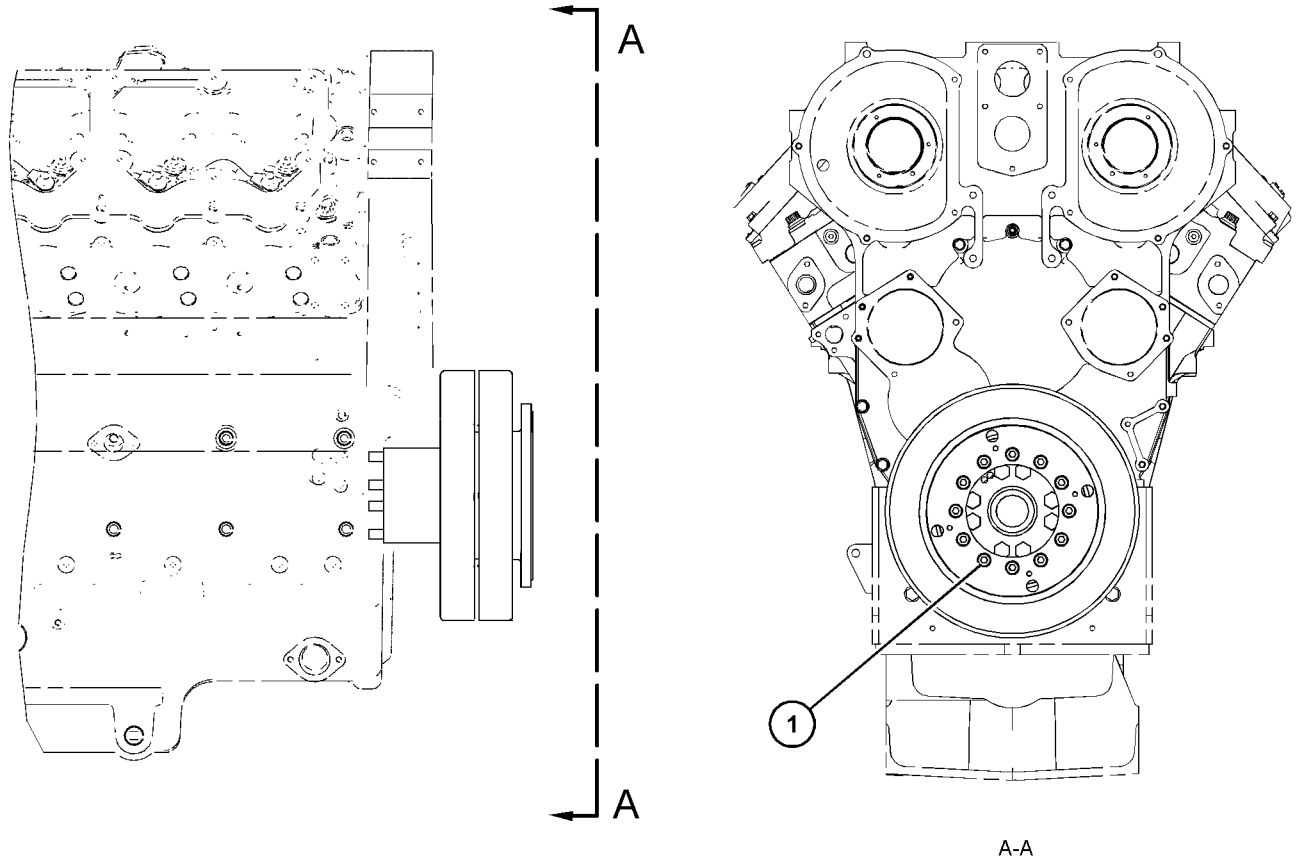


Illustration 132 g06280661

Table 74

Item	Qty	Part	Specification Description
1	12	155-5968 Bolt	Torque to 135 ± 20 N·m (100 ± 15 lb ft).

i07726645

Vibration Damper

SMCS Code: 1205

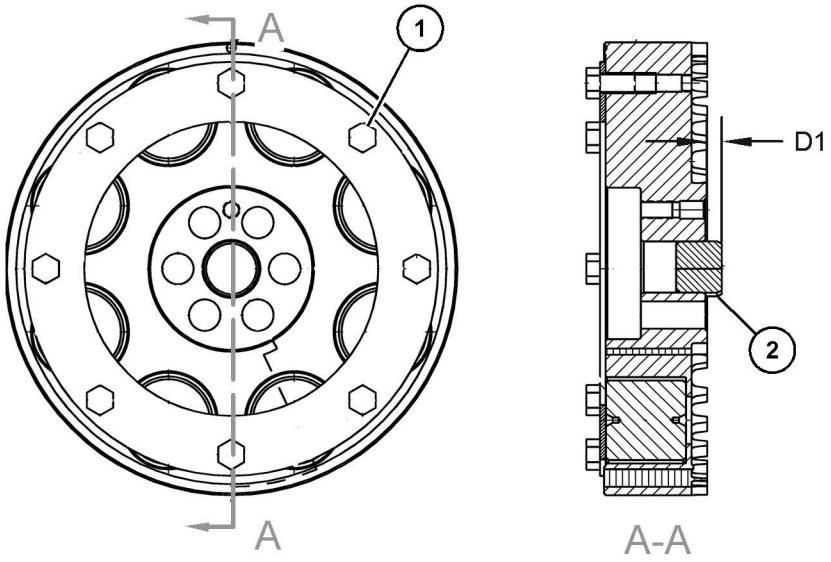


Illustration 133 g06412615

Table 75

Item	Qty	Part	Specification Description
1	8	0S-1571 Bolt	Torque to 66 ± 6 N·m (49 ± 4 lb ft).
2	1	103-0126 Dowel	Extension of the dowel (D1) is 8.0 ± 0.5 mm (0.31 ± 0.02 inch).

i07595002

Connecting Rod Bearing Journal

SMCS Code: 1202; 1219; 1225

Refer to Guideline For Reusable Parts and Salvage Operations, SEBF8042, “Reuse and Salvage for Crankshafts”.

Table 76

Diameter of Crankshaft Journal (Bearing Surface) For Connecting Rod	
Original Size Journal	97.028 ± 0.020 mm (3.8200 ± 0.0008 inch)

Clearance between new bearing and new journal . . . . . 0.070 to 0.178 mm ((0.0028 to 0.0070 inch))

i07777618

Main Bearing Journal

SMCS Code: 1202; 1203

Connecting Rod Bearing Journals

Refer to Guideline For Reusable Parts And Salvage Operations, SEBF8009, “Main and Connecting Rod Bearings”.

Refer to Guideline For Reusable Parts and Salvage Operations, SEBF8041, “Specifications for Crankshaft in Caterpillar Engines” for 3500 Engines.

Refer to Guideline For Reusable Parts and Salvage Operations, SEBF9217, “Specifications for Crankshaft in Caterpillar Engines” for C7-C32 Engines.

Clearance between new bearing and new journal
. . . . . 0.070 to 0.178 mm ((0.0028 to 0.0070 inch))

Main Bearing Journals

Table 77

Main Bearing Journals	
Original Size Journal	120.650 ± 0.020 mm (4.7500 ± 0.0008 inch)
Undersize Journal 0.63 mm (0.025 inch)	120.015 ± 0.020 mm (4.7250 ± 0.0008 inch)
Undersize Journal 1.27 mm (0.050 inch)	119.380 ± 0.020 mm (4.7000 ± 0.0008 inch)

Main bearing cap with two bolts

Clearance between new bearing and new journal
. . . . 0.076 to 0.186 mm ((0.0030 to 0.0073 inch))

Main bearing cap with four bolts

Clearance between new bearing and new journal
. . . . 0.071 to 0.178 mm ((0.0028 to 0.0070 inch))

Table 78

Main Bearing Bore	
Original Size of the Bore In the Block	129.891 ± 0.013 mm (5.1138 ± 0.0005 inch)
Oversize Bore 0.63 mm (0.025 inch)	130.521 ± 0.013 mm (5.1387 ± 0.0005 inch)

i05551925

Connecting Rod

SMCS Code: 1218

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 232-3232
S/N: E9Z1–Up

S/N: KDZ1–Up

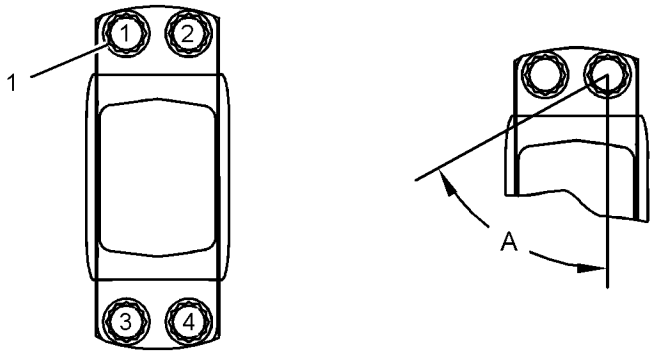


Illustration 134 g02578016

Tightening sequence

Table 79

Specification for 232-3232 Rod As			
Item	**Qty**	**Part**	**Specification Description**
1	4	213-3217 Bolt	Use the following procedure for tightening the bolts for the rod cap. Refer Illustration 134 .
			1. Before assembly, lubricate the threads of the bolts and the seating face of the bolt heads with clean engine oil.
			2. Finger tighten all the bolts.
			3. Tighten bolts 1 and 3 to 70 ± 4 N·m (52 ± 3 lb ft).
			4. Tighten bolts 2 and 4 to 70 ± 4 N·m (52 ± 3 lb ft).
			Note : Use a paint stick to place an index mark on each of the bolts. Use the index mark as a reference in order to torque the bolts for an additional angle.
			5. Tighten bolts 2 and 4 by an additional angle (A) of 60 ± 5 degrees.
			6. Tighten bolts 1 and 3 again to 70 ± 4 N·m (52 ± 3 lb ft).
			7. Tighten bolts 1 and 3 by an additional angle (A) of 60 ± 5 degrees.
The connecting rods should be installed in the engine so that the part number of the forging for the rod assembly is facing the connecting rod that is on the same crankshaft pin. The opposite side of the connecting rods will face the thrust surface of the crankshaft journal.			

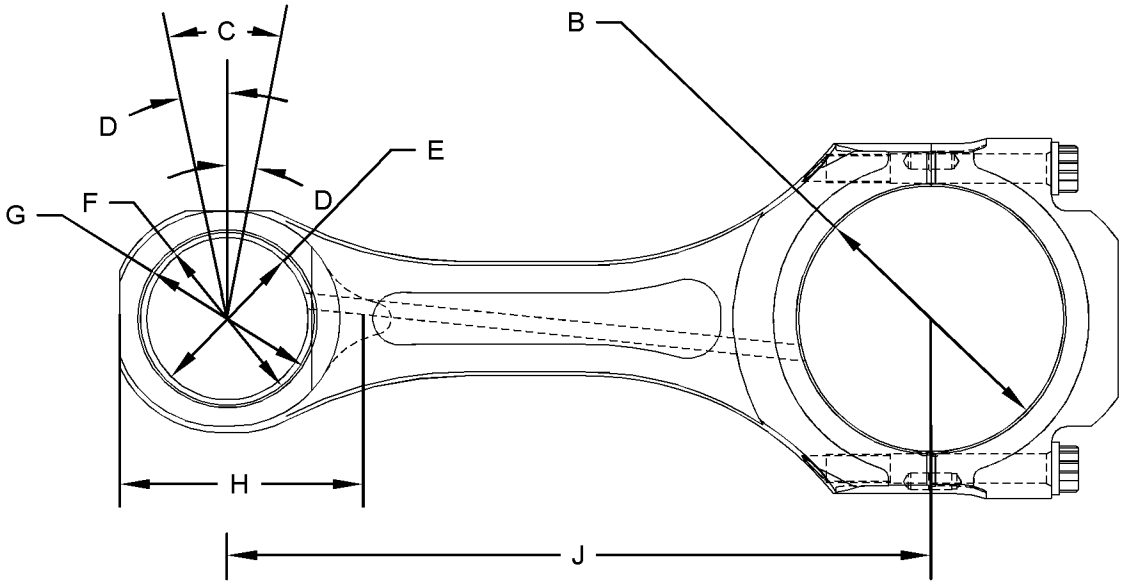


Illustration 135 g02577978

Table 80

Specification for 232-3232 Rod As			
Item	**Qty**	**Part**	**Specification Description**
B	-	-	Inside diameter of connecting rod for bearing for the crankshaft journal is 103.500 ± 0.013 mm (4.0748 ± 0.0005 inch).
C	-	-	The bearing joint must be located within area (C) along the horizontal centerline of the piston pin bore.
D	-		Maximum angle from the horizontal centerline is ± 5 degrees.
E	-	-	Inside diameter of connecting rod of bearing for the piston pin is 64.592 ± 0.013 mm (2.5430 ± 0.0005 inch).
F	-	-	Bore diameter of bearing for the piston pin is 60.035 ± 0.008 mm (2.3636 ± 0.0003 inch).
G	-	-	Outside diameter of bearing for piston pin before installation into the connecting rod is 64.717 ± 0.013 mm (2.5479 ± 0.0005 inch).
-	-	-	Note : Apply heat to the connecting rod prior to installation of bearing for piston pin. **Do not use a torch to heat the connecting rod.**
H	-	-	Maximum length for heating the connecting rod during the installation of bearing for piston pin is 95 mm (3.7 inch).
-	-	-	Temperature for heating the connecting rod is 175 to 260 °C (347 to 500 °F)
J	-	-	Distance between the center of the bore for the bearing for piston pin and the center of the bore for the crankshaft journal is 274.91 mm (10.823 inch).

i07107317

Piston and Rings

SMCS Code: 1214; 1215

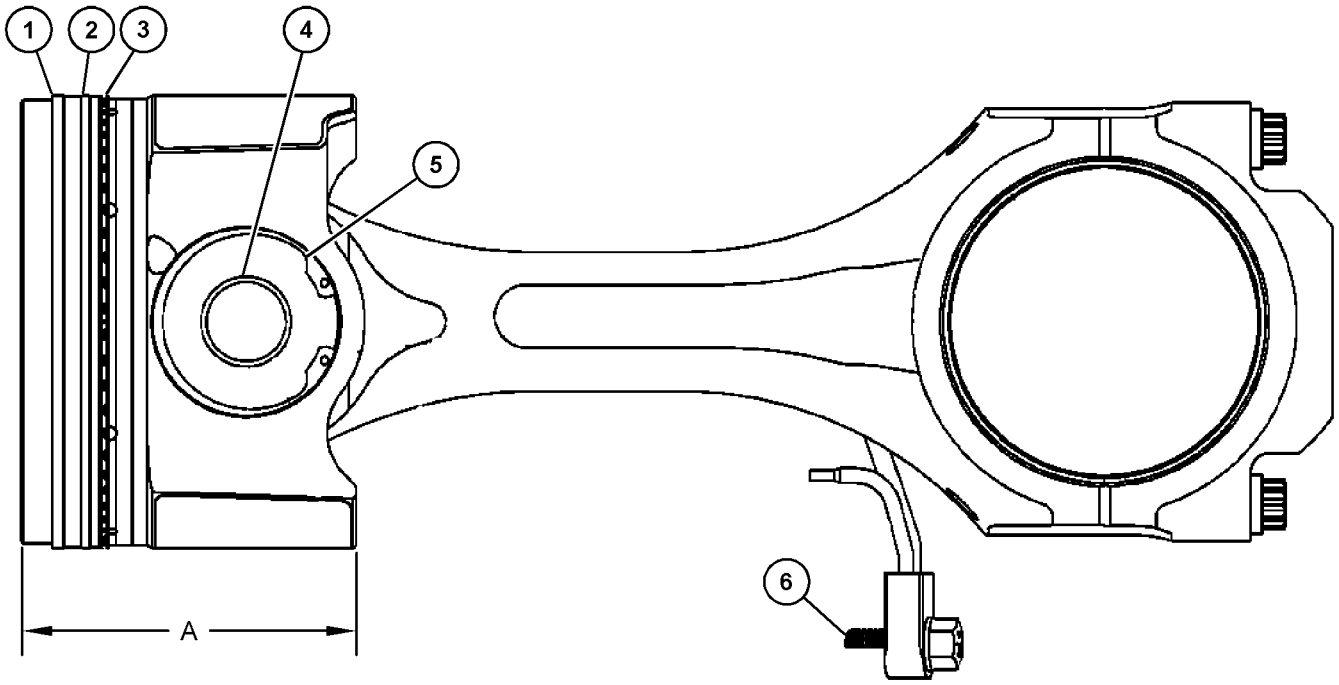


Illustration 136 g06226990

Table 81

Item	Qty	Part	Specification Description
1	1	223-9159 Top Piston Ring	Install the top piston ring with the side marked “Up-1” toward the top of the piston. Orient the purple stripe face to the right of the end gaps of the piston ring.
			Clearance between the ends of the top piston ring in a cylinder liner bore of 145.0 mm (5.71 inch) is 0.40 ± 0.10 mm (0.016 ± 0.004 inch).
			Increase in the clearance between the ends of the top piston ring for each 0.03 mm (0.001 inch) increase in the cylinder liner bore is 0.08 mm (0.003 inch).
			Thickness of new top piston ring is 3.845 mm (0.1514 inch).
2	1	344-5153 Piston Ring	Install the intermediate piston ring with the side marked “Up-2” toward the top of the piston. Orient the white stripe face to the right of the end gaps of the piston ring.
			Clearance between the ends of the intermediate piston ring in a cylinder liner bore of 145.0 mm (5.71 inch) is 0.825 ± 0.125 mm (0.0325 ± 0.0049 inch).
			Increase in the clearance between the ends of the intermediate piston ring for each 0.03 mm (0.001 inch) increase in the cylinder liner bore is 0.08 mm (0.003 inch).
			Thickness of new intermediate piston ring is 2.94 mm (0.116 inch).

(continued)

(Table 81, contd)

Item	Qty	Part	Specification Description
3	1	246-5659 Piston Ring	The ends of the oil control piston ring should be at a distance of 180 degrees from the ring end gap when the oil control piston ring is assembled. The green stripe faces to the right or left of the piston ring end gap.
			Clearance between the groove and the new oil control piston ring in a cylinder liner bore of 145.0 mm (5.71 inch) is 0.55 ± 0.15 mm (0.022 ± 0.006 inch).
			Increase in the clearance between the ends of the oil control piston ring for each 0.03 mm (0.001 inch) increase in the cylinder liner bore is 0.08 mm (0.003 inch).
			Thickness of new oil control piston ring is 2.980 ± 0.010 mm (0.1173 ± 0.0004 inch).
			Width of groove in new piston body assembly for oil control piston ring is 3.020 ± 0.010 mm (0.1189 ± 0.0004 inch).
4	1	524-5565 Piston Pin	Thoroughly lubricate the piston pin with clean engine oil before the piston pin is inserted into the piston body assembly and the rod assembly.
			Outside diameter of the new piston pin is 59.975 ± 0.005 mm (2.3612 ± 0.0002 inch).
			Inside diameter of the new piston pin is 25.1 to 25.7 N·m (222.1 to 227.4 lb in).
			Length of the new piston pin is 89.8 ± 0.2 N·m (66.2 ± 0.1 lb ft).
			Bore in the new piston body assembly for the piston pin is 60.095 ± 0.005 mm (2.3659 ± 0.0002 inch).
5	2	250-2940 Pin Retainer	Install the pin retainer with the gap at the bottom of the piston as shown in Illustration 136 .
6	1	150-1156 Special Bolt	Torque to 25 ± 6 N·m (221 ± 53 lb in).
A	-	-	Thoroughly lubricate the entire piston with clean engine oil prior to assembly into the cylinder block.
-	-	-	After the piston rings have been installed, rotate the piston rings so that the end gaps are 120 degrees from each other.
Refer to Guideline for Reusable Parts for information on the pistons, the piston pins, and the retaining rings.			
The 1U-6431 Piston Ring Groove Gauge Gp is used for measuring the ring grooves in keystone style pistons. Refer to the Special Instruction that is supplied with the piston ring groove gauge group.			
The 5P-3519 Piston Ring Groove Gauge Gp is available for checking the ring grooves with straight sides. Refer to the Guideline for Reusable Parts for instructions on the piston ring groove gauge group.			

i07398028

Piston and Rings
(C27 Engines)

SMCS Code: 1214; 1215

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 213-4836
S/N: E9Z1–Up

S/N: KDZ1–Up

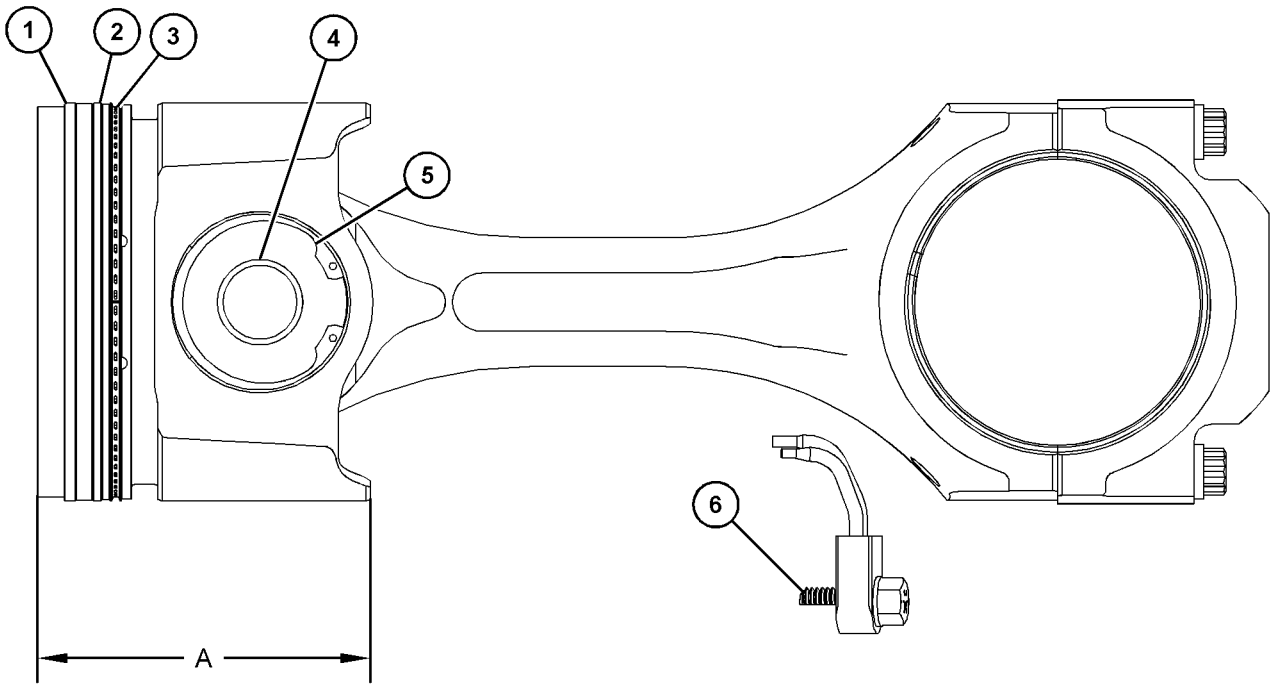


Illustration 137 g06309422

Table 82

Item	Qty	Part	Specification Description
1	1	247-6130 Top Piston Ring	Install the top piston ring with the side marked “Up-1” toward top of the piston. Orient the blue and yellow color stripe face to the right of the piston ring end gaps.
			Clearance between the ends of the top piston ring is 0.40 ± 0.10 mm (0.016 ± 0.004 inch).
			Thickness is 3.81 mm (0.15 inch).
2	1	164-4187 Piston Ring	Install the intermediate piston ring with the side marked “Up-2” toward top of the piston. Orient the violet color stripe face to the right of the piston ring end gaps.
			Clearance between the ends of the intermediate piston ring is 0.770 ± 0.125 mm (0.0303 ± 0.0049 inch).
3	1	238-0294 Piston Ring	The ends of the oil control piston ring should be at a distance of 180 degrees from the ring end gap when the oil control piston ring is assembled. The blue color stripe faces to the right or left of the piston ring end gap.
			Clearance between the ends of the new oil control piston ring is 0.55 ± 0.15 mm (0.022 ± 0.006 inch).
			Width of groove in new piston body assembly for piston ring is 4.030 ± 0.010 mm (0.1587 ± 0.0004 inch).
			Thickness is 3.980 ± 0.010 mm (0.1567 ± 0.0004 inch).
-	-	-	After the piston rings have been installed, rotate the piston rings so that the end gaps are 120 degrees apart from each other.
4	1	524-5565 Piston Pin	Thoroughly lubricate the piston pin with clean engine oil before the piston pin is inserted into the piston body assembly and the rod assembly.

(continued)

(Table 82, contd)

Item	Qty	Part	Specification Description
			Outside diameter is 59.975 ± 0.005 mm (2.3612 ± 0.0002 inch).
			Inside diameter is 25.4 ± 0.3 mm (1 ± 0.01 inch).
			Length is 89.8 ± 0.2 mm (3.54 ± 0.01 inch).
			Bore in the new piston body assembly for the piston pin is 60.095 ± 0.010 mm (2.3659 ± 0.0004 inch).
5	2	250-2940 Pin Retainer	Install the pin retainer with the gap at the bottom of the piston as shown in Illustration 137 .
6	1	150-1156 Special Bolt	Torque to 25 ± 6 N·m (221 ± 53 lb in).
A	-	-	Thoroughly lubricate the entire piston with clean engine oil prior to assembly into the cylinder block.

i07678099

Piston and Rings
(C32 Engines)

SMCS Code: 1214; 1215

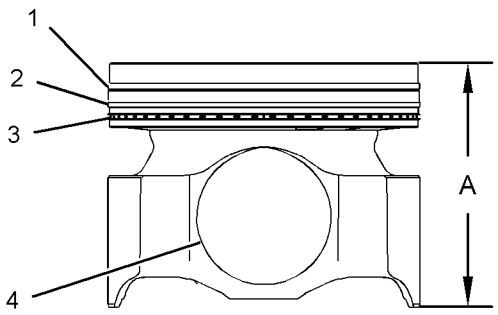


Illustration 138 g01391600

Note: Refer to Guideline for Reusable Parts for information on the pistons, the piston pins, and the retaining rings.

The 1U-6431 Piston Ring Groove Gauge Gp is used for measuring the ring grooves in keystone style pistons. Refer to the Special Instruction that is supplied with the piston ring groove gauge group.

The 5P-3519 Piston Ring Groove Gauge Gp is available for checking the ring grooves with straight sides. Refer to the Guideline for Reusable Parts for instructions on the piston ring groove gauge group.

Note: Lubricate the entire piston in zone (A) with clean engine oil prior to assembly into the cylinder block.

Top Piston Ring (1)

Install the piston ring with the side marked “UP-1” toward the top of the piston. The purple colored stripe faces to the right of the piston ring end gap.

When a new piston ring is installed in a cylinder liner with a bore of 145 mm (5.7 inch), the clearance between the ends of the piston ring is the following value: . . . . . 0.40 ± 0.10 mm ((0.016 ± 0.004 inch))

Increase in clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore . . . . . 0.08 mm ((0.003 inch))

Intermediate Piston Ring (2)

Install the piston ring with the side marked “UP-2” toward the top of the piston. The white-colored stripes face to the right of the piston ring end gap.

When a new piston ring is installed in a cylinder liner with a bore of 145 mm (5.7 inch), the clearance between the ends of the piston ring is the following value: . . . . 0.825 ± 0.125 mm ((0.0325 ± 0.005 inch))

Increase in clearance between the ends of the piston ring for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore . . . . . 0.08 mm ((0.003 inch))

Oil Control Piston Ring (3)

The spring ends of the new piston ring should be a distance of 180 degrees from the ring end gap when the piston ring is assembled. The green colored stripe must be visible at the ring end gap.

Width of groove in new piston for piston ring . . . . . 3.020± 0.010 mm ((0.1189 ± 0.0004 inch))

Thickness of new piston ring . . . . 2.980 ± 0.010 mm ((0.1173 ± 0.0004 inch))

Clearance between groove and piston ring
. . . . . 0.05 mm ((0.002 inch))

When a new piston ring is installed in a cylinder liner with a bore of 145 mm (5.7 inch), the clearance between the ends of the piston ring is the following value. . . . . 0.55 ± 0.15 mm ((0.022 ± 0.006 inch))

Increase in clearance between the ends of the piston ring for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore . . . . . 0.08 mm ((0.003 inch))

Note: After all piston rings have been installed, rotate the piston rings so that the end gaps are 120 degrees from each other.

Piston Pin Bore (4)

Note: Thoroughly lubricate the piston pin with clean engine oil before the piston is inserted into the piston and the rod assembly.

Diameter of the bore in the bearing that is installed into the piston skirt for the piston pin
. . .60.0925 ± 0.0075 mm ((2.36584 ± 0.00030 inch))

Diameter of the new piston pin . . 59.975 ± 0.005 mm ((2.3612 ± 0.0002 inch))

i04397653

Housing (Front)

SMCS Code: 1151

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 238-9862
S/N: E9Z1–Up

S/N: KDZ1–Up

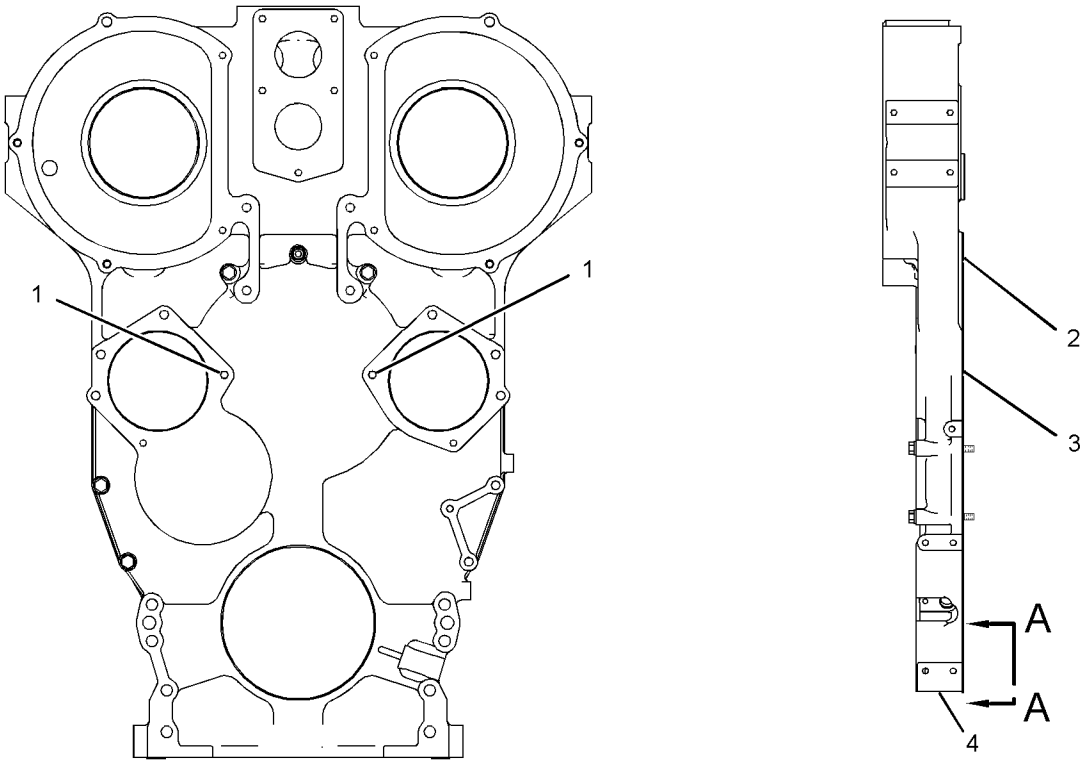


Illustration 139 g02575497

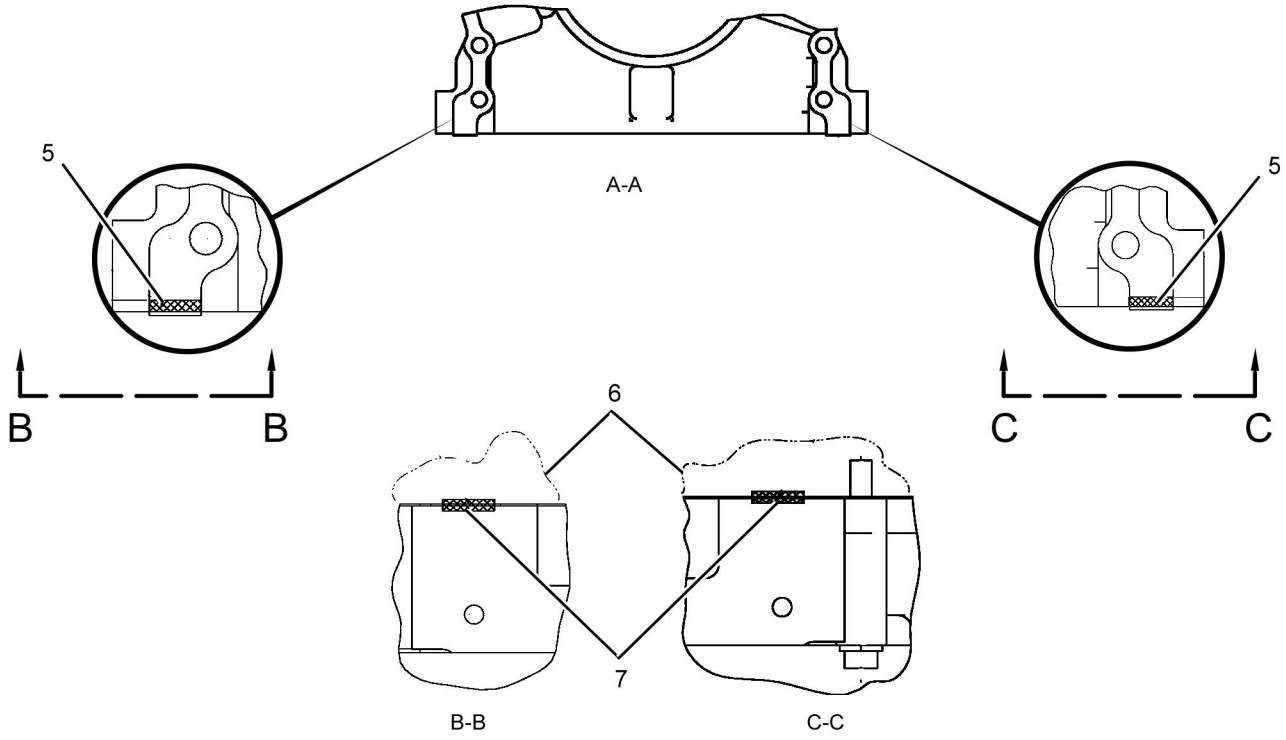


Illustration 140 g02575499

(6) Cylinder block (1) Taperlock stud

Table 83

Specification for 238-9862 Front Housing Gp			
Item	**Qty**	**Part**	**Specification Description**
2	1	214-1727 Gasket	The rear face of the front housing assembly (3) and the front face of the cylinder block (6) must be free of oil, fuel, water, dirt and any other contaminants during assembly. The gasket for the front housing assembly must be trimmed after assembly with the face (4) so that the gasket is flush.
5	-	-	Apply a continuous bead of ultrablack Loctite 598 immediately prior to assembling the front housing assembly. After assembly of the front housing assembly, remove excess sealant from the flange with a straight edge.
7	-	-	Apply ultrablack Loctite 598 to the T-shaped joints immediately prior to the installation of the gasket for the pan. The application of the sealant should cover the entire width of the T-shaped joints.

i02801118

Housing (Rear)

SMCS Code: 1157

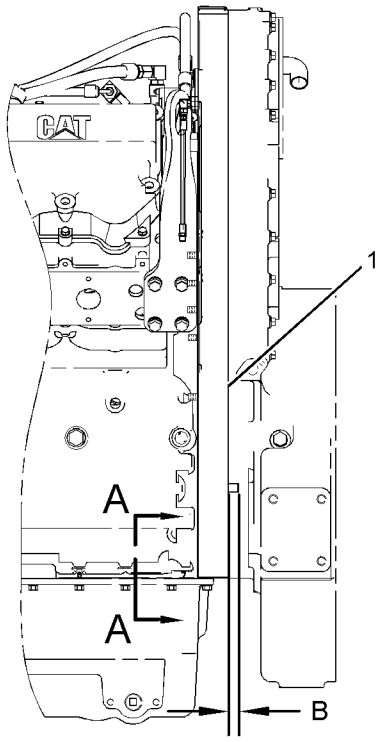


Illustration 141 g01399863

Left side view of engine

Note: The rear face of the cylinder block and the front face of the rear housing (1) must be free of oil, fuel, water, dirt, assembly compounds and any other contaminants during assembly. The gasket for the rear housing must also be free of contaminants during assembly.

(B) Dowel extension from the rear housing at two places . . . . . 19.0 ± 0.5 mm ((0.75 ± 0.02 inch))

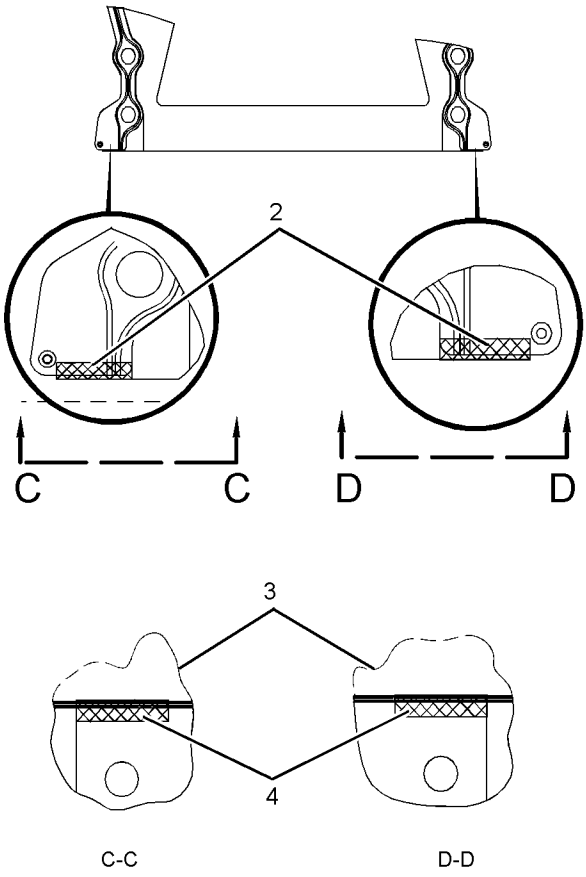


Illustration 142 g01399864

View A-A

(3) Cylinder block

(2) Apply a continuous bead of 230-6262 Sealant immediately prior to assembling the rear housing. After assembly of the rear housing, remove any excess sealant from the flange with a straight edge.

(4) Apply 230 - 6262 Sealant to the T-shaped joints immediately prior to the installation of the gasket for the pan. The application of the sealant should cover the entire width of the T-shaped joints, as shown.

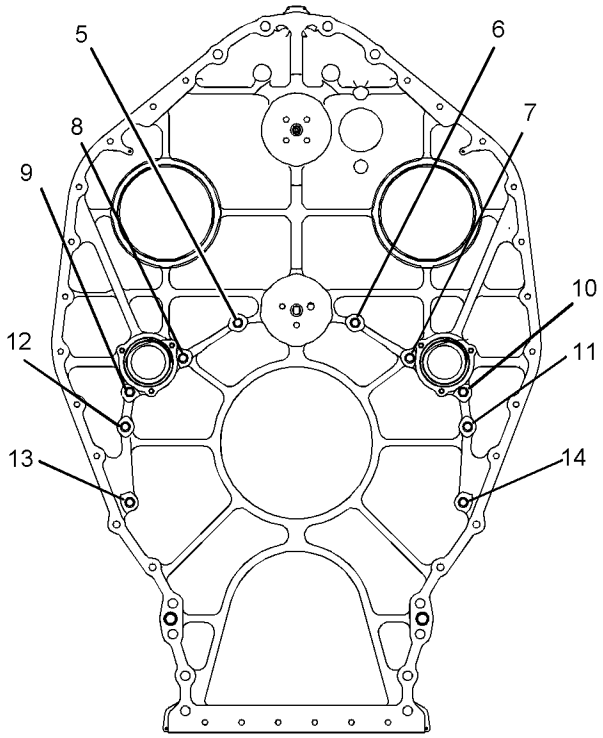


Illustration 143 g01399869

Rear view

Use the following procedure to tighten the bolts for the rear housing:

1. Start with bolt (5) and continue to tighten all of the remaining bolts in the numerical sequence that is shown to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

- Bolt (5) and bolt (6) are 3/8-16 X 1 3/4 inches.
- Bolts (7) through bolts (14) are 3/8-16 X 2 1/4 inches.

i04397631

Housing (Rear)

SMCS Code: 1157

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 350-8861
S/N: E9Z1–Up

S/N: KDZ1–Up

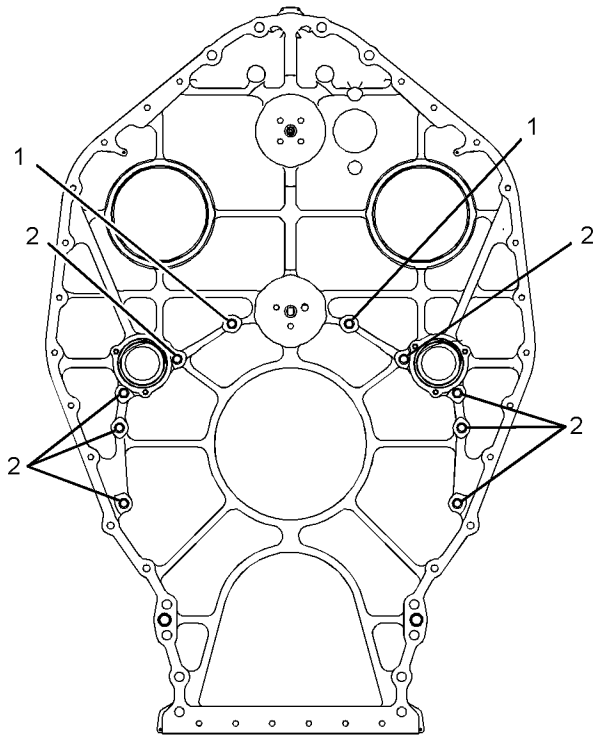


Illustration 144 g02575378

Rear view

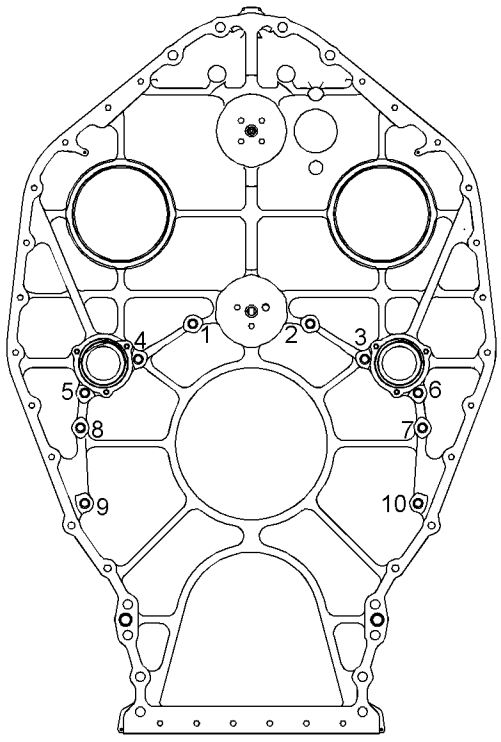


Illustration 145 g02604156

Tightening sequence

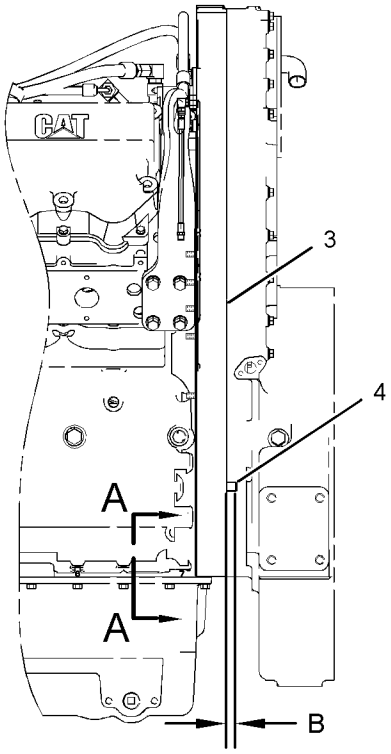


Illustration 146 g02575381

Left side view of engine

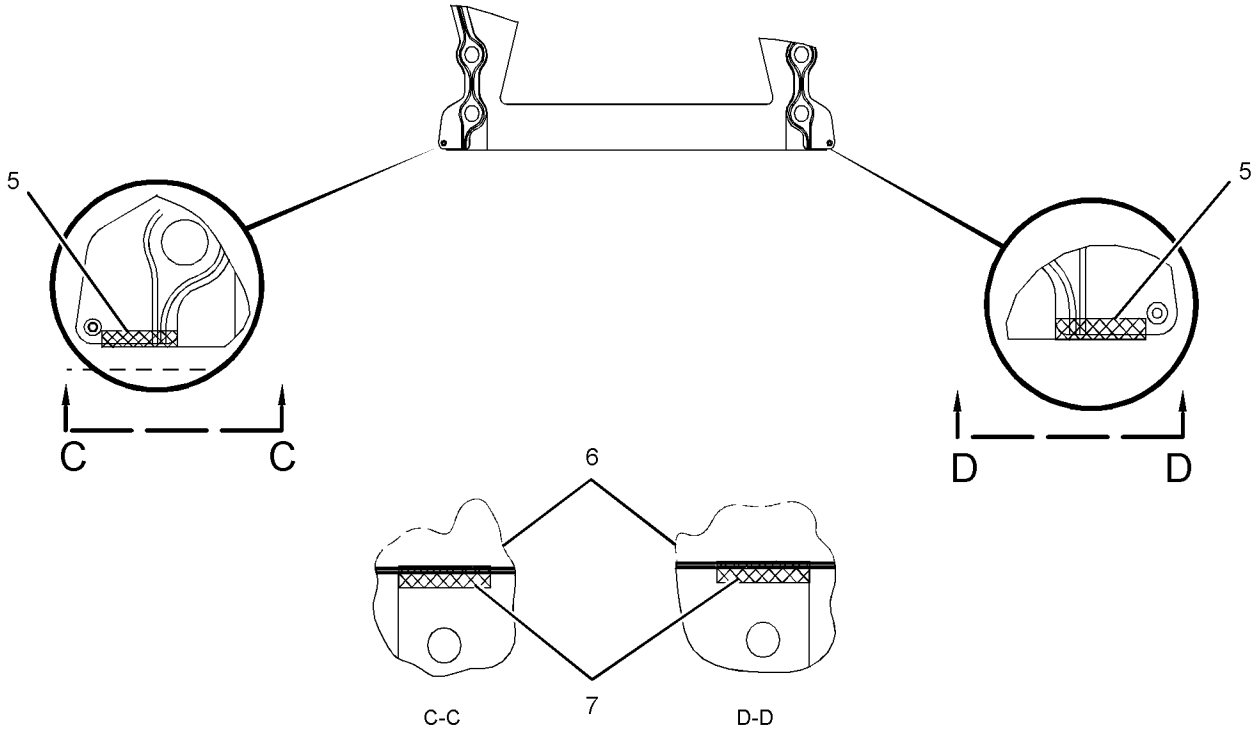


Illustration 147 g02575382

View A-A

(6) Cylinder block

Table 84

Specification for 233-2462 Rear Housing and 350-8861 Rear Housing			
Item	**Qty**	**Part**	**Specification Description**
-	-	-	The rear face of the cylinder block and the front face of the rear housing assembly must be free of oil, fuel, water, dirt, assembly compounds, and any other contaminants during assembly.
1	2	053-2294 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft) in the numerical sequence as shown in Illustration 145 .
2	8	3S-0127 Bolt	
B	-	-	Protrusion of the dowels (4) from the rear housing (3) is 19.0 ± 0.5 mm (0.75 ± 0.02 inch).
5	-	-	Apply a continuous bead of Ultrablack Loctite 598 immediately prior to assembling the rear housing assembly. After assembly of the rear housing assembly, remove any excess sealant from the flange with a straight edge.
7	-	-	Apply Ultrablack Loctite 598 to the T-shaped joints immediately prior to the installation of the gasket for the pan. The application of the sealant should cover the entire width of the T-shaped joints.

i04396759

Gear Group (Front)

SMCS Code: 1206

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 355-2286
S/N: E9Z1–Up

S/N: KDZ1–Up

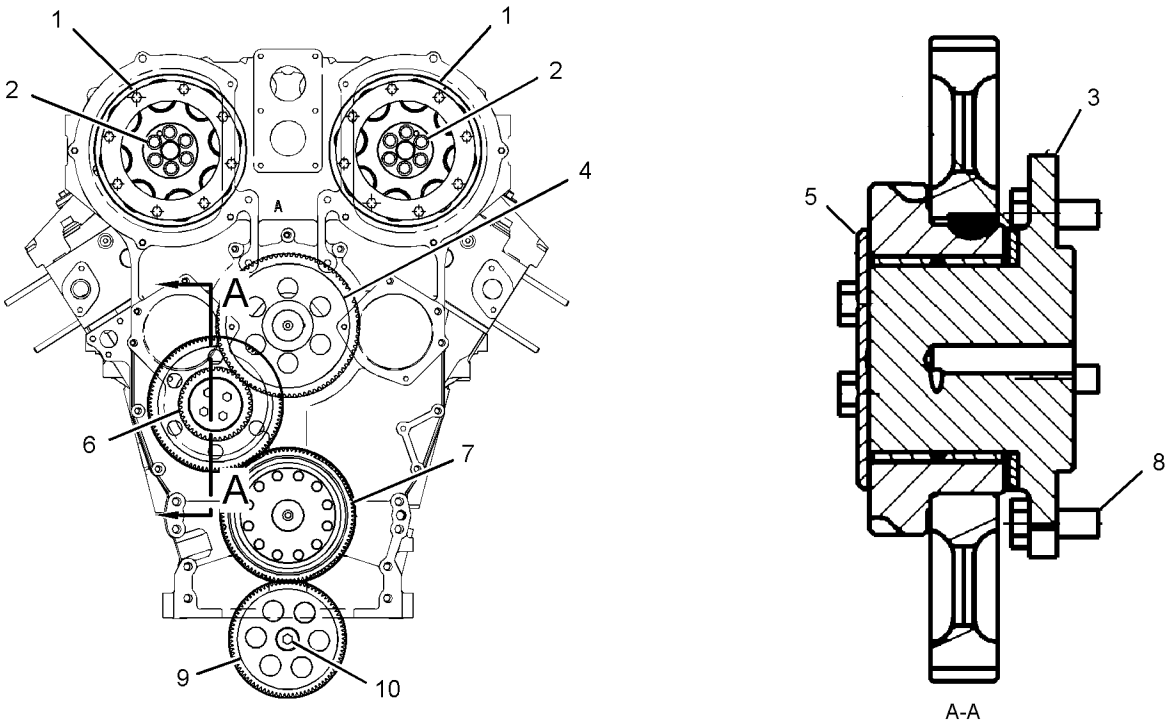


Illustration 148 g02575316

(1) Damper group
(4) Gear assembly
(7) Crankshaft gear
(9) Gear

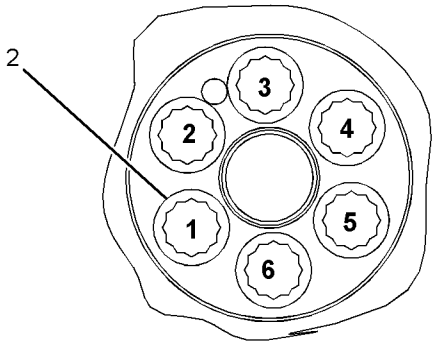


Illustration 149 g01399901

Tightening sequence

Table 85

Specification for 235 - 0993 Front Gear Gp and 355 - 2286 Front Gear Gp			
Item	**Qty**	**Part**	**Specification Description**
2	12	7K - 3116 Bolt	Torque to 240 ± 40 N·m (177 ± 30 lb ft) in the sequence 1, 4, 2, 5, 3, 6, 1, 4 as shown in Illustration 149 .

(continued)

(Table 85, contd)

3	1	117-9712 Drive Idler Shaft	Lubricate the shaft, the bearing bore, and the thrust faces of with clean engine oil.
5	1	112-9217 Thrust Plate	Install the thrust plate with the oil groove side toward the idler gear assembly.
			Lubricate the shaft, the bearing bore, and the thrust faces of with clean engine oil.
6	1	300-5575 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces of with clean engine oil.
8	5	3G-2292 Locking Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
10	1	0S-1571 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).

i04970134

Gear Group (Front)

SMCS Code: 1206

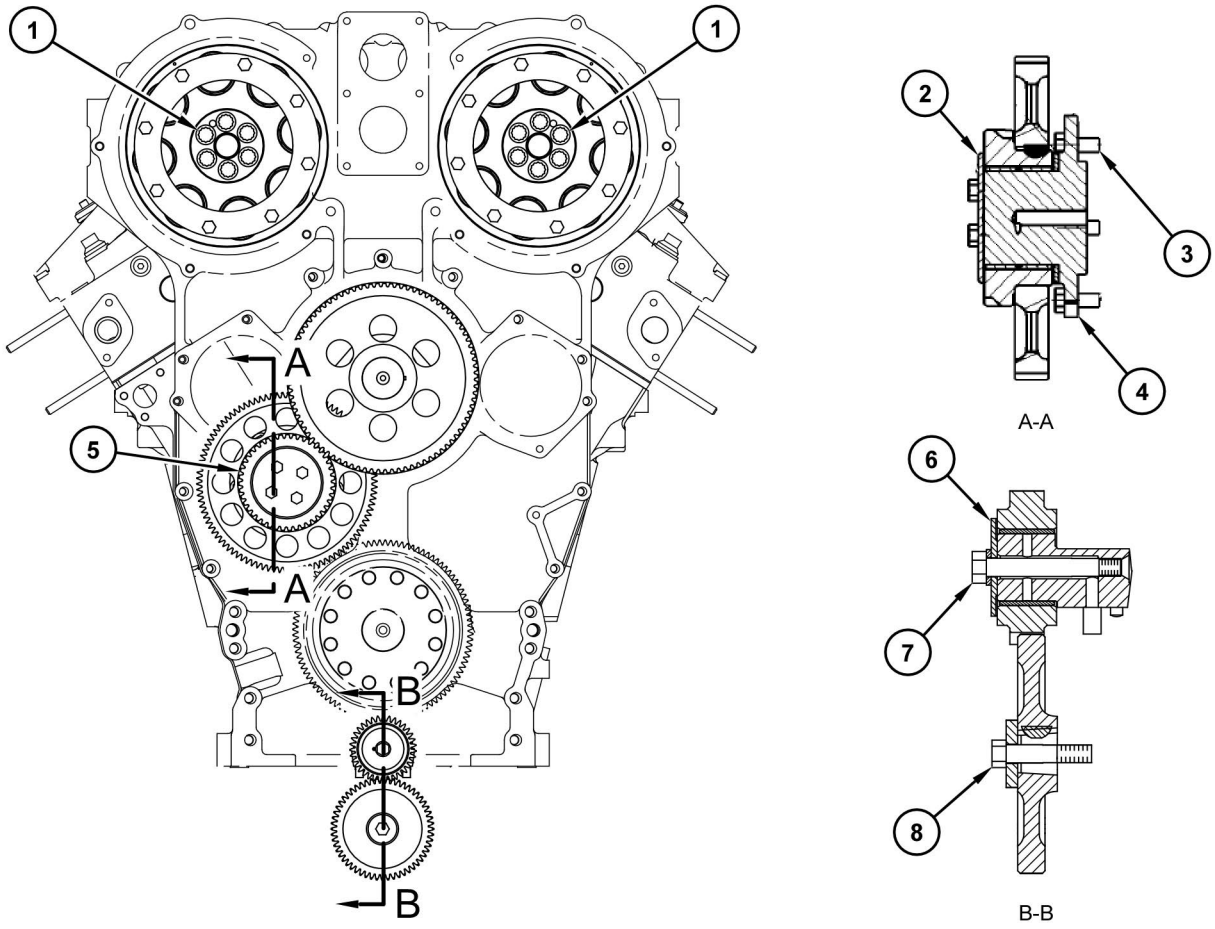


Illustration 150 g03153319

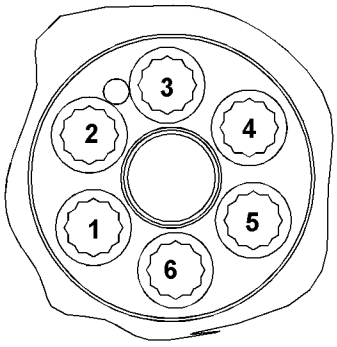


Illustration 151 g03153320

Cam gear bolt tightening sequence

Table 86

Specification for 235-7134 Front Gear Gp			
Item	**Qty**	**Part**	**Specification Description**
1	12	7K-3116 Bolt	Tighten bolt in the sequence 1, 4, 2, 5, 3, 6, 1, 4 as shown in Illustration 151 to 240 ± 40 N·m (177 ± 30 lb ft).
2	1	112-9217 Thrust Plate	Install the thrust plate with the oil groove side toward the idler gear assembly.
			Before assembly, lubricate the thrust faces with clean engine oil.
			Thickness is 4.00 ± 0.25 mm (0.157 ± 0.010 inch).
3	5	3G-2292 Locking Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
4	1	117-9712 Drive Idler Shaft	Before assembly, lubricate the shaft with clean engine oil. Diameter over 128-2661 Bushing end is 63.500 ± 0.013 mm (2.5000 ± 0.0005 inch).
5	1	300-5575 Idler Gear As	Before assembly, lubricate the bore of 128-2661 Bushing in the idler gear assembly with clean engine oil. After installation, bore in the bushing for the drive idler shaft is 63.566 ± 0.013 mm (2.5026 ± 0.0005 inch). Installation depth of the bushing is 0.38 ± 0.25 mm (0.015 ± 0.010 inch).
6	1	6N-1027 Thrust Plate	Install the thrust plate with the oil groove side toward the idler gear assembly.
			Thickness is 3.175 mm (0.1250 inch).
7	1	0T-0573 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
8	1	0S-1571 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).

i07071711

Gear Group (Rear)

SMCS Code: 1204; 1206

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

S/N: E9Z1–Up

S/N: KDZ1–Up

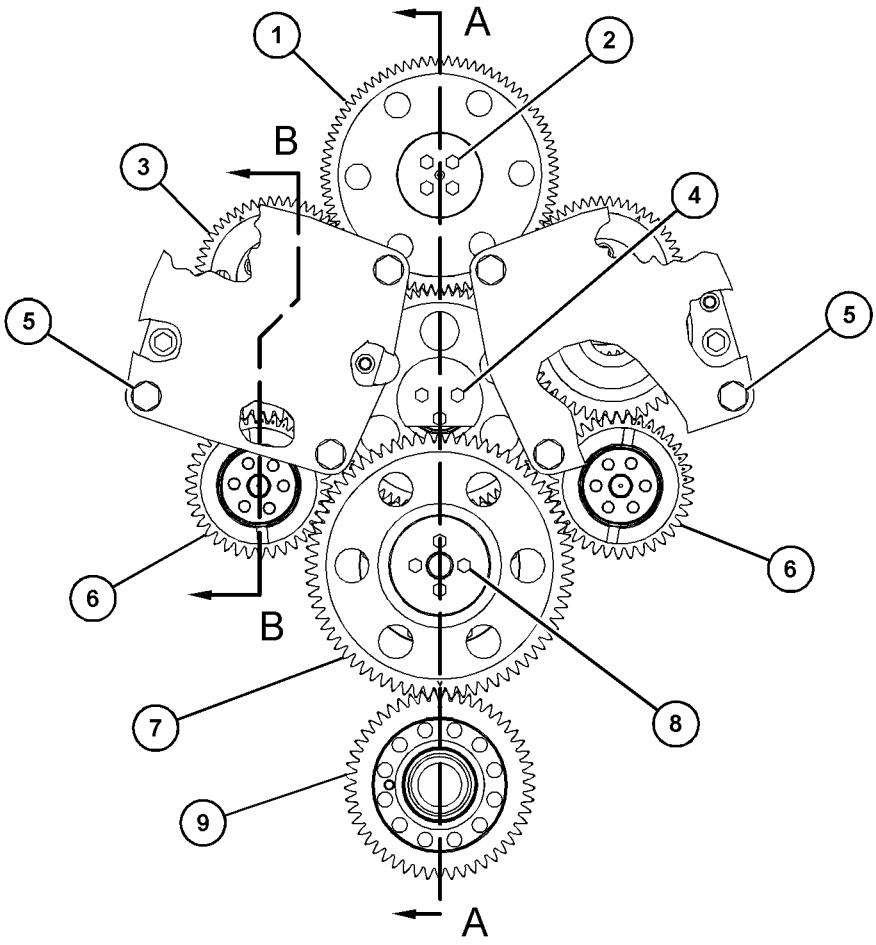


Illustration 152 g06214744
Rear view of engine

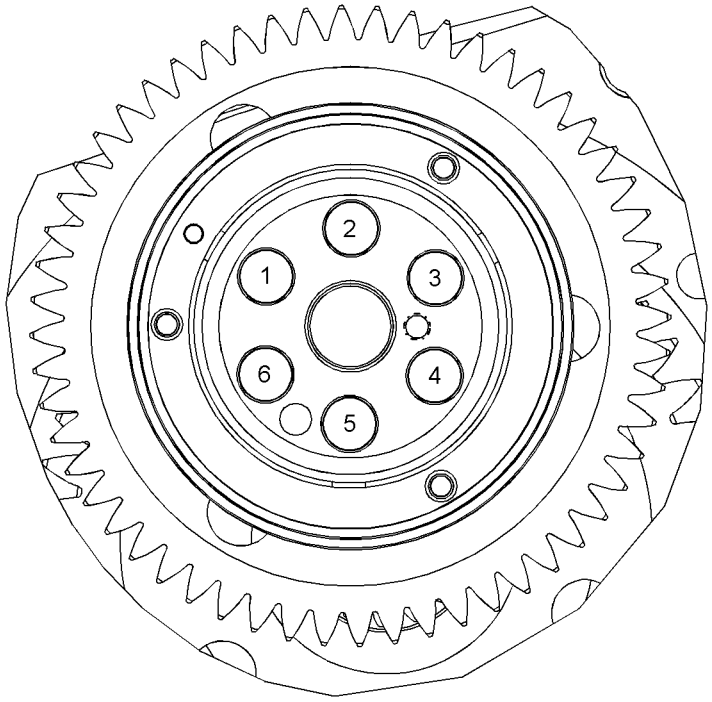


Illustration 153 g06214761

Cam gear bolt tightening sequence

Table 87

Item	Qty	Part	Specification Description
1	1	230-6202 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. After installation, bore of the 224-9664 Bushing is 71.035 ± 0.013 mm (2.7967 ± 0.0005 inch). Installation depth of the bushing is 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
2	6	5B-0213 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
3	2	331-6188 Camshaft Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.
4	1	245-3804 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
5	8	8T-0651 Bolt	Torque to 250 ± 40 N·m (184 ± 30 lb ft).
6	2	228-5814 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
7	1	261-3443 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. With the number one piston in the top dead center position, align the timing marks. The mark on the idler gear must be in alignment with the mark on the crankshaft gear (10). After installation, bore of the 226-6052 Bushing is 88.090 ± 0.013 mm (3.4681 ± 0.0005 inch). Installation depth of the bushing is 3.2 ± 0.5 mm (0.13 ± 0.02 inch).
8	4	1A-2029 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
9	1	261-3441 Crankshaft Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.

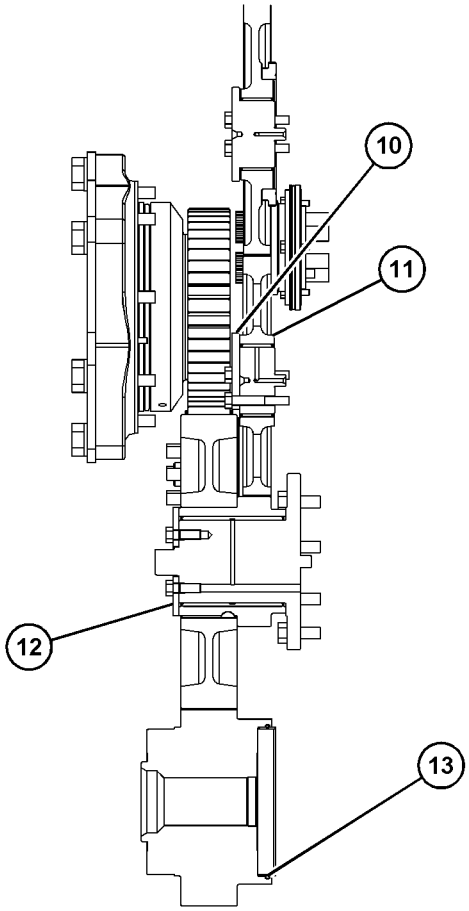


Illustration 154 g06214766

Section A-A

Table 88

Item	Qty	Part	Specification Description
10	1	224 - 1220 Plate	Install the plate with the side marked “OUT” away from the gear face. Thickness is 8.0 ± 0.5 mm (0.31 ± 0.02 inch).
11	1	185 - 1497 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. After installation, bore of the 224 - 9664 Bushing is 71.035 ± 0.013 mm (2.7967 ± 0.0005 inch). Installation depth of the bushing is 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
12	1	229 - 1663 Thrust Plate	Install the thrust plate with the side marked “OUT” away from the gear face. Thickness is 6.35 ± 0.25 mm (0.250 ± 0.010 inch).
13	1	502 - 4034 O-Ring Seal	Before assembly, lubricate the bore lightly with the lubricant that is being sealed.

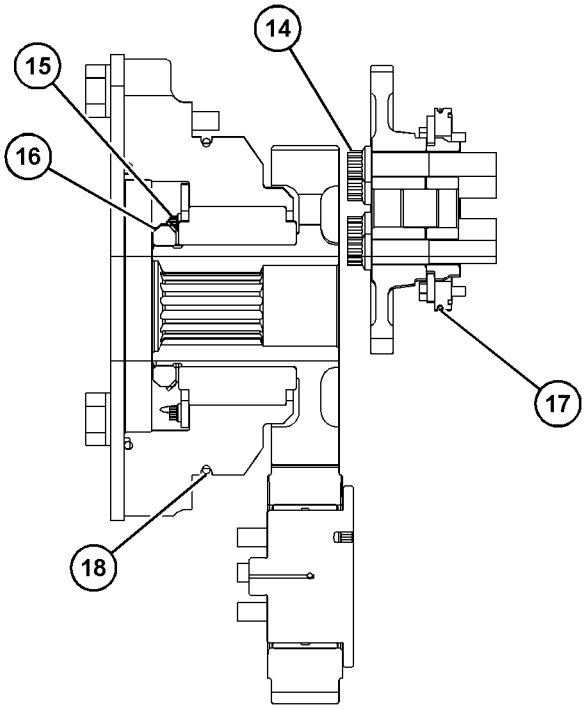


Illustration 155 g06214765

Section B-B

Table 89

Item	Qty	Part	Specification Description
14	12	6J - 3913 Bolt	Tighten bolt in the sequence 1, 4, 2, 5, 3, 6, 1, 4 as per Illustration 153 to 240 ± 40 N·m (177 ± 30 lb ft).
15	2	5F - 7403 Lockwasher	Bend the tab on the lockwashers that aligns with the slot in the bearing locknut (16).
16	2	5F - 7404 Bearing Locknut	Torque to 406 ± 68 N·m (299 ± 50 lb ft).
17	2	117 - 8801 O-Ring Seal	Before assembly, lubricate the bore lightly with the lubricant that is being sealed.
18	2	5P - 8429 O-Ring Seal	Before assembly, lubricate the bore lightly with the lubricant that is being sealed.

i07089098

Gear Group (Rear)

SMCS Code: 1204; 1206

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

S/N: E9Z1–Up

S/N: KDZ1–Up

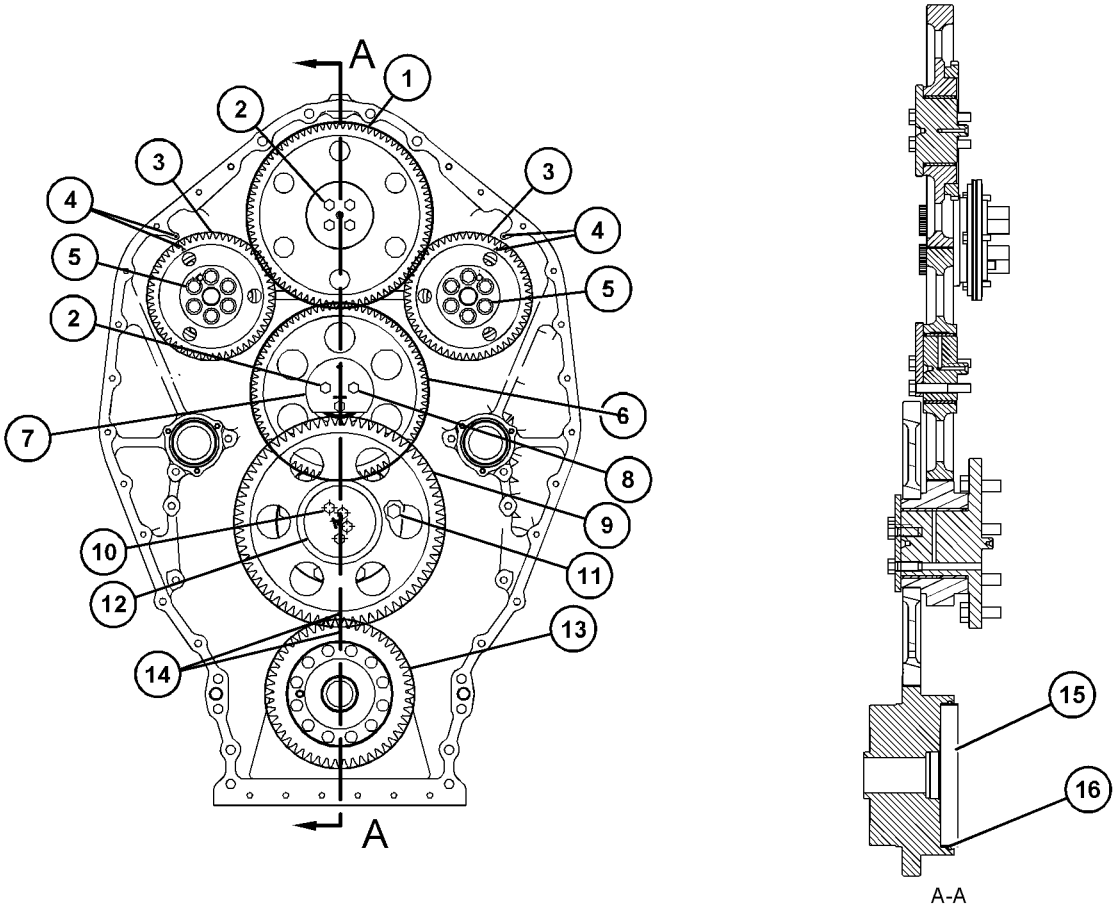


Illustration 156 g06220751

Rear view of engine

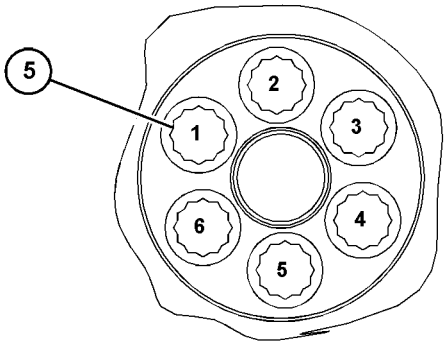


Illustration 157 g06220753

Tightening sequence

Table 90

Item	Qty	Part	Specification Description
1	1	230-6202 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
2	6	5B-0213 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
3	2	331-6188 Camshaft Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
4	-	-	With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.
5	12	6J-3913 Bolt	Torque to 240 ± 40 N·m (177 ± 30 lb ft) in the sequence 1, 4, 2, 5, 3, 6, 1, 4 as per illustration 157 .
6	1	185-1497 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
7	1	224-1220 Plate	Install the plate with the side marked “OUT” away from the gear face.
8	1	245-3804 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
9	1	331-6185 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
10	4	5P-4255 Locking Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
11	8	7B-3235 Bolt	Torque to 135 ± 20 N·m (100 ± 15 lb ft).
12	1	101-1365 Thrust Plate	Install the thrust plate with the side marked “OUT” away from the gear face.
13	1	224-1214 Crankshaft Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
14	-	-	With the number one piston in the top dead center position, align the timing marks. The mark on the idler gear must be in alignment with the mark on the crankshaft gear.
15	1	4N-0848 Wear Sleeve	Before assembly, apply 4C-9506 Retaining Compound to the sleeve ID.
16	2	502-4034 O-Ring Seal	Lubricate lightly with clean engine oil.

i07103909

Gear Group (Rear)

SMCS Code: 1204; 1206

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

S/N: E9Z1–Up

S/N: KDZ1–Up

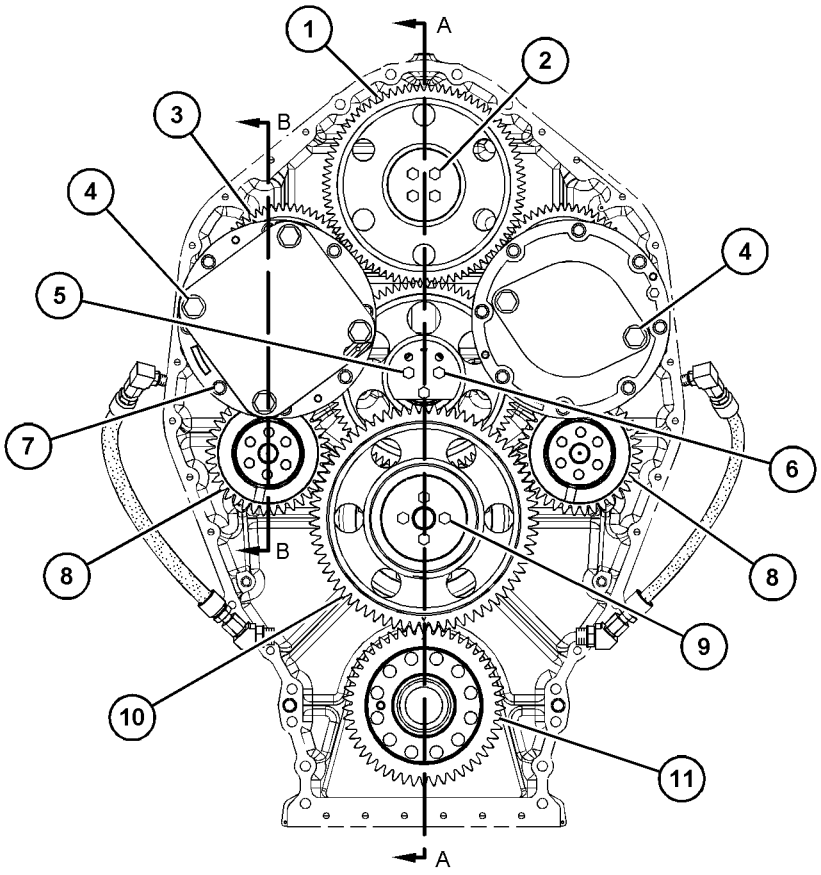


Illustration 158 g06225508

Table 91

Item	Qty	Part	Specification Description
1	1	230-6202 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
2	4	5B-0213 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
3	-	-	With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.
4	6	8T-0299 Bolt	Torque to 215 ± 40 N·m (159 ± 30 lb ft).
5	2	5B-0213 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
6	1	245-3804 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
7	16	8M-2530 Bolt	Torque to 135 ± 20 N.m (100 ± 15 lb ft).
8	2	228-5814 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
9	4	1A-2029 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
10	1	226-6036 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
11	1	228-5813 Crankshaft Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.

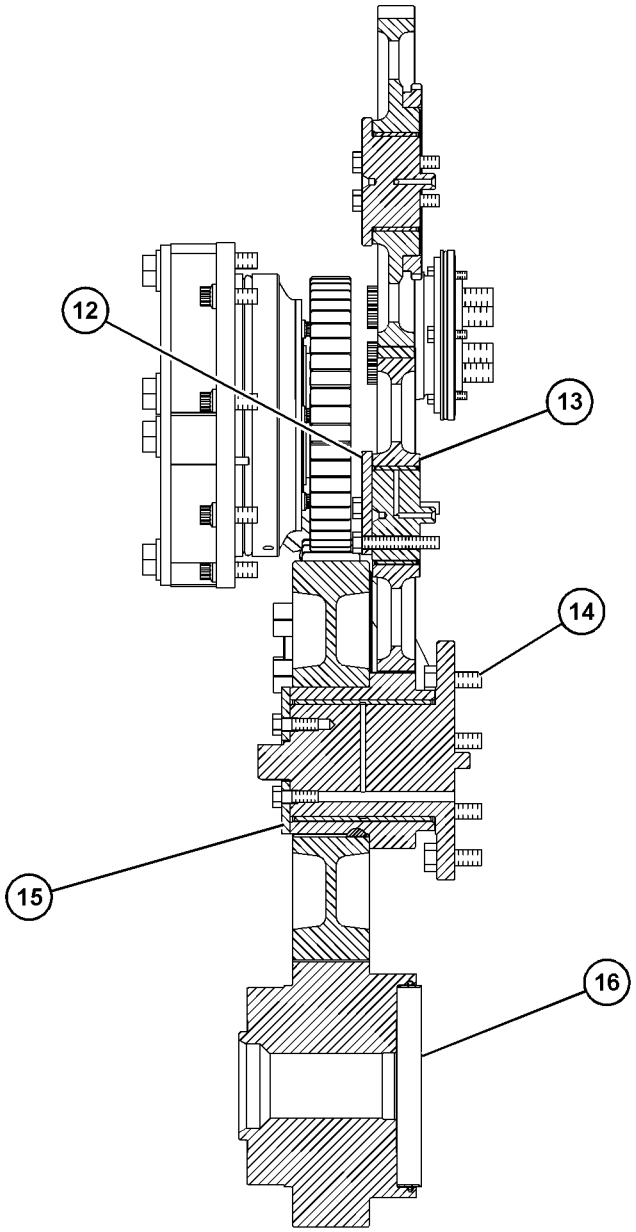


Illustration 159 g06225527

Section A-A

Table 92

Item	Qty	Part	Specification Description
12	1	101-1365 Thrust Plate	Install the thrust plate with the side marked “OUT” away from the gear face.
13	1	185-1497 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
14	8	7B-3235 Bolt	Torque to 135 ± 20 N.m (100 ± 15 lb ft).
15	1	229-1663 Thrust Plate	Install the thrust plate with the side marked “OUT” away from the gear face.
16	1	4N-0848 Wear Sleeve	Before assembly, apply 4C-9506 Retaining Compound to the sleeve ID.

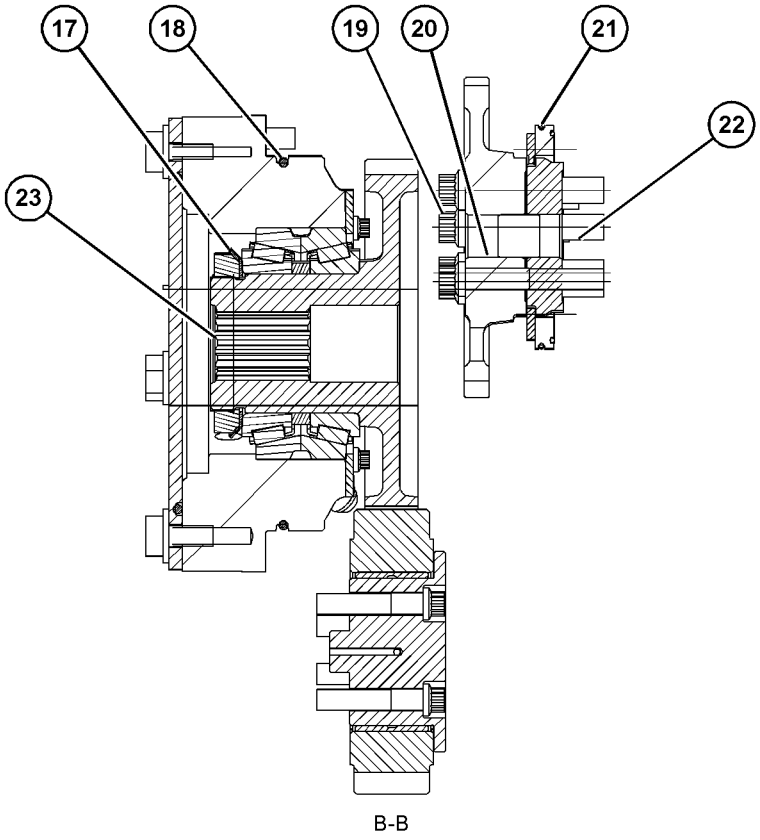


Illustration 160 g06225529

Section B-B

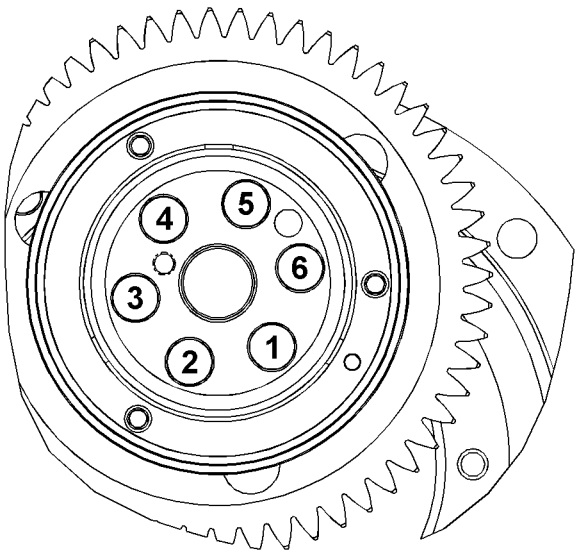


Illustration 161 g06225531

Tightening sequence

Table 93

Item	Qty	Part	Specification Description
17	2	5F-7403 Lockwasher	Bend the tab on the lockwashers that aligns with the slot in the bearing locknut.
18	2	5P-8429 O-Ring Seal	Before assembly, Lubricate the bore lightly with the lubricant that is being sealed.
19	12	6J-3913 Bolt	Tighten the bolts to 240 ± 40 N.m (177 ± 30 lb ft) in numerical sequence as shown in Illustration 161 .
20	2	331-6188 Camshaft Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
21	2	117-8801 O-Ring Seal	Before assembly, Lubricate the bore lightly with the lubricant that is being sealed.
22	6	031-5085 Locking Bolt	Torque to 12 ± 3 N.m (106 ± 27 lb in).
23	2	5F-7404 Bearing Locknut	Torque to 406 ± 68 N.m (299 ± 50 lb ft).

i07397035

Gear Group (Rear)

SMCS Code: 1204; 1206

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 473-8698
S/N: E9Z1–Up

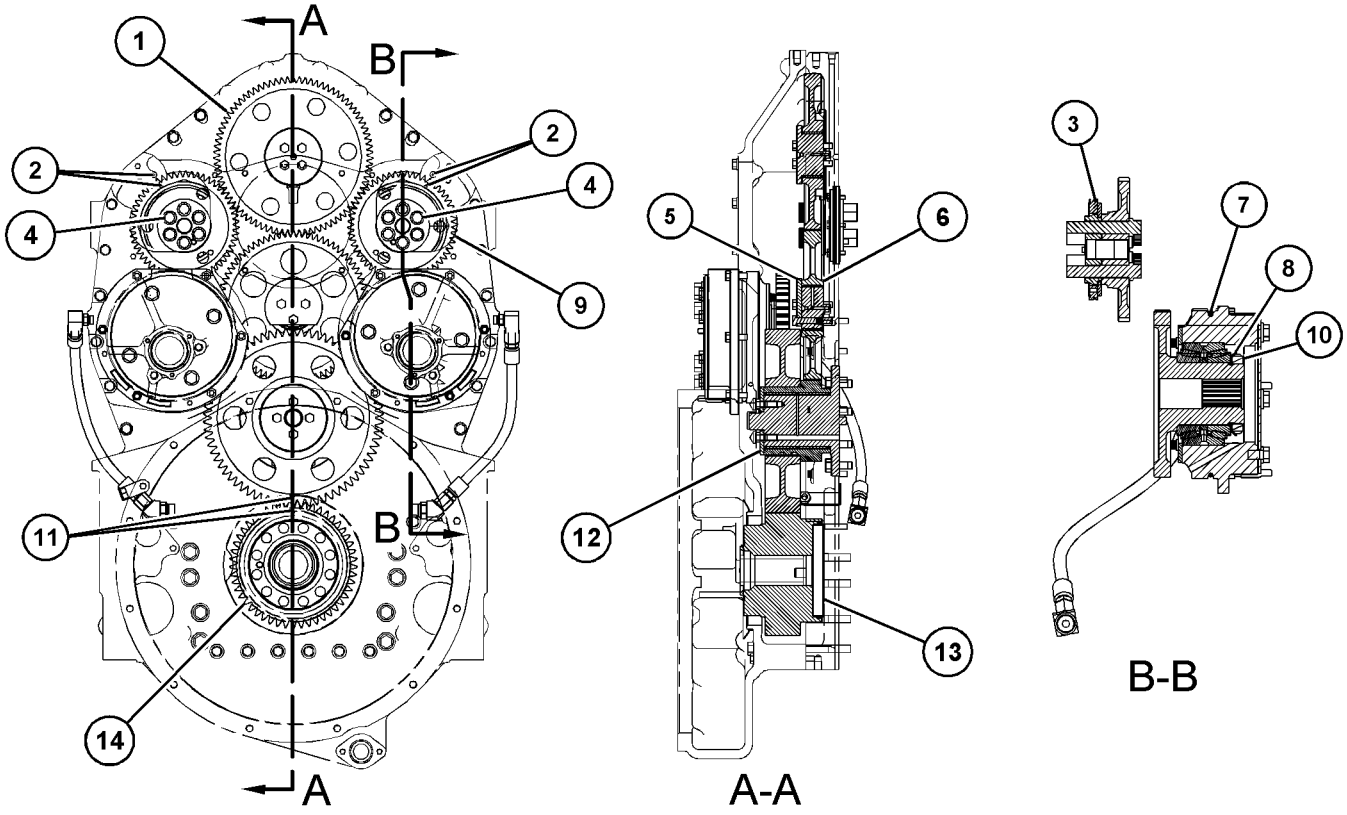


Illustration 162 g06308674
Rear view of engine

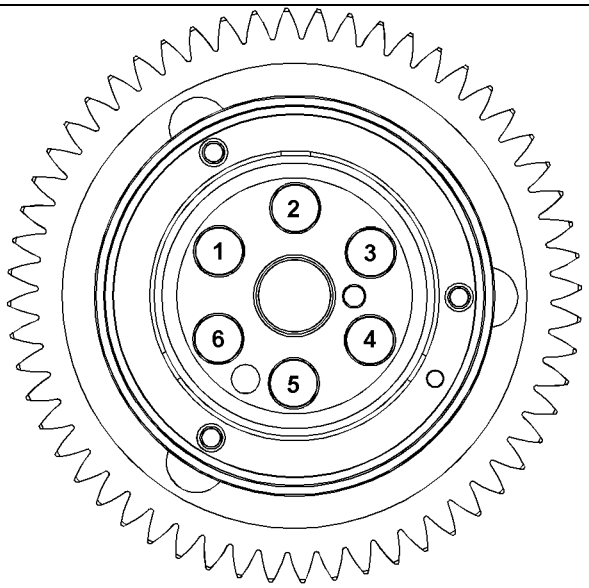


Illustration 163 g06308927

Tightening sequence

Table 94

Item	Qty	Part	Specification Description
1	1	230-6202 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
2	-	-	With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.
3	2	117-8801 O-Ring Seal	Before assembly, lubricate bore lightly with fluid being sealed.
4	12	6J-3913 Bolt	Use the following procedure to tighten the bolt: 1. Torque to 240 ± 40 N·m (177 ± 30 lb ft). 2. Use the tightening sequence as shown in illustration 163
5	1	224-1220 Plate	Install the plate with the side marked “OUT” away from the gear face.
6	1	185-1497 Idler Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
7	2	5P-8429 O-Ring Seal	Before assembly, lubricate bore lightly with fluid being sealed.
8	2	5F-7403 Lockwasher	Use the following procedure to tighten the lockwasher. 1. Torque to 406 ± 68 N·m (300 ± 50 lb ft). 2. Bend the tab on the lock that aligns with the slot in the nut.
9	2	331-6188 Camshaft Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.
10	2	5F-7404 Bearing Locknut	Use the following procedure to tighten the bearing locknut. 1. Torque to 406 ± 68 N·m (300 ± 50 lb ft). 2. Bend the tab on the lock that aligns with the slot in the nut.
11	-	-	With the number one piston in the top dead center position, align the timing marks. The mark on the idler gear must be in alignment with the mark on the crankshaft gear.

(continued)

(Table 94, contd)

12	1	229-1663 Thrust Plate	Install the plate with the side marked “OUT” away from the gear face.
13	1	4N-0848 Wear Sleeve	Before assembly, apply Loctite® 620™ to the sleeve ID.
14	1	228-5813 Crank-shaft Gear As	Lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.

i07445258

Gear Group (Rear)

SMCS Code: 1204; 1206

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

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S/N: E9Z1–Up

S/N: KDZ1–Up

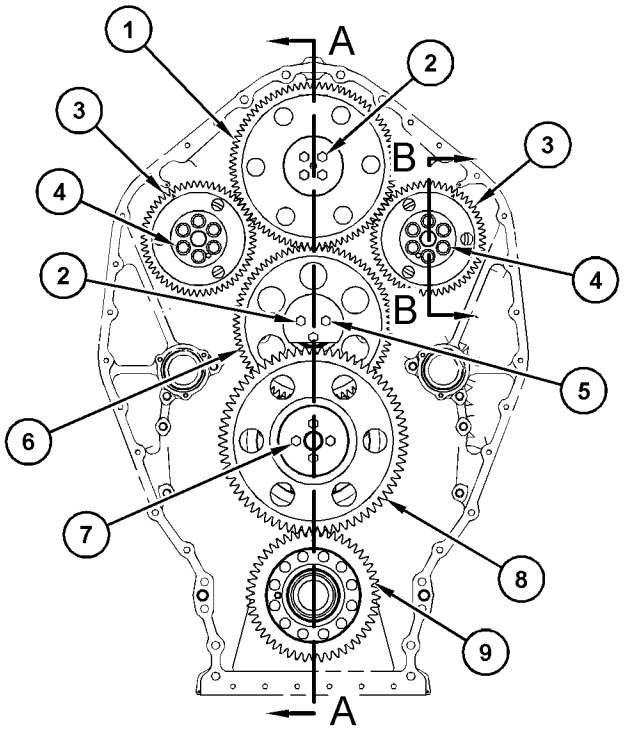


Illustration 164 g03155496

Rear view of engine

Typical Example

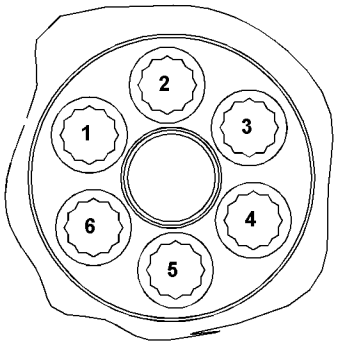


Illustration 165 g03155497

Cam gear bolt tightening sequence

Table 95

Item	Qty	Part	Specification Description
1	1	230 - 6202 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. After installation, bore in the 224 - 9664 Bushing is 71.035 ± 0.013 mm (2.7967 ± 0.0005 inch). Installation depth of the bushing is 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
2	6	5B - 0213 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
3	2	331 - 6188 Camshaft Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.
4	12	6J - 3913 Bolt	Tighten bolt in the sequence 1, 4, 2, 5, 3, 6, 1, 4 as per Illustration 165 to 240 ± 40 N·m (177 ± 30 lb ft).
5	1	245 - 3804 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
6	1	185 - 1497 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. After installation, bore in the 224 - 9664 Bushing is 71.035 ± 0.013 mm (2.7967 ± 0.0005 inch). Installation depth of the bushing is 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
7	4	1A - 2029 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
8	1	226 - 6036 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. With the number one piston in the top dead center position, align the timing marks. The mark on the idler gear must be in alignment with the mark on the crankshaft gear (9). After installation, bore in the 226 - 6052 Bushing is 88.090 ± 0.013 mm (3.4681 ± 0.0005 inch). Installation depth of the bushing is 3.2 ± 0.5 mm (0.13 ± 0.02 inch).
9	1	228 - 5813 Crankshaft Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.

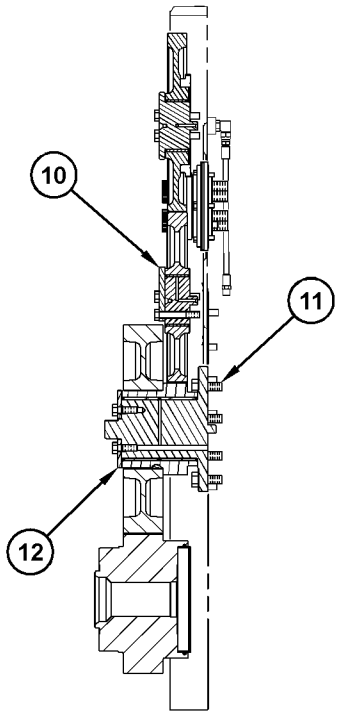


Illustration 166 g03155498

Section A-A

Table 96

Item	Qty	Part	Specification Description
10	1	224-1220 Plate	Install the plate with the side marked “OUT” away from the gear face. Thickness is 8.0 ± 0.5 mm (0.31 ± 0.02 inch).
11	8	7B-3235 Bolt	Torque to 135 ± 20 N·m (100 ± 15 lb ft).
12	1	229-1663 Thrust Plate	Install the thrust plate with the side marked “OUT” away from the gear face. Thickness is 6.35 ± 0.25 mm (0.250 ± 0.010 inch).

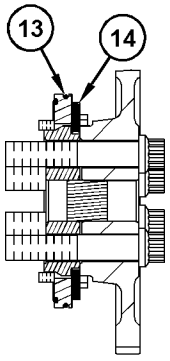


Illustration 167 g03155499

Section B-B

Table 97

Item	Qty	Part	Specification Description
13	2	117-8801 O-Ring Seal	Before assembly, lubricate the bore lightly with the lubricant that is being sealed.
14	1	102-5861 Thrust Plate	Thickness is 5.000 ± 0.025 mm (0.1969 ± 0.0010 inch).

i07449205

Gear Group (Rear)

SMCS Code: 1204; 1206

S/N: HSE1–Up

S/N: PZE1–Up

Part No.: 216-0812
S/N: RJG1–Up

S/N: ZEN1–Up

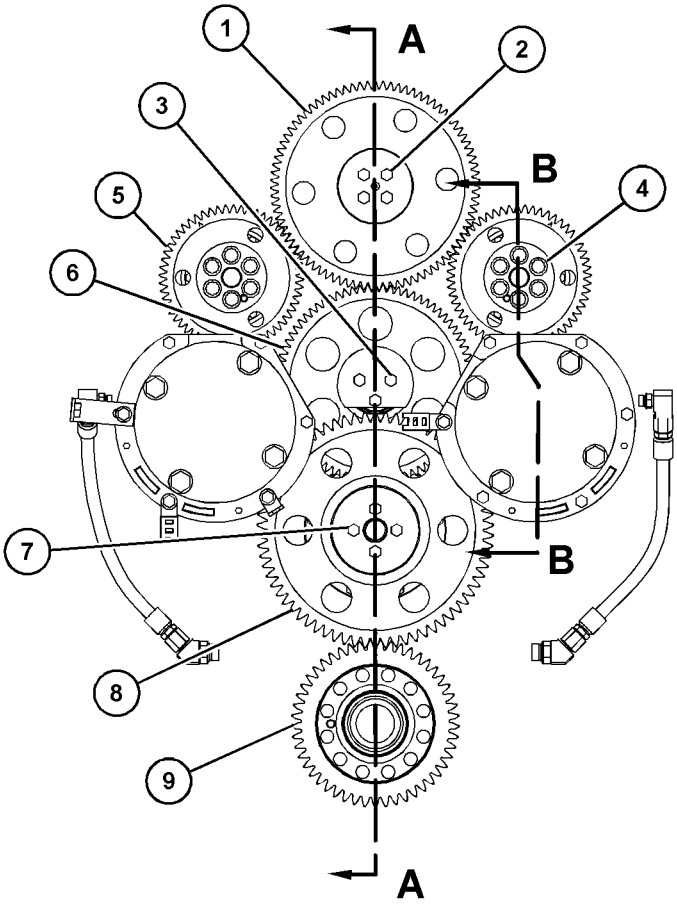


Illustration 168 g06326972
Rear view of engine

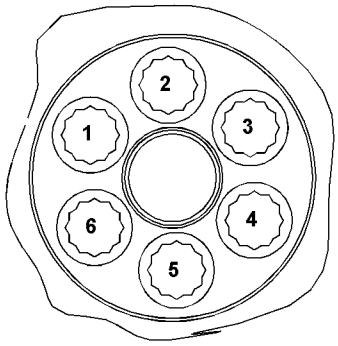


Illustration 169 g03155497

Cam gear bolt tightening sequence

Table 98

Item	Qty	Part	Specification Description
1	1	230 - 6202 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. After installation, bore in the 224 - 9664 Bushing is 71.035 ± 0.013 mm (2.7967 ± 0.0005 inch). Installation depth of the bushing is 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
2	6	5B - 0213 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
3	1	245 - 3804 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
4	12	6J - 3913 Bolt	Tighten bolt in the sequence 1, 4, 2, 5, 3, 6, 1, 4 as per Illustration 169 to 240 ± 40 N·m (177 ± 30 lb ft).
5	2	331 - 6188 Camshaft Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.
6	1	185 - 1497 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. After installation, bore in the 224 - 9664 Bushing is 71.035 ± 0.013 mm (2.7967 ± 0.0005 inch). Installation depth of the bushing is 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
7	4	1A - 2029 Bolt	Torque to 55 ± 10 N·m (41 ± 7 lb ft).
8	1	226 - 6036 Idler Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil. With the number one piston in the top dead center position, align the timing marks. The mark on the idler gear must be in alignment with the mark on the crankshaft gear (9). After installation, bore in the 226 - 6052 Bushing is 88.090 ± 0.013 mm (3.4681 ± 0.0005 inch). Installation depth of the bushing is 3.2 ± 0.5 mm (0.13 ± 0.02 inch).
9	1	228 - 5813 Crankshaft Gear As	Before assembly, lubricate the shaft, the bearing bore, and the thrust faces with clean engine oil.

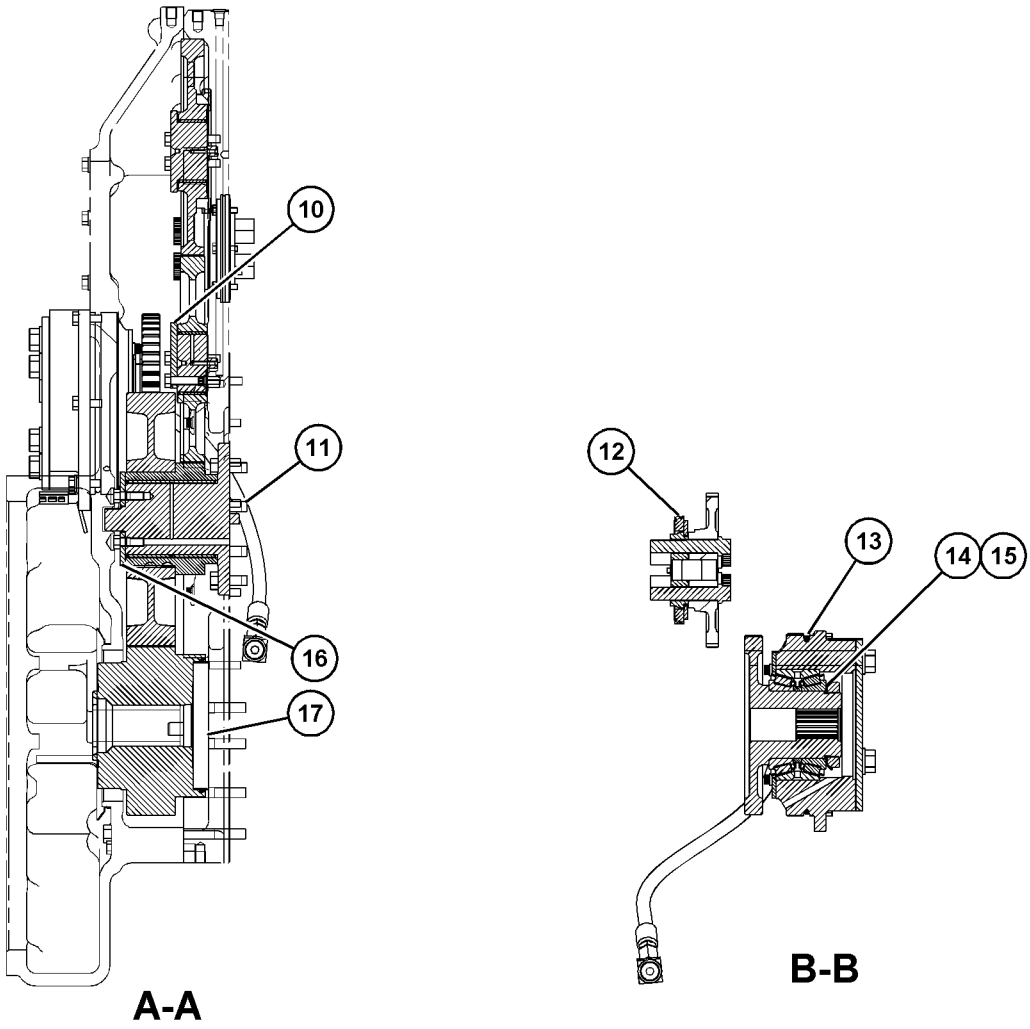


Illustration 170 g06327033

Table 99

Item	Qty	Part	Specification Description
10	1	224-1220 Plate	Install the plate with the side marked “OUT” away from the gear face. Thickness is 8.0 ± 0.5 mm (0.31 ± 0.02 inch).
11	8	7B-3235 Bolt	Torque to 135 ± 20 N·m (100 ± 15 lb ft).
12	2	117-8801 O-Ring Seal	Before assembly, lubricate the bore lightly with the lubricant that is being sealed.
13	2	5P-8429 O-Ring Seal	Before assembly, lubricate the bore lightly with the lubricant that is being sealed.
14	2	5F-7403 Lockwasher	Torque to 406 ± 68 N·m (299 ± 50 lb ft) and bend the tab on the lock which aligns with a nut slot.
15	2	5F-7404 Bearing Locknut	
16	1	229-1663 Thrust Plate	Install the thrust plate with the side marked “OUT” away from the gear face. Thickness is 6.35 ± 0.25 mm (0.250 ± 0.010 inch).
17	1	4N-0848 Wear Sleeve	Before assembly, lubricate the sleeve inner diameter with Loctite ® 620.

i02857719

Flywheel

SMCS Code: 1156

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 224-3167
S/N: E9Z1–Up

S/N: KDZ1–Up

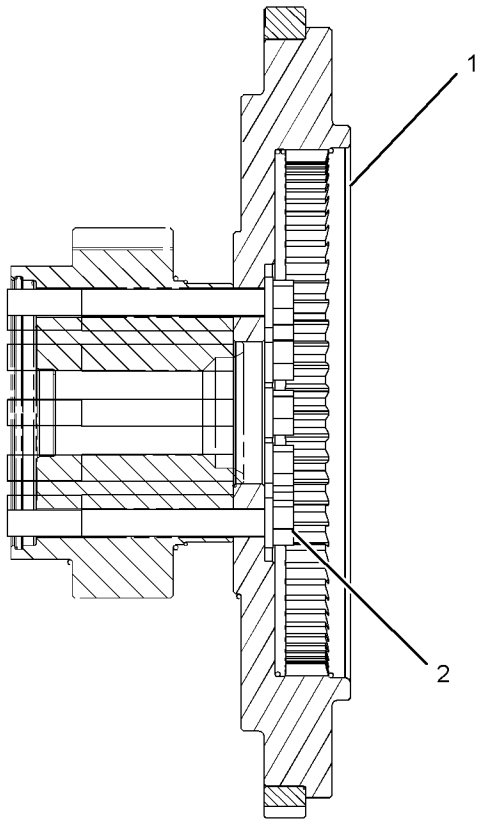


Illustration 171 g01427833

(1) Flywheel assembly

Maximum runout of the face . . . . . 0.43 mm ((0.017 inch))
Maximum eccentricity of the pilot bore in the drive hub . . . . . 0.23 mm ((0.009 inch))
Eccentricity of the coupling pilot bore . . . . . N/A

Note: Lubricate the threads of the bolts with clean engine oil, molybdenum disulfide or a graphite base lubricant before assembly.

(2) Torque for 12 bolts . . . . . 270 ± 40 N·m ((200 ± 30 lb ft))

i02857727

Flywheel

SMCS Code: 1156

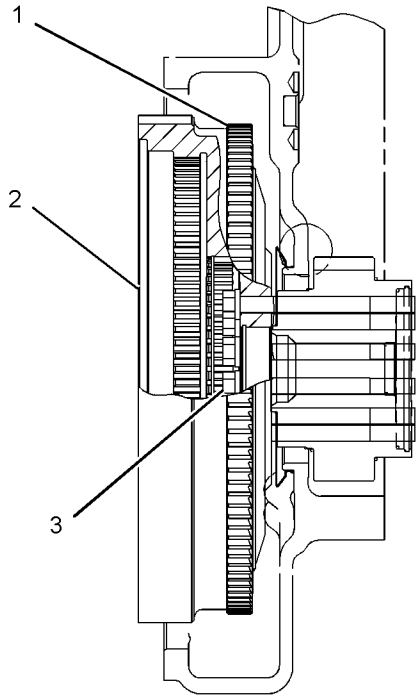


Illustration 172 g01249502

(1) Gear

(2) Flywheel assembly

Maximum runout of the face . . . . . 0.43 mm ((0.017 inch))
Maximum eccentricity of the pilot bore in the drive hub . . . . . 0.23 mm ((0.009 inch))
Eccentricity of the coupling pilot bore . . . . . N/A

Note: Lubricate the threads with clean engine oil, molybdenum disulfide or a graphite base lubricant before assembly.

(3) Torque for 12 bolts . . . . . 270 ± 40 N·m ((200 ± 30 lb ft))

i04962129

Flywheel

SMCS Code: 1156

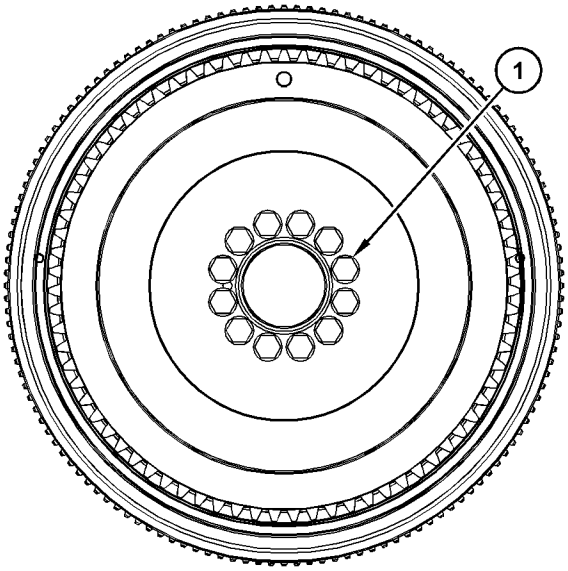


Illustration 173 g03146676

Table 100

Specification for 245-9777 Flywheel Gp			
Item	**Qty**	**Part**	**Specification Description**
1	12	349-8521 Bolt	Before assembly lubricate the threads of the bolts with clean engine oil, molybdenum disulfide or a graphite base lubricant.
			Torque to 270 ± 40 N·m (199 ± 30 lb ft).

i07317765

Flywheel

SMCS Code: 1156

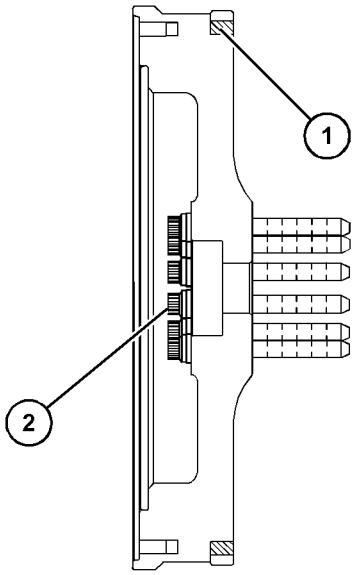


Illustration 174 g06281237

Note: Refer to Systems Operation, Testing and Adjusting for the correct method for flywheel runout and flywheel inspection.

Table 101

Item	Qty	Part	Specification Description
1	-	-	Do not use a torch in order to heat the ring gear.
			Maximum permissible temperature of the ring gear for installation onto the flywheel is 300 °C (572 °F).
2	12	131-7880 Bolt	Before assembly, lubricate the threads with clean engine oil, molybdenum disulfide, or a graphite base lubricant.
			Torque to 270 ± 40 N·m (200 ± 30 lb ft).

i02857899

Flywheel Housing

SMCS Code: 1157

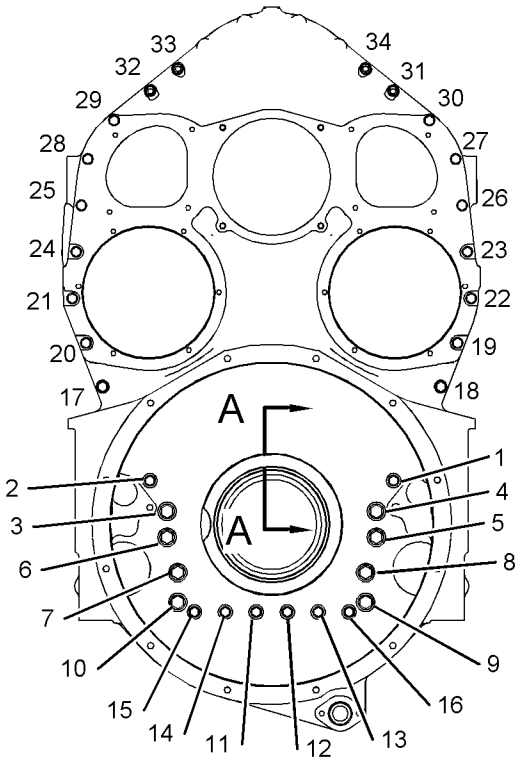


Illustration 175 g01423950

Rear view of engine

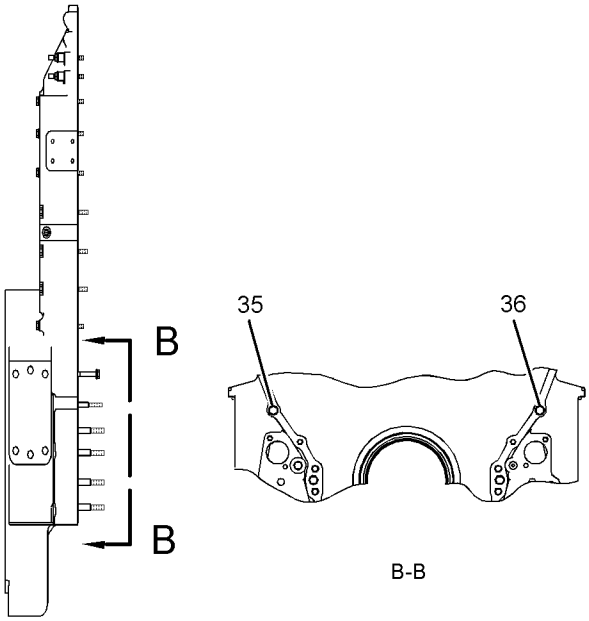


Illustration 176 g01423951

Right side view of engine

Note: The front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds and any other contaminants during assembly. The gasket for the flywheel housing group must be free of contaminants during assembly.

Use the following procedure to tighten the bolts for the flywheel housing group:

1. For bolt (1) and bolt (2), use 3/8-16 X 6 1/4 inch bolts. Torque the bolt (1) and bolt (2) in the numerical sequence that is shown in Illustration 175 to 55 ± 10 N·m (41 ± 7 lb ft).
2. For bolt (3) through bolt (10), use 1/2-13 X 6 1/2 inch bolts. Torque the bolt (3) through bolt (10) in the numerical sequence that is shown in Illustration 175 to 135 ± 20 N·m (100 ± 15 lb ft).
3. For bolt (11) through bolt (16), use 3/8-16 X 4 inch bolts. For bolt (17) through bolt (30), use 3/8-16 X 5 1/4 inch bolts. For bolt (31) through bolt (36), use 3/8-16 X 3 inch bolts. Torque the bolt (11) through bolt (36) in the numerical sequence that is shown in Illustration 175 to 47 ± 9 N·m (35 ± 7 lb ft).

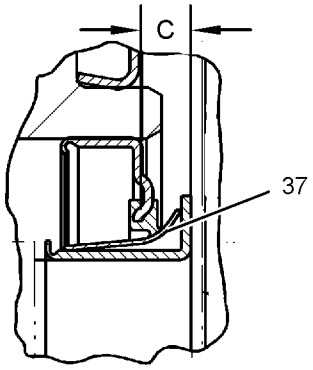


Illustration 177 g01427297

Section A-A

Note: The seal and the sleeve of the crankshaft seal group must not be used if the seal and the sleeve have been separated.

(37) The seal driver must not contact the seal within the following diameter. . . . . 177.80 ± 0.25 mm ((7.000 ± 0.010 inch))

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft in any axial position.

(C) Assembled installation depth . . . . . .6.4 ± 0.6 mm ((0.25 ± 0.02 inch))

i02858265

Flywheel Housing

SMCS Code: 1157

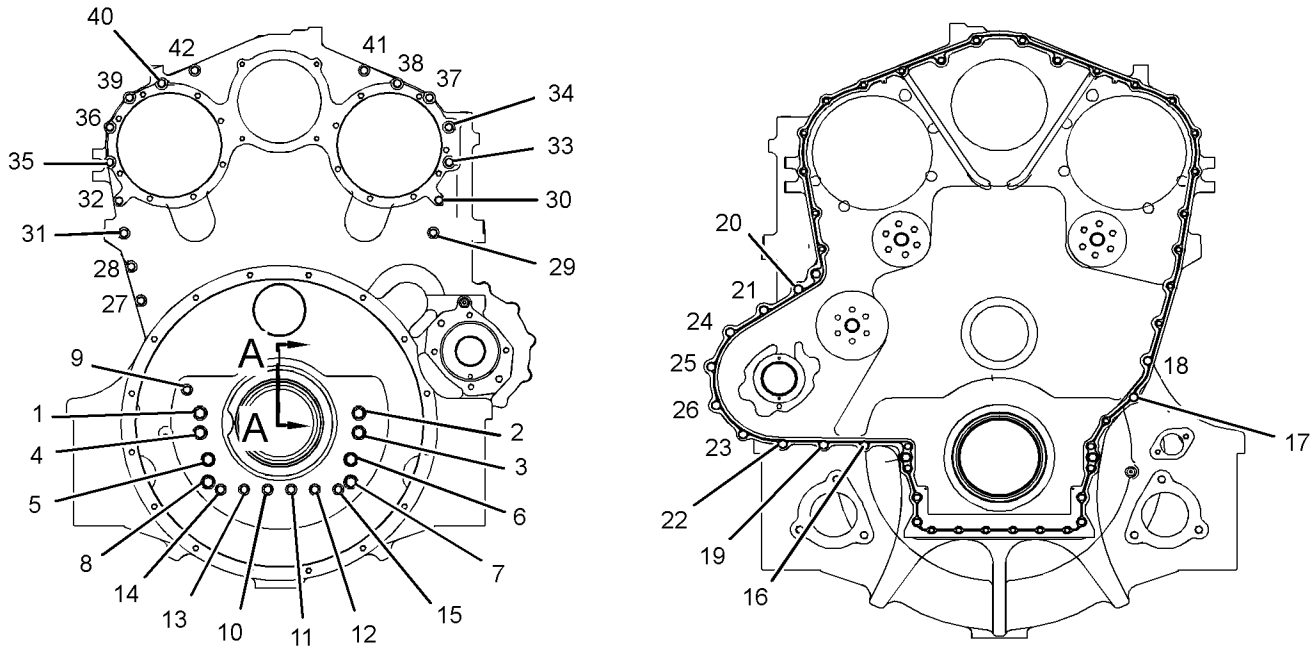


Illustration 178 g01424195

Rear view of engine

Note: The front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds and any other contaminants during assembly. The gasket for the flywheel housing group must be free of contaminants during assembly.

Use the following procedure to tighten the bolts for the flywheel housing group:

1. For bolt (1) through bolt (8), use 1/2-13 X 6 1/2 inch bolts. Torque the bolt (1) through bolt (8) in the numerical sequence that is shown in Illustration 178 to 135 ± 20 N·m (100 ± 15 lb ft).
2. For bolt (9), use bolt size of 3/8-16 X 6 1/4 inches. Torque the bolt (9) in the numerical sequence that is shown in Illustration 178 to 55 ± 10 N·m (41 ± 7 lb ft).
3. For bolt (10) through bolt (15), use 3/8-16 X 4 inch bolts. For bolt (16) through bolt (26), use 3/8-16 X 3 inch bolts. For bolt (27) through bolt (42), use 3/8-16 X 5 1/4 inch bolts. Torque the bolt (10) through bolt (42) in the numerical sequence that is shown in Illustration 178 to 47 ± 9 N·m (35 ± 7 lb ft).

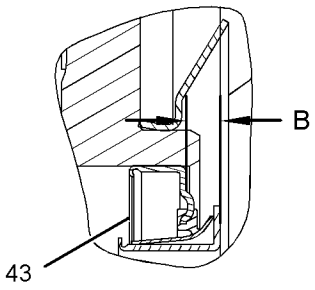


Illustration 179 g01427322

Section A-A

Note: The seal and the sleeve of the crankshaft seal group must not be used if the seal and the sleeve have been separated.

(43) The seal driver must not contact the seal within the following diameter. . . . . 177.80 ± 0.25 mm ((7.000 ± 0.010 inch))

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft in any axial position.

(B) Assembled installation depth . . . . . .6.4 ± 0.6 mm ((0.25 ± 0.02 mm))

i02883213

Flywheel Housing

SMCS Code: 1157

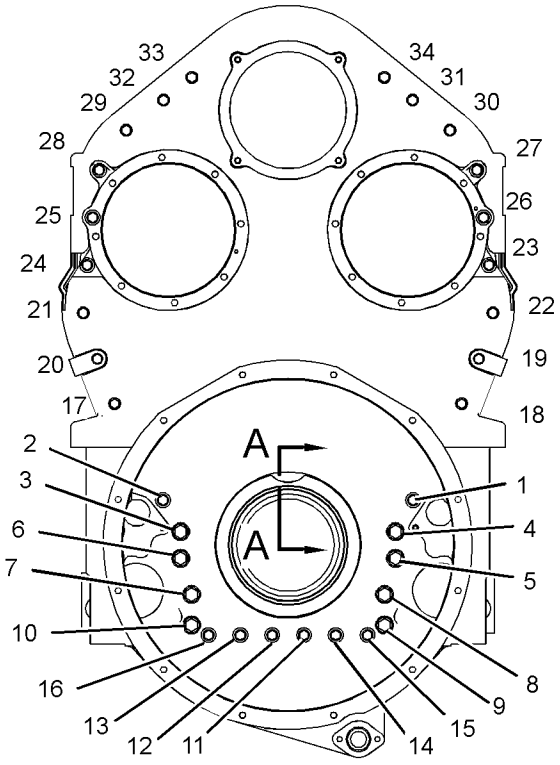
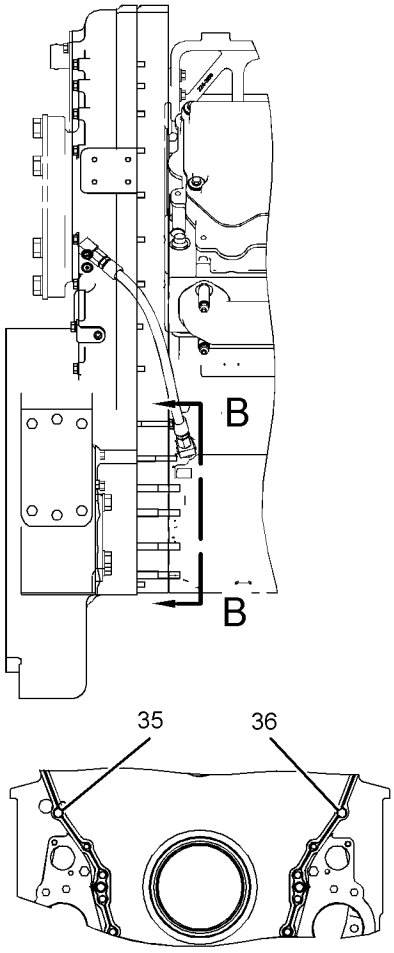


Illustration 180 g01435183

Rear view of engine



B-B

Illustration 181 g01435181

Right side view of the engine

Note: The front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds and any other contaminants during assembly. The gasket for the flywheel housing group must be free of contaminants during assembly.

Use the following procedure to tighten the bolts for the flywheel housing group:

1. For bolt (1) and bolt (2), use 3/8-16 X 6 1/4 inch bolts. Torque the bolt (1) and bolt (2) in the numerical sequence that is shown in Illustration 180 to 55 ± 10 N·m (41 ± 7 lb ft).

1. For bolt (3) through bolt (10), use 1/2-13 X 6 1/2 inch bolts. Torque the bolt (3) through bolt (10) in the numerical sequence that is shown in Illustration 180 to 135 ± 20 N·m (100 ± 15 lb ft).

2. For bolt (11) through bolt (16), use 3/8-16 X 4 inch bolts. For bolt (17) and bolt (18), use 3/8-16 X 5 1/2 inch bolts. For bolt (19) and bolt (20), use 3/8-16 X 4 3/4 inch bolts. For bolt (21) and bolt (22), use 3/8-16 X 5 1/2 inch bolts. For bolt (23) through bolt (28), use 3/8-16 X 4 3/4 inch bolts. For bolt (29) through bolt (34), use 3/8-16 X 5 1/2 inch bolts. For bolt (35) and bolt (36), use 3/8-16 X 3 inch bolts. Torque the bolt (11) through bolt (36) in the numerical sequence that is shown in Illustration 180 to 47 ± 9 N·m (35 ± 7 lb ft).

3. Again torque the bolt (1) and bolt (2) in the numerical sequence that is shown in Illustration 180 to 55 ± 10 N·m (41 ± 7 lb ft).

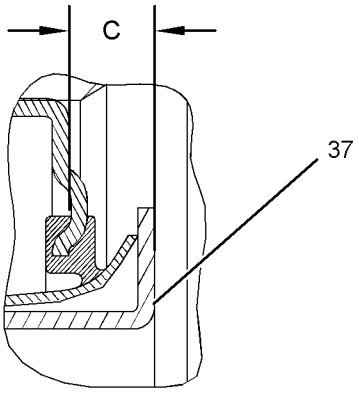


Illustration 182 g01435182

Section A-A

Note: The seal and the sleeve of the crankshaft seal group must not be used if the seal and the sleeve have been separated.

(37) The seal driver must not contact the seal within the following diameter. . . . . 177.80 ± 0.25 mm ((7.000 ± 0.010 inch))

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft in any axial position.

(C) Assembled installation depth . . . . . 6.4 ± 0.6 mm ((0.25 ± 0.02 inch))

i02884495

Flywheel Housing

SMCS Code: 1157

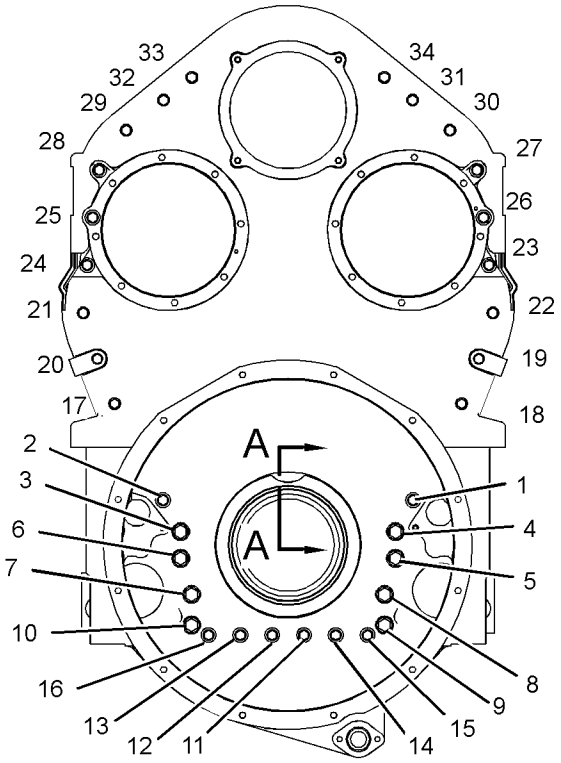
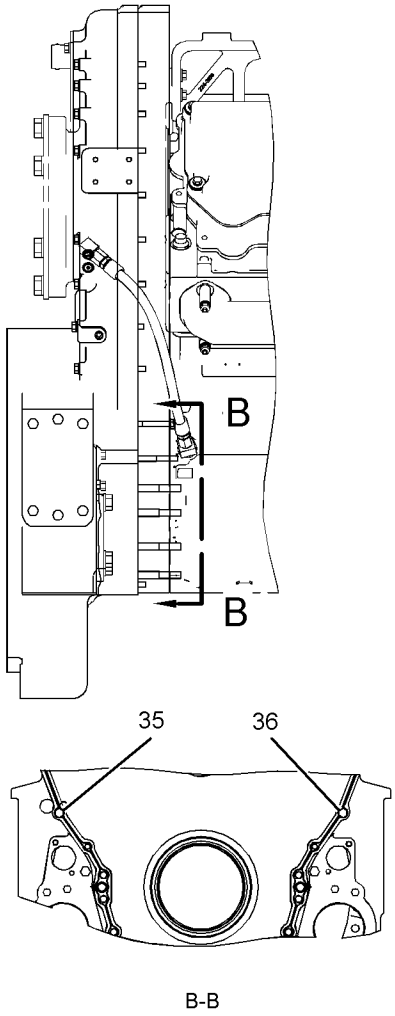


Illustration 183 g01424781

Typical example

Rear view of engine



B-B

Illustration 184 g01424823

Typical example

Right side view of the engine

Note: The front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds and any other contaminants during assembly. The gasket for the flywheel housing group must be free of contaminants during assembly.

Use the following procedure to tighten the bolts for the flywheel housing group:

1. For bolt (1) and bolt (2), use 3/8-16 X 6 1/4 inch bolts. Torque the bolt (1) and bolt (2) in the numerical sequence that is shown in Illustration 183 to 55 ± 10 N·m (41 ± 7 lb ft).

1. For bolt (3) through bolt (10), use 1/2-13 X 6 1/2 inch bolts. Torque the bolt (3) through bolt (10) in the numerical sequence that is shown in Illustration 183 to 135 ± 20 N·m (100 ± 15 lb ft).

2. For bolt (11) through bolt (16), use 3/8-16 X 4 inch bolts. For bolt (17) through bolt (34), use 3/8-16 X 4 3/4 inch bolts. For bolt (35) and bolt (36), use 3/8-16 X 3 inch bolts. Torque the bolt (11) through bolt (36) in the numerical sequence that is shown in Illustration 183 to 47 ± 9 N·m (35 ± 7 lb ft).

3. Again torque the bolt (1) and bolt (2) in the numerical sequence that is shown in Illustration 183 to 55 ± 10 N·m (41 ± 7 lb ft).

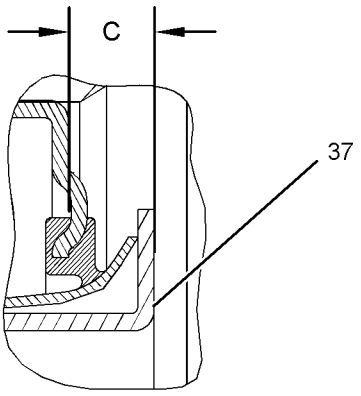


Illustration 185 g01436141

Section A-A

Note: The seal and the sleeve of the crankshaft seal group must not be used if the seal and the sleeve have been separated.

(37) The seal driver must not contact the seal within the following diameter. . . . . 177.80 ± 0.25 mm ((7.000 ± 0.010 inch))

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft in any axial position.

(C) Assembled installation depth . . . . . .6.4 ± 0.6 mm ((0.25 ± 0.02 inch))

i03351120

Flywheel Housing

SMCS Code: 1157

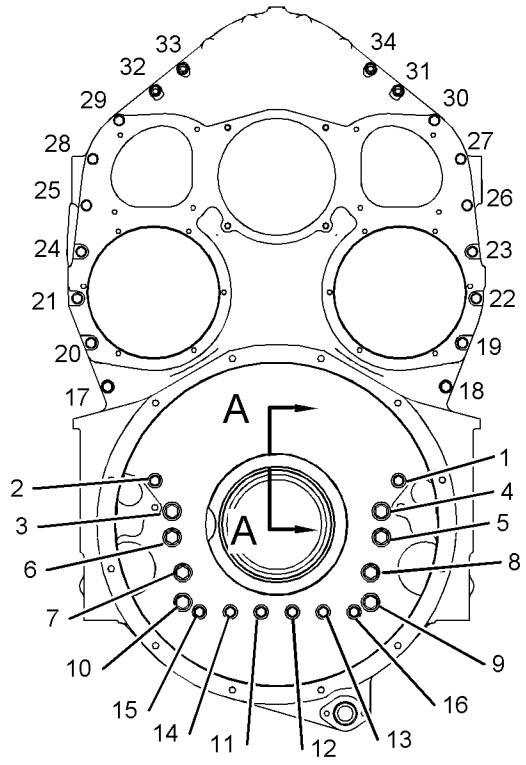


Illustration 186 g01435177

Rear view of engine

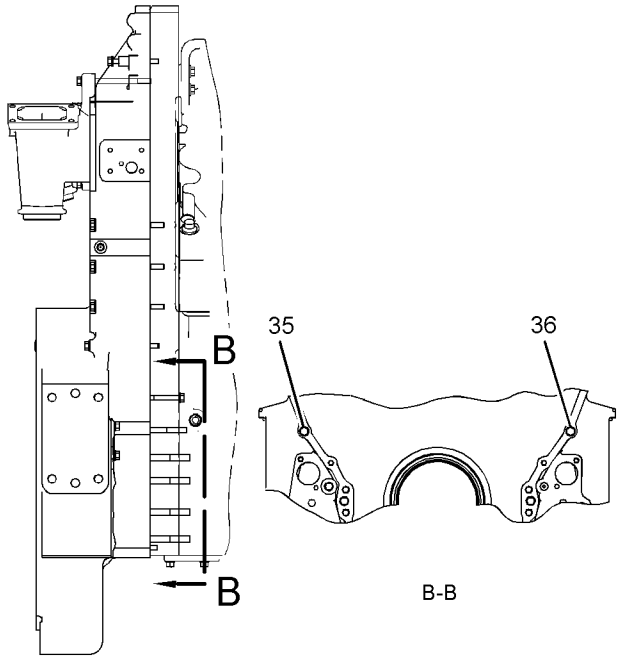


Illustration 187 g01435175

Right side view of engine

Note: The front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds and any other contaminants during assembly. The gasket for the flywheel housing group must be free of contaminants during assembly.

Use the following procedure to tighten the bolts for the flywheel housing group:

1. For bolt (1) and bolt (2), use 3/8-16 X 6 1/4 inch bolts. Torque the bolt (1) and bolt (2) in the numerical sequence that is shown in Illustration 186 to 55 ± 10 N·m (41 ± 7 lb ft).

2. For bolt (3) through bolt (10), use 1/2-13 X 6 1/2 inch bolts. Torque the bolt (3) through bolt (10) in the numerical sequence that is shown in Illustration 186 to 135 ± 20 N·m (100 ± 15 lb ft).

3. For bolt (11) through bolt (16), use 3/8-16 X 4 inch bolts. For bolt (17), use bolt size of 3/8-16 X 5 1/2 inches. For bolt (18) through bolt (24), use 3/8-16 X 5 1/4 inch bolts. For bolt (33) and bolt (34), use 3/8-16 X 3 1/2 inch bolts. For bolt (35) and bolt (36), use 3/8-16 X 3 inch bolts. Torque the bolt (11) through bolt (36) in the numerical sequence that is shown in Illustration 186 to 47 ± 9 N·m (35 ± 7 lb ft).

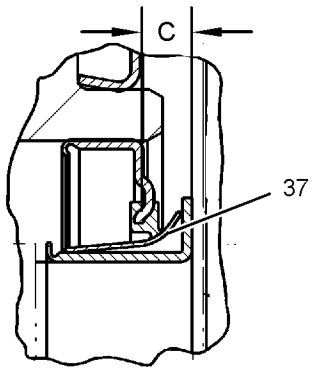


Illustration 188 g01435176

Section A-A

Note: The seal and the sleeve of the crankshaft seal group must not be used if the seal and the sleeve have been separated.

(37) The seal driver must not contact the seal within the following diameter. . . . . 177.80 ± 0.25 mm ((7.000 ± 0.010 inch))

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft at maximum rearward position.

(C) Assembled installation depth . . . .6.52 ± 0.13 mm ((0.257 ± 0.005 inch))

i04972950

Flywheel Housing

SMCS Code: 1157

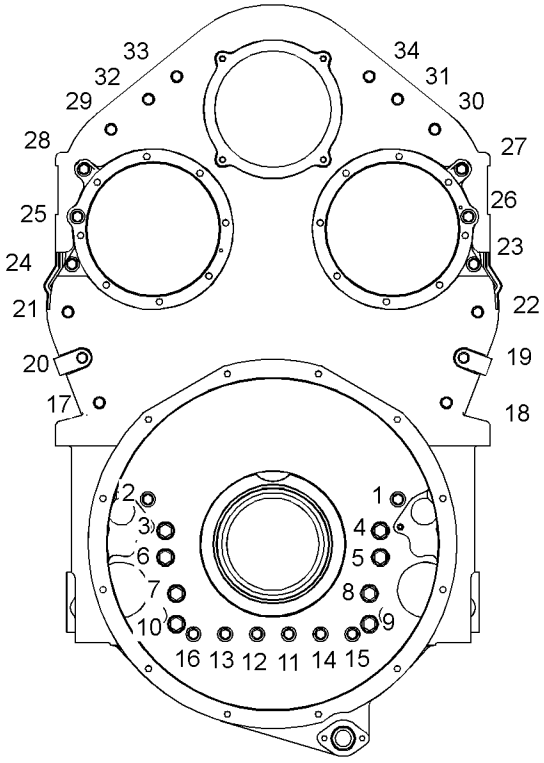


Illustration 189 g03156276

Rear view of engine

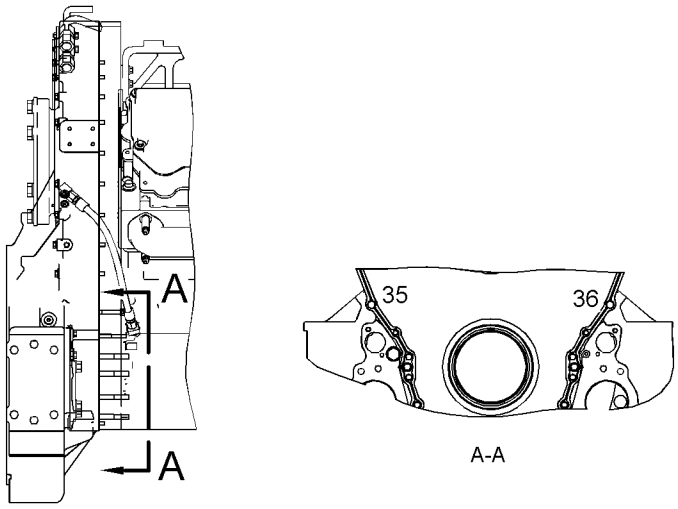


Illustration 190 g03156277

Right side view of the engine

Table 102

Specification for 245-9775 Flywheel Housing Gp			
Item	**Qty**	**Part**	**Specification Description**
During assembly, the front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds, and any other contaminants.			
-	2	231-4470 Bolt	Use bolt 1 and bolt 2. Length of 3/8 inch diameter bolt is 158.75 mm (6.250 inch).
-	8	231-4471 Bolt	Use bolt 3 to bolt 10. Length of 1/2 inch diameter bolt is 165.1 mm (6.50 inch).
-	6	8S-9191 Bolt	Use bolt 11 to bolt 16. Length of 3/8 inch diameter bolt is 101.6 mm (4.00 inch).
-	14	1A-5183 Bolt	Use bolt 17, bolt 18, bolt 21 through bolt 30, bolt 32, and bolt 33. Length of 3/8 inch diameter bolt is 120.65 mm (4.750 inch).
-	4	5B-9603 Bolt	Use bolt 19, bolt 20, bolt 31, and bolt 34. Length of 3/8 inch diameter bolt is 127.0 mm (5.00 inch).
-	2	0S-1619 Bolt	Use bolt 35 and bolt 36. Length of 3/8 inch diameter bolt is 76.2 mm (3.00 inch).
-	-	-	Use the following procedure in order to tighten the bolts for the flywheel housing group: Refer Illustration 189 for bolt tightening sequence. 1. Tighten bolt 1 and bolt 2 in a numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft). 2. Tighten bolt 3 through bolt 10 in a numerical sequence to 135 ± 20 N·m (100 ± 15 lb ft). 3. Tighten bolt 11 through bolt 36 in a numerical sequence to 47 ± 9 N·m (35 ± 7 lb ft). 4. Again, tighten bolt 1 and bolt 2 in a numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft)

i04978169

Flywheel Housing

SMCS Code: 1157

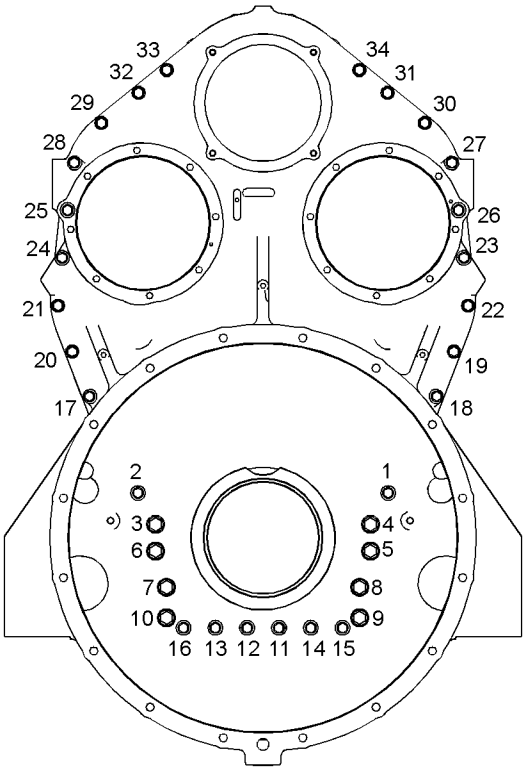


Illustration 191 g03160625

Rear view

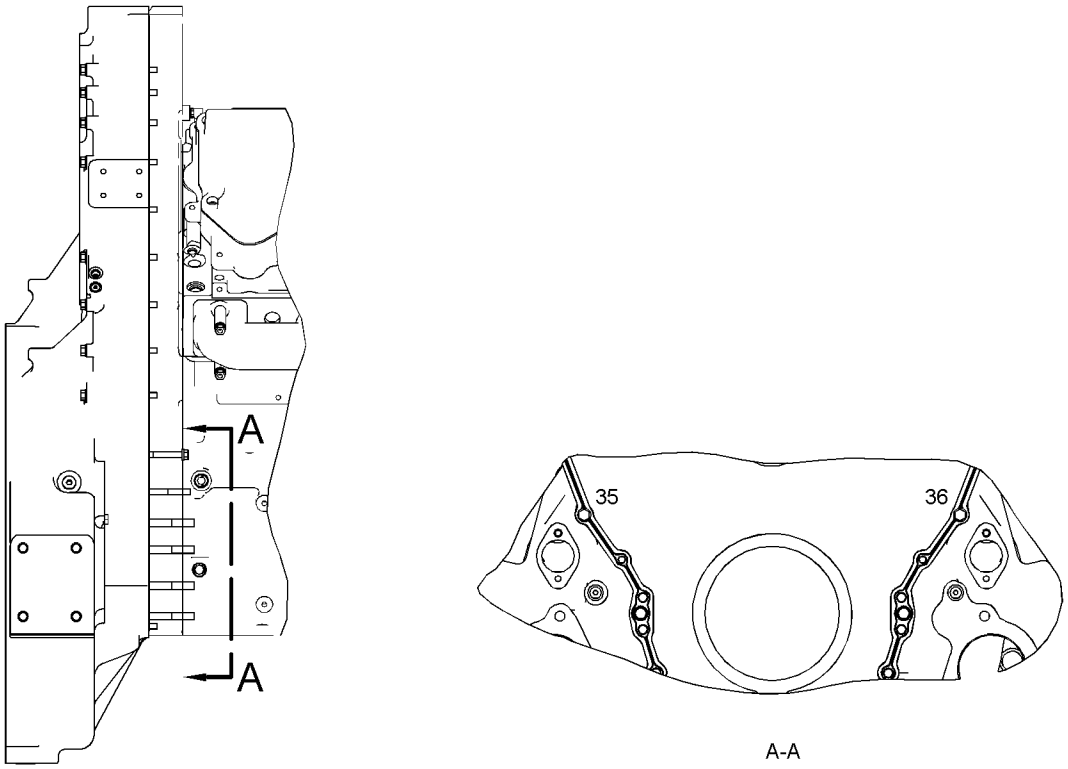


Illustration 192 g03160657

Right side view

Table 103

Specification for 259-3123 Flywheel Housing Gp			
Item	**Qty**	**Part**	**Specification Description**
During assembly, the front face of the flywheel housing group and the rear face of the rear housing must be free of oil, fuel, water, assembly compounds, and any other contaminants.			
-	2	231-4470 Bolt	Use bolt 1 and bolt 2. Length of 3/8 inch diameter bolt is 158.75 mm (6.250 inch).
-	8	231-4471 Bolt	Use bolt 3 to bolt 10. Length of 1/2 inch diameter bolt is 165.1 mm (6.50 inch).
-	6	8S-9191 Bolt	Use bolt 11 to bolt 16. Length of 3/8 inch diameter bolt is 101.6 mm (4.00 inch).
-	18	1A-5183 Bolt	Use bolt 17 to bolt 34. Length of 3/8 inch diameter bolt is 120.65 mm (4.750 inch).
-	2	0S-1619 Bolt	Use bolt 35 and bolt 36. Length of 3/8 inch diameter bolt is 76.2 mm (3.00 inch).
-	-	-	Use the following procedure in order to tighten the bolts for the flywheel housing group: Refer Illustration 191 for bolt tightening sequence. 1. Tighten bolt 1 and bolt 2 in a numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft). 2. Tighten bolt 3 through bolt 10 in a numerical sequence to 135 ± 20 N·m (100 ± 15 lb ft). 3. Tighten bolt 11 through bolt 36 in a numerical sequence to 47 ± 9 N·m (35 ± 7 lb ft). 4. Again, tighten bolt 1 and bolt 2 in a numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft)

i07304892

Flywheel Housing

SMCS Code: 1157

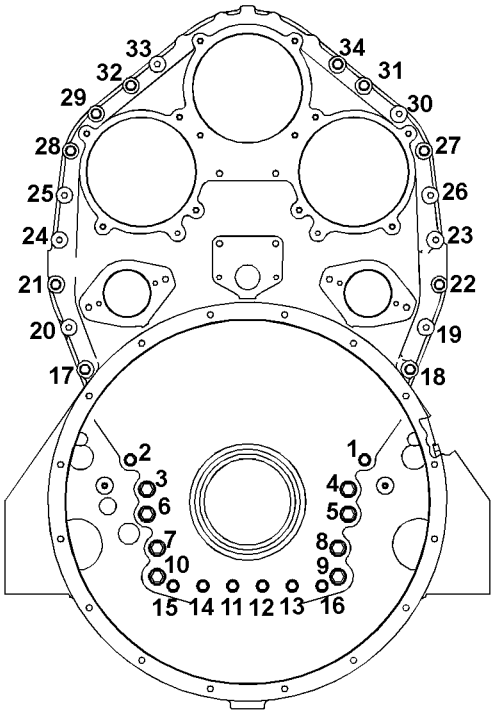


Illustration 193 g06277080

Table 104

Item	Qty	Part	Specification Description
-	-	-	Before installation of the flywheel housing, inspect the front face of the flywheel housing and the rear face of the rear housing. The components must be free of the following substances: oil, fuel, water, assembly compounds, and any other contaminants Use the following procedure to tighten the flywheel housing bolts: Refer Illustration 193 for bolt tightening sequence. 1. Tighten bolt 1 through bolt 2 in a numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft). 2. Tighten bolt 3 through bolt 10 in a numerical sequence to 135 ± 20 N·m (100 ± 15 lb ft). 3. Again, tighten bolt 11 through bolt 34 in a numerical sequence to 47 ± 9 N·m (35 ± 7 lb ft).

i07394775

Flywheel Housing

SMCS Code: 1157

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 488-7156
S/N: E9Z1–Up

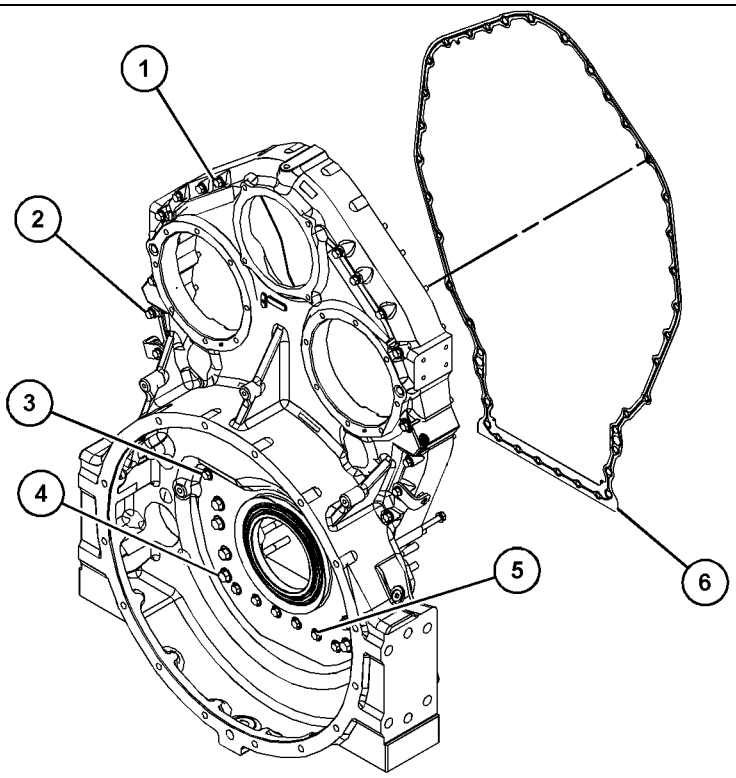


Illustration 194 g06306820

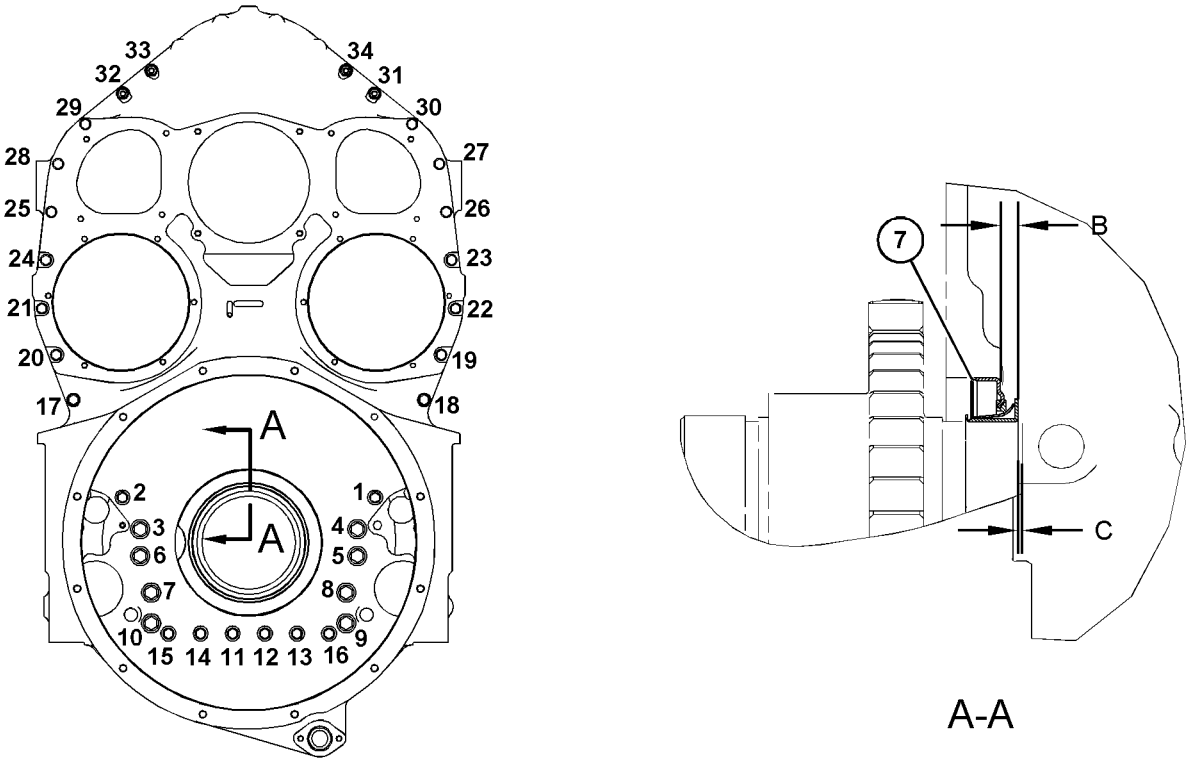


Illustration 195 g06306840

Tightening sequence

Table 105

Item	Qty	Part	Specification Description
1	4	170-0612 Stud	Use the following procedure to tighten the flywheel housing bolts and studs: Refer Illustration 195 for bolt tightening sequence. 1. Tighten bolt 1 through bolt 2 in a numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft). 2. Tighten bolt 3 through bolt 10 in a numerical sequence to 135 ± 20 N·m (100 ± 15 lb ft). 3. Again, tighten bolt 11 through bolt 34 in a numerical sequence to 47 ± 9 N·m (35 ± 7 lb ft).
2	14	5B-2638 Bolt	
3	2	231-4470 Bolt	
4	8	231-4471 Bolt	
5	6	8S-9191 Bolt	
6	1	225-1242 Gasket	During assembly, inspect the front face of the flywheel housing and the rear face of the rear housing. The components must be free of the following substances: oil, fuel, water, assembly compounds, and any other contaminants.
7	1	319-0785 Crankshaft Seal Gp	The seal and the sleeve of the crankshaft seal group must not be used if the seal and the sleeve have been separated.
			The seal driver must not contact the seal within the 177.80 ± 0.25 mm (7.000 ± 0.010 inch) diameter.
B	-	-	Distance from the sleeve to the seal is 6.15 to 6.55 mm (0.242 to 0.258 inch).
C	-	-	Installation depth of the sleeve from the rear face of the crank shaft is 1.5 ± 0.5 mm (0.06 ± 0.02 inch).

i04405418

Coolant Temperature Sensor

SMCS Code: 1906

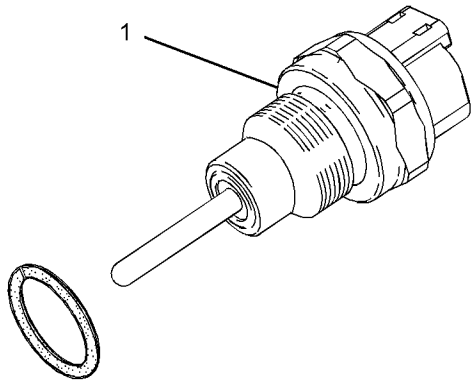


Illustration 196 g02553996

Table 106

Specification for 264-4297 Temperature Sensor and 256-6453 Temperature Sensor			
Item	**Qty**	**Part**	**Specification Description**
1	1	-	Torque to temperature sensor 20 ± 3 N·m (177 ± 27 lb in).
-	-	-	Output type is Passive.

i04448859

Coolant Temperature Sensor

SMCS Code: 1906

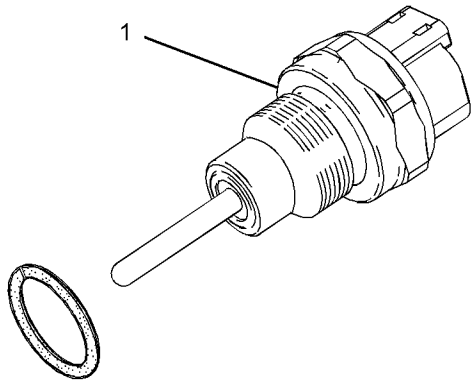


Illustration 197 g02574738

Table 107

Specification for 130-9811 Temperature Sensor Gp, 274-7396 Temperature Sensor Gp, 197-8392 Temperature Sensor Gp, and 256-6453 Temperature Sensor			
Item	**Qty**	**Part**	**Specification Description**
1	1	-	Torque to 20 ± 3 N·m (175 ± 25 lb in).
			Output type is passive.

i04974669

Coolant Temperature Sensor

SMCS Code: 1906

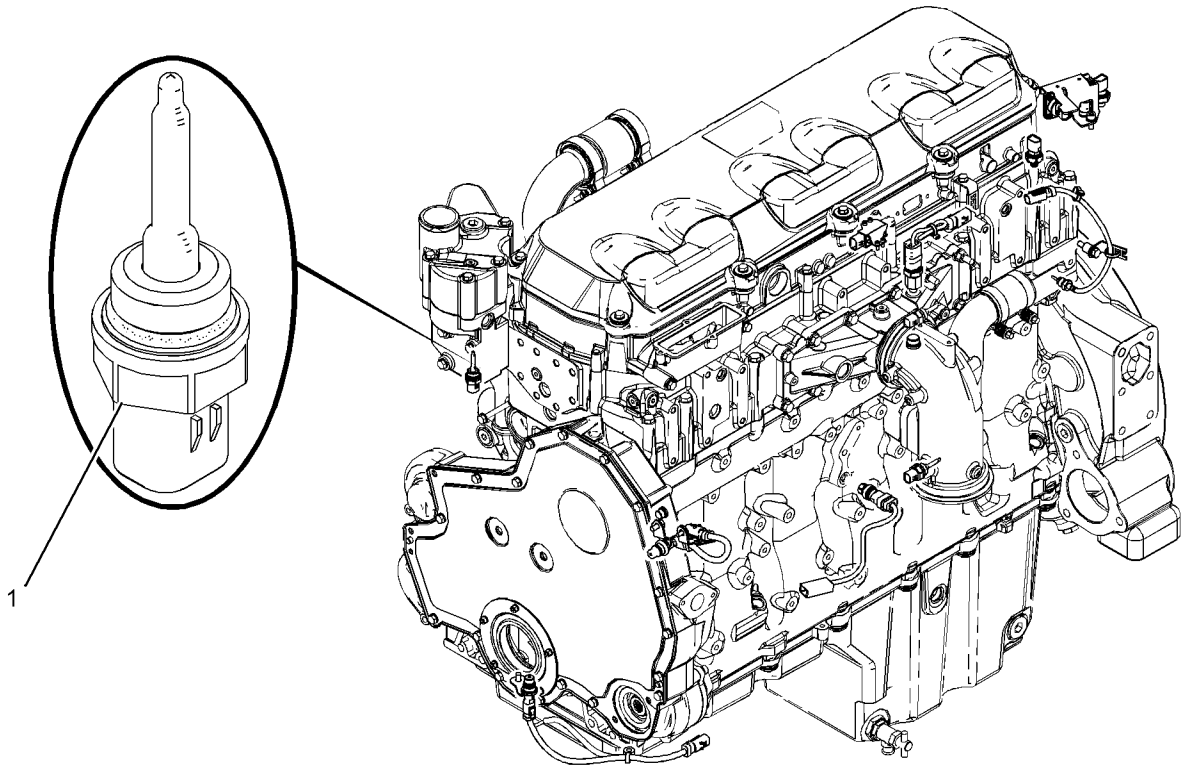


Illustration 198 g02543656

Typical example

Table 108

Specification for 234-5012 Temperature Sensor Gp and 234-5013 Temperature Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	256-6453 Temperature Sensor	Final installation torque is 20 ± 3 N·m (177 ± 27 lb in).
-	-	-	Output type is Passive.

i06952245

Coolant Temperature Sensor

SMCS Code: 1906

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 234-5012
S/N: E9Z1–Up

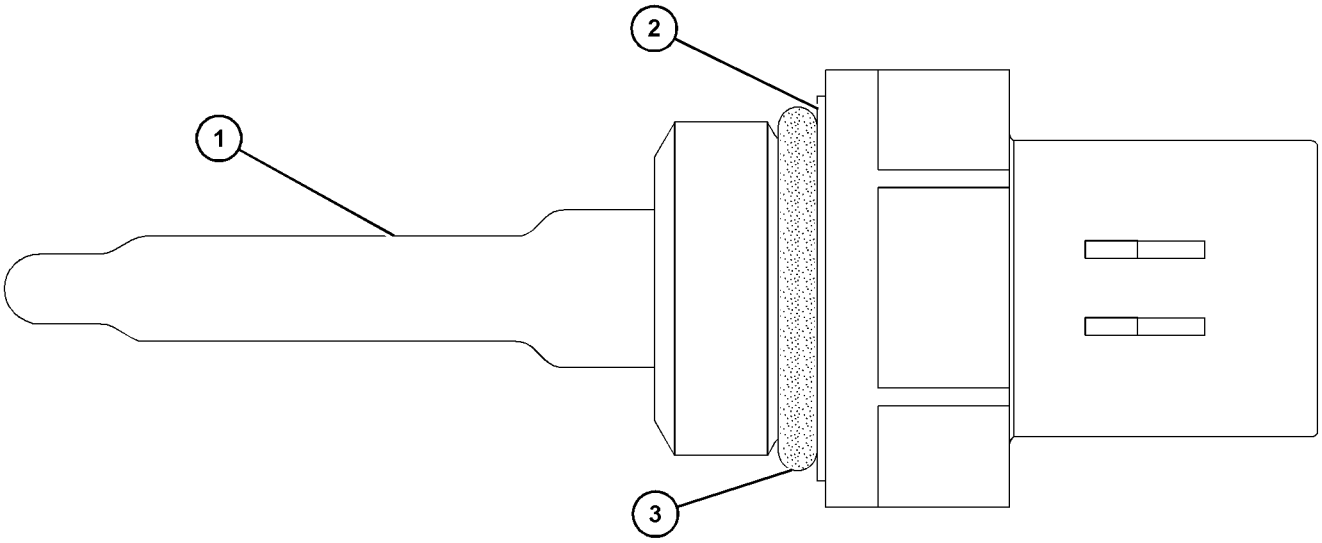


Illustration 199 g06180597

Table 109

Specification for 234-5012 Temperature Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	256-6453 Temperature Sensor	Output type is passive
2	1	234-5012 Temperature Sensor Gp	Torque to 20 ± 3 N·m (177 ± 26 lb in)
3	1	6V-6609 O-Ring Seal	-

i04949170

Coolant Flow Switch

SMCS Code: 7422

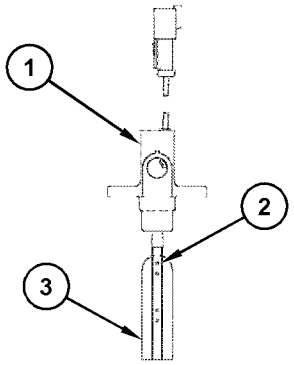


Illustration 200 g03136217

Typical example

Table 110

Specification for 171-8708 Flow Switch, 171-8709 Flow Switch, 171-8710 Flow Switch Gp, and 171-8711 Flow Switch Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	9X-4730 Flow Switch	Test the flow switch with the paddle (3) in the vertical position and apply force on the rivet head (2).
			Actuation force is 0.362 ± 0.029 N (0.081 ± 0.007 lb).
			Minimum deactuation force is 0.303 N (0.068 lb).
			Contact position is normally open.
-	-	-	When the switch is installed in the engine cooling system, there is not enough force from the flow of coolant at engine cranking speed in order to activate the switch. When the engine is running at low idle, the flow of coolant has enough force in order to activate the switch.

i04385495

Fuel Temperature Sensor

SMCS Code: 1922

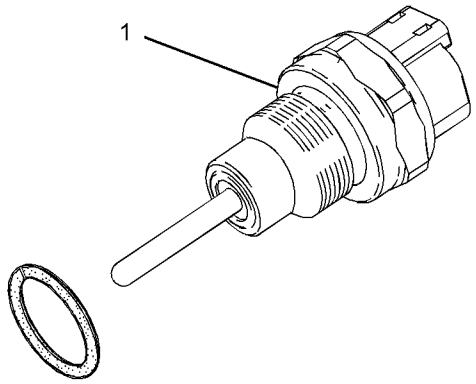


Illustration 201 g02574738

Table 111

Specification for the 130-9811 Temperature Sensor Gp, 197-8391 Temperature Sensor Gp, and 256-6453 Temperature Sensor			
Item	**Qty**	**Part**	**Specification Description**
1	1	-	Torque to 20 ± 3 N·m (175 ± 25 lb in).
			Output type is passive.

i04390215

Fuel Temperature Sensor

SMCS Code: 1922

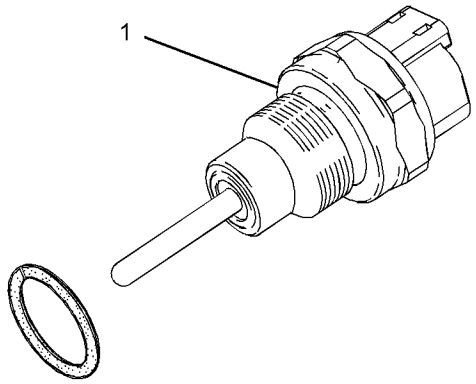


Illustration 202 g02553996

Table 112

Specification for the 264-4297 Temperature Sensorand 256-6453 Temperature Sensor			
Item	**Qty**	**Part**	**Specification Description**
1	-	-	Torque to 20 ± 3 N·m (15 ± 2 lb ft).
			Output type is Passive.

i04428590

Fuel Filter Pressure Differential Switch

SMCS Code: 1256; 1261

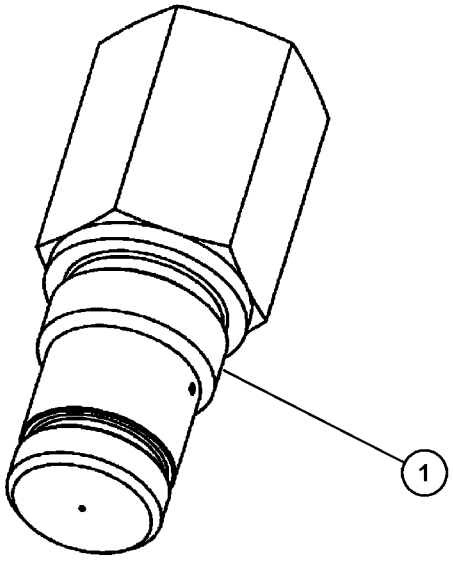


Illustration 203 g06225868

Table 113

Item	Qty	Part	Specification Description
1	1	-	Torque to 6.78 ± 1.41 N·m (60.01 ± 12.48 lb in).
-	-	-	Contact position is normally closed below de-actuation pressure. Minimum de-actuation pressure at −40 to 121 °C (−40 to 250 °F) is 69 kPa (10 psi).

i02853437

Mass Air Flow Sensor

SMCS Code: 1439-AI

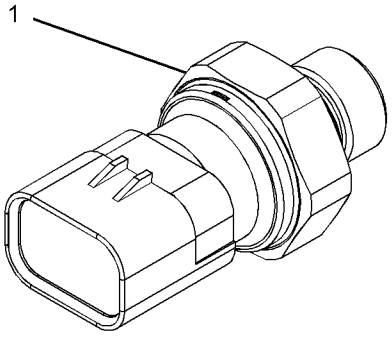


Illustration 204 g01275664

(1) Final installation torque for the pressure sensor group . . . . . 10 ± 2 N·m ((90 ± 18 lb in))

Operating voltage . . . . . .5.0 ± 0.5 VDC

Operating temperature . . . . . −40 to 125 °C ((−40 to 257 °F))

i02853439

Mass Air Flow Sensor

SMCS Code: 1439-AI

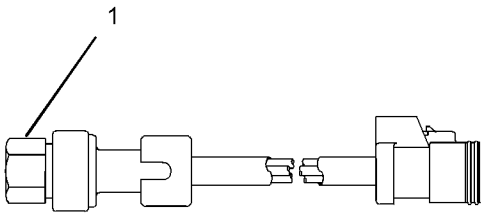


Illustration 205 g01421159

(1) Final installation torque for the pressure sensor group . . . . . 10 ± 2 N·m ((90 ± 18 lb in))

Operating voltage . . . . . .5.00 ± 0.25 VDC

Operating temperature . . . . . −40 to 125 °C ((−40 to 257 °F))

i04363031

Engine Oil Pressure Sensor

SMCS Code: 1924

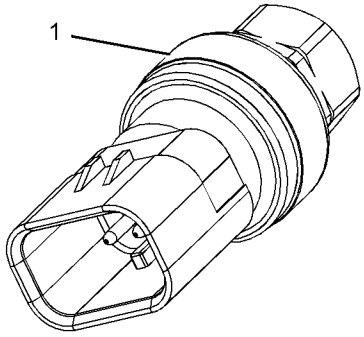


Illustration 206 g02544036

Table 114

Specification for the 276-9067 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	274-6719 Pressure Sensor Gp	Torque to 10 ± 2 N·m (89 ± 18 lb in)
			Operating voltage is 5.0 ± 0.5 VDC

i04397599

Engine Oil Pressure Sensor

SMCS Code: 1924

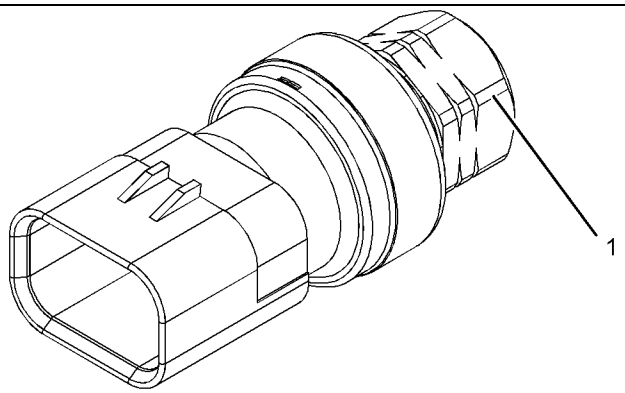


Illustration 207 g02575276

Table 115

Specification for 274-6719 Pressure Sensor Gp, 299-3222 Pressure Sensor Gp, 248-2167 Pressure Sensor Gp, 276-9067 Pressure Sensor Gp, and 293-5535 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	-	-	Torque to 10 ± 2 N·m (89 ± 18 lb in).
-	-	-	Operating voltage is 5.0 ± 0.5 VDC.

i04753349

Engine Oil Pressure Sensor

SMCS Code: 1924

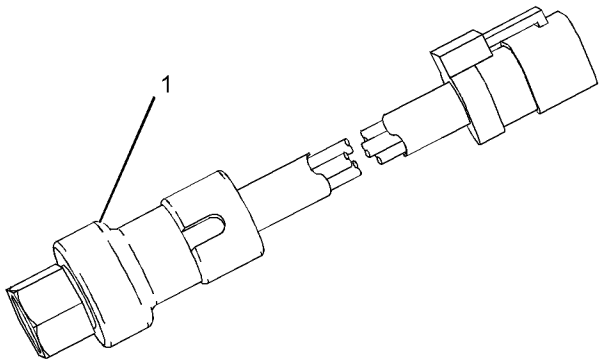


Illustration 208 g02554200

Table 116

Specification for the 194-6725 Pressure Sensor Gp, 161-9931 Pressure Sensor Gp, 163-8523 Pressure Sensor Gp, 299-3222 Pressure Sensor Gp, 161-9926 Pressure Sensor Gp, 239-2396 Pressure Sensor Gp, 239-3478 Pressure Sensor Gp, and 3E-8652 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	-	Torque to 10 ± 2 N·m (90 ± 18 lb in).
			Operating voltage is 5.00 ± 0.25 VDC.

i07398027

Engine Oil Pressure Sensor

SMCS Code: 1924

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 276-9067
S/N: E9Z1–Up

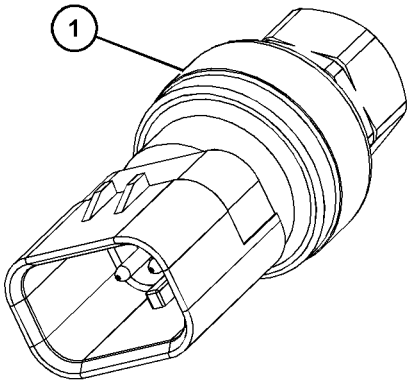


Illustration 209 g06309478

Table 117

Item	Qty	Part	Specification Description
1	1	274-6719 Pressure Sensor Gp	Torque to 10 ± 2 N·m (89 ± 18 lb in).
			Operating voltage is 5.00 ± 0.5 VDC.
			Operating temperature is −40 °C to 125 °C (−40 °F to 257 °F).

i04385589

Atmospheric Pressure Sensor

SMCS Code: 1923

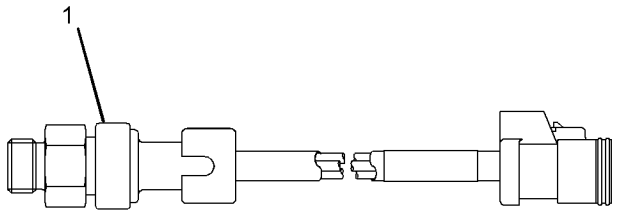


Illustration 210 g02554277

Table 118

Specification for the 194-6722 Pressure Sensor Gp, 194-6724 Pressure Sensor Gp, 194-6725 Pressure Sensor Gp,163-8530 Pressure Sensor Gp, and 239-3478 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	-	Torque to 10 ± 2 N·m (90 ± 18 lb in).
			Operating voltage is 5.00 ± 0.25 VDC.

i04397550

Atmospheric Pressure Sensor

SMCS Code: 1923

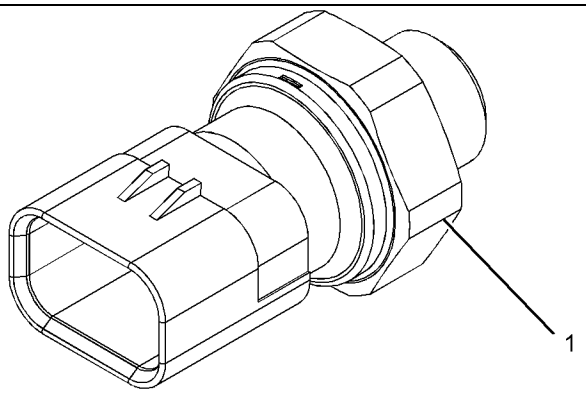


Illustration 211 g02575237

Table 119

Specification for 274-6717 Pressure Sensor, 248-2162 Pressure Sensor Gp, 276-6793 Pressure Sensor Gp, 306-6834 Pressure Sensor Gp, 296-8060 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	-	-	Torque to 10 ± 2 N·m (89 ± 18 lb in).
-	-	-	Operating voltage is 5.0 ± 0.5 VDC.

i07321090

Atmospheric Pressure Sensor

SMCS Code: 1923

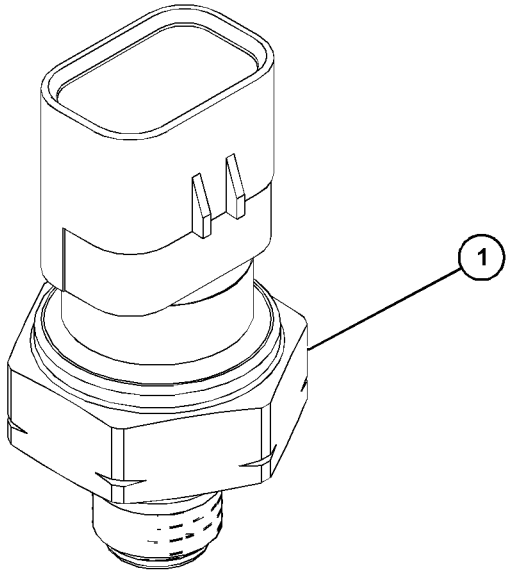


Illustration 212 g06088946

Table 120

Item	Qty	Part	Specification Description
1	1	320-3063 Pressure Sensor Gp	Torque to 13 ± 3 N·m (115 ± 27 lb in).
-	-	-	Operating voltage is 5.00 ± 0.25 VDC.
-	-	-	Operating temperature is −40 °C to 125 °C (−40 °F to 257 °F).

i07397982

Atmospheric Pressure Sensor

SMCS Code: 1923

S/N: HSE1–Up

S/N: PZE1–Up

S/N: ZEN1–Up

Part No.: 331-1134
S/N: E9Z1–Up

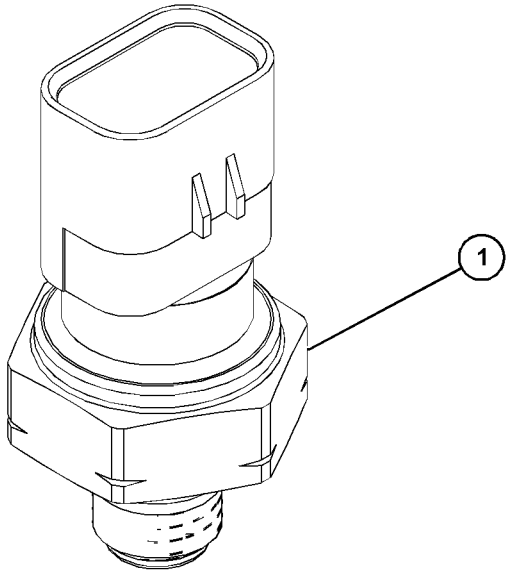


Illustration 213 g06088946

Table 121

Item	Qty	Part	Specification Description
1	1	320-3063 Pressure Sensor Gp	Torque to 13 ± 3 N·m (115 ± 27 lb in).
-	-	-	Operating voltage is 5.00 ± 0.25 VDC.
-	-	-	Operating temperature is −40 °C to 125 °C (−40 °F to 257 °F).

i04561288

Inlet Manifold Temperature Sensor

SMCS Code: 1921

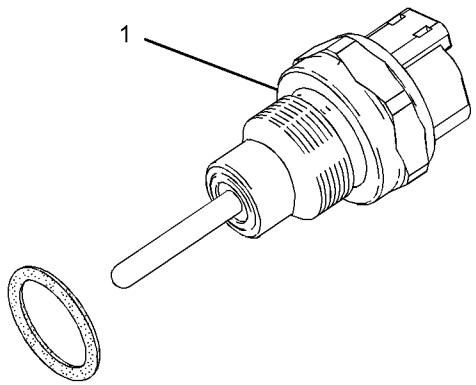


Illustration 214 g02727184

Table 122

Specification for 130-9811 Temperature Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	-	130-9811 Temperature Sensor Gp	Torque to 20 ± 5 N·m (177 ± 44 lb in).
			Output type is passive.

i05198754

Inlet Manifold Temperature Sensor

SMCS Code: 1921

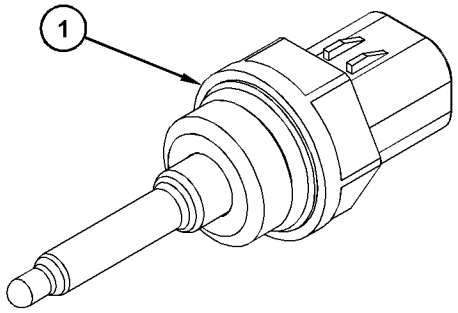


Illustration 215 g03331249

Table 123

Specification for 234-5013 Temperature Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	256-6453 Temperature Sensor	Torque to 20 ± 3 N·m (177 ± 27 lb in).
-	-	-	Output type is Passive.

i05153049

Turbocharger Inlet Pressure Sensor

SMCS Code: 1052; 1917

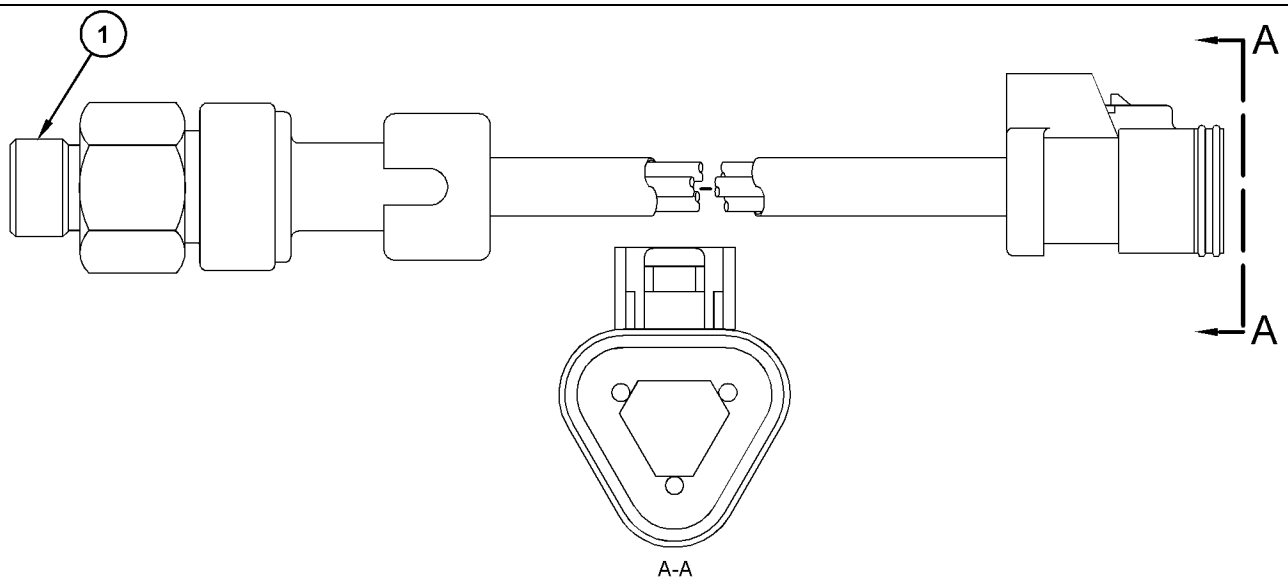


Illustration 216 g03309196

Typical example

Table 124

Specification for the 194-6722 Pressure Sensor Gp , 194-6724 Pressure Sensor Gp , and 194-6725 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	-	-	Torque to 10 ± 2 N·m (90 ± 18 lb in).
			Operating voltage is 5.00 ± 0.25 VDC.

i05319688

Turbocharger Inlet Pressure Sensor

SMCS Code: 1052; 1917

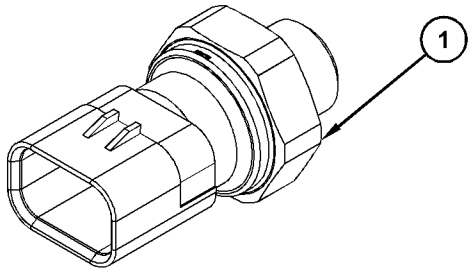


Illustration 217 g03371119

Table 125

Specification for 274-6717 Pressure Sensor, 274-6719 Pressure Sensor Gp and 276-6793 Pressure Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	274-6717 Pressure Sensor	Torque to 10 ± 2 N·m (89 ± 18 lb in).
			Operating voltage is 5.0 ± 0.5 VDC.

i04402191

Turbocharger Exhaust Temperature Sensor

SMCS Code: 1052; 1919

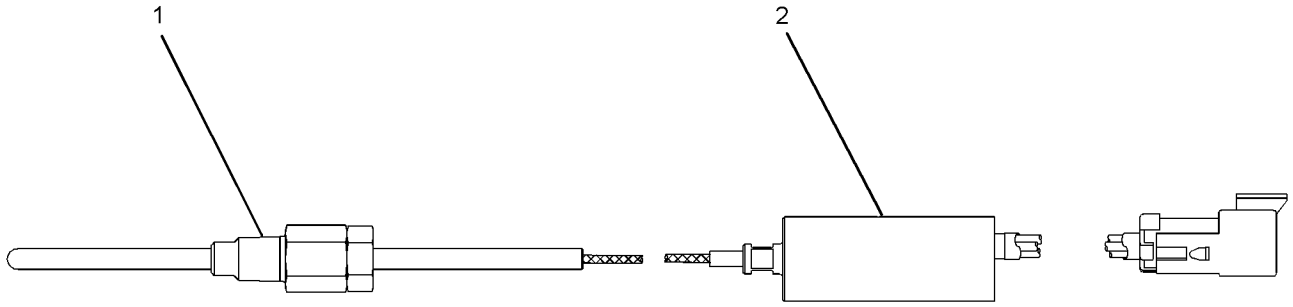


Illustration 218 g02587496

(2) Exhaust temperature sensor group

Table 126

Specification for the 163-7882 Turbocharger Exhaust Temperature Sensor Gp and 261-6848 Turbocharger Exhaust Temperature Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
1	-	-	Torque to 45 ± 5 N·m (33 ± 4 lb ft).
			Apply 4C-5599 Anti-Seize Compound to the threads of the adapter (1) before installation.
			Operating voltage is 7.5 to 8.5 VDC.
			Output type is PWM.
			Output frequency is 500 ± 100 Hz.

i02857202

Speed/Timing Sensor

SMCS Code: 1907; 1912

Camshaft Position Sensor

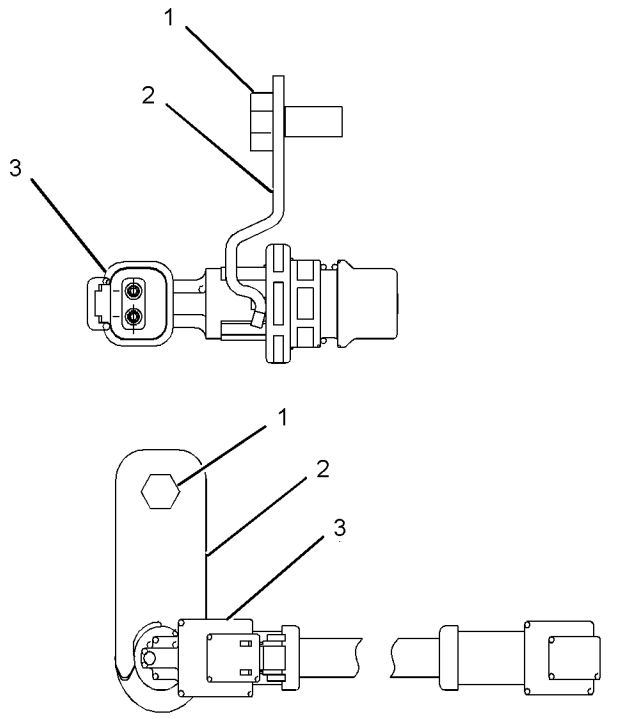


Illustration 219 g01423337

(2) Bracket
(3) Speed sensor

Ensure that the bracket is installed in the orientation that is shown.

Lubricate the seal for the speed sensor with clean engine oil before installation.

(1) Torque for the bolt . . . . .28 ± 7 N·m ((21 ± 5 lb ft))

Ensure that the speed sensor is seated before the bolt is tightened.

Crankshaft Position Sensor

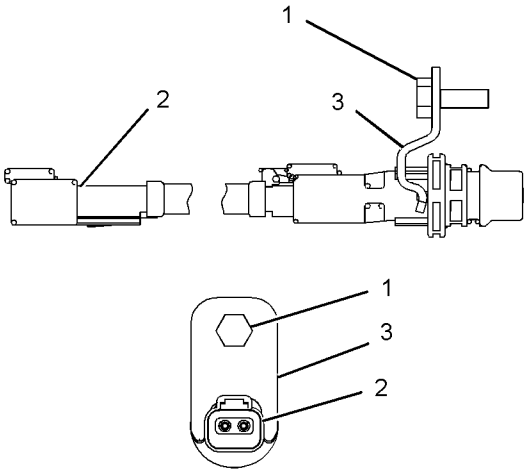


Illustration 220 g01423342

(2) Speed sensor
(3) Bracket

Ensure that the bracket is installed in the orientation that is shown.

Lubricate the seal for the speed sensor with clean engine oil before installation.

(1) Torque for bolt . . . . . .28 ± 7 N·m ((21 ± 5 lb ft))

Ensure that the speed sensor is seated before the bolt is tightened.

i04390432

Speed/Timing Sensor

SMCS Code: 1907; 1912

S/N: 5301–Up

S/N: 2211–Up

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DN61–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DN71–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DS91–Up

S/N: DT91–Up

S/N: DW91–Up

S/N: LWA1–Up

S/N: GEB1–Up

S/N: RAB1–Up

S/N: TPB1–Up

S/N: H4C1–Up

S/N: EED1–Up

S/N: EXD1–Up

S/N: FKD1–Up

S/N: HLD1–Up

S/N: HSE1–Up

S/N: PZE1–Up

S/N: DHG1–Up

S/N: EYG1–Up

S/N: RJG1–Up

S/N: DHJ1–Up

S/N: DLK1–Up

S/N: Z9K1–Up

S/N: DHL1–Up

S/N: WSN1–Up

S/N: ZEN1–Up

S/N: JRP1–Up

S/N: JXP1–Up

S/N: KDP1–Up

S/N: DLS1–Up

S/N: BTW1–Up

S/N: JNW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: PWW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

Part No.: 300-9805, 300-9806
S/N: E9Z1–Up

S/N: KDZ1–Up

Primary Speed/Timing Sensor (Crankcase)

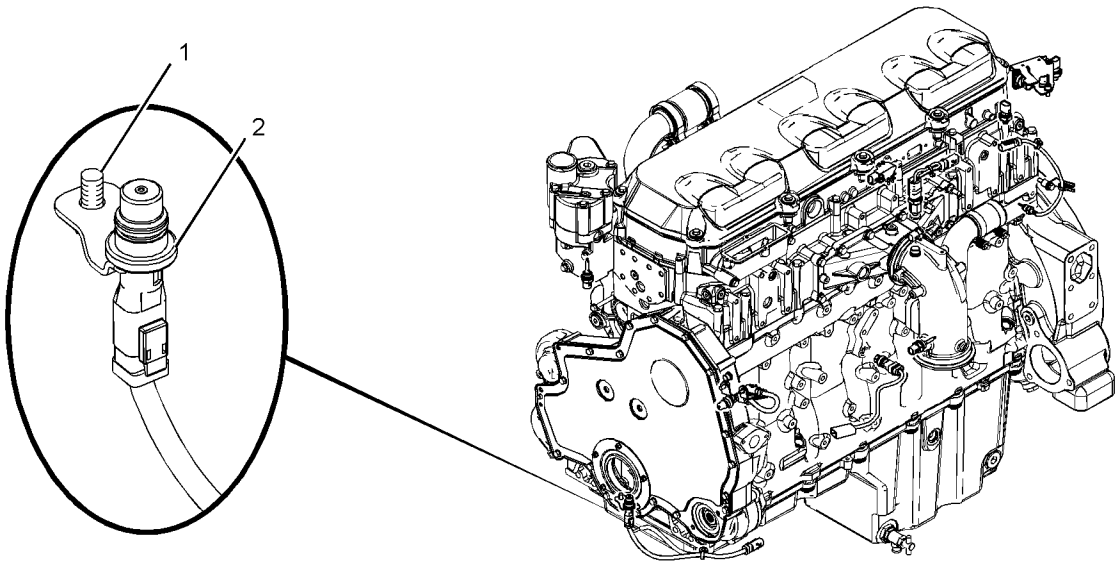


Illustration 221 g02560816

Table 127

Specification for 300-9805 Speed Sensor Gp (PRIMARY, TIMING)			
Item	**Qty**	**Part**	**Specification Description**
1	1	6V-5215 Bolt	Torque to 28 ± 7 N·m (248 ± 62 lb in).
2	1	279-9828 Speed Sensor Gp	Lubricate the bore with the lubricant that is being sealed. Ensure that the sensor is seated before the bolt is tightened.

Secondary Speed/Timing Sensor (Camshaft)

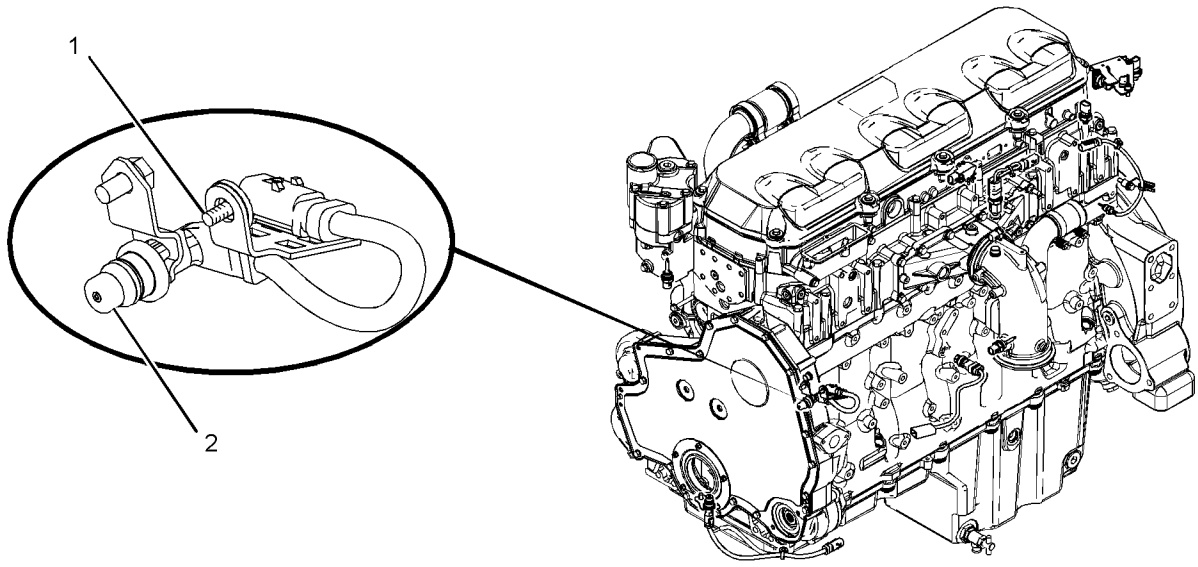


Illustration 222 g02560960

Table 128

Specification for 300-9806 Speed Sensor Gp (SECONDARY, TIMING)			
Item	**Qty**	**Part**	**Specification Description**
1	1	8T-4970 Bolt	Torque to 28 ± 7 N·m (248 ± 62 lb in).
2	1	279-9829 Speed Sensor Gp	Lubricate the bore with the lubricant that is being sealed. Ensure that the sensor is seated before the bolt is tightened.

i05393010

Speed/Timing Sensor

SMCS Code: 1907; 1912

Primary Speed/Timing Sensor

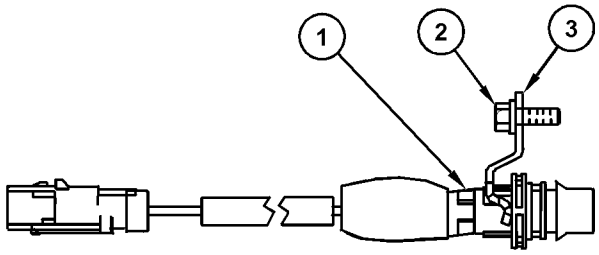


Illustration 223 g03409389

Table 129

Specification for 279-9828 Speed Sensor Gp, and 284-3163 Speed Sensor Gp			
Item	**Qty**	**Part**	**Specification Description**
-	-	-	Lubricate the O-ring seal lightly with the lubricant that is being sealed.
2	-	-	Torque for the bolt is 28 ± 7 N·m (248 ± 62 lb in). Ensure that the sensor (1) is seated before the bolt (2) is tightened.
3	2	133-0260 Bracket	Ensure that the bracket is installed in the orientation, as shown. Refer to Illustration 223 .

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SENR9936
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SENR9937-30 (en-us)
August 2019

Systems Operation Testing and Adjusting

C27 and C32 Engines for Caterpillar Built Machines

4YC 1-UP (Machine)
4XJ 1-UP (Machine)
3PR 1-UP (Machine)
AGC 1-UP (Machine)
JRP 1-UP (Machine)
EED 1-UP (Machine)
DLS 1-UP (Machine)
BTW 1-UP (Machine)
221 1-UP (Machine)
JNW 1-UP (Machine)
FKR 1-UP (Machine)
EXD 1-UP (Machine)
JXP 1-UP (Machine)
EYG 1-UP (Machine)
DR2 1-UP (Machine)
DR4 1-UP (Machine)
DS7 1-UP (Machine)
DS6 1-UP (Machine)
DT6 1-UP (Machine)
DT7 1-UP (Machine)
DT4 1-UP (Machine)
DT9 1-UP (Machine)
DS9 1-UP (Machine)
DN2 1-UP (Machine)
DN3 1-UP (Machine)
DN6 1-UP (Machine)
DW9 1-UP (Machine)
9TR 1-UP (Machine)
9XR 1-UP (Machine)
7PZ 1-UP (Machine)
AAF 1-UP (Machine)
KNW 1-UP (Machine)
NNW 1-UP (Machine)
DLT 1-UP (Engine)
KDP 1-UP (Machine)
KDZ 1-UP (Machine)
RJG 1-UP (Machine)
BWX 1-UP (Machine)
GEB 1-UP (Machine)
TPB 1-UP (Machine)
LWA 1-UP (Machine)
Z9K 1-UP (Machine)
H4C 1-UP (Machine)
RAB 1-UP (Machine)
DHL 1-UP (Machine)
DHJ 1-UP (Machine)
DHG 1-UP (Machine)
DHX 1-UP (Machine)
FKD 1-UP (Machine)
WSN 1-UP (Machine)
PZE 1-UP (Machine)
HLD 1-UP (Machine)
PWW 1-UP (Machine)
ZEN 1-UP (Machine)
HSE 1-UP (Machine)

i06558969

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

i03355569

General Information

SMCS Code: 1000

General Information

The C27 and C32 Machine Engines incorporate an electronic control system with electronically controlled fuel injection. These advancements in technology offer the following improvements over engines with mechanically operated fuel systems: enhanced engine efficiency, reduced smoke levels and lower exhaust emissions.

The Electronic Unit Injection (EUI) fuel system eliminates many of the mechanical components that are traditionally used in the fuel injector assembly. The EUI system increases engine timing accuracy and air/fuel ratio control. The engine's timing advance is achieved by precise control of the fuel injection timing, while engine rpm is controlled by adjusting the injection duration.

The engine is equipped with an Electronic Control Module (ECM) that is used to control engine operation. The ECM has built-in diagnostics in order to ensure that all of the components are operating properly. In the event of a system component failure, the ECM can send a signal to a warning lamp or a diagnostic lamp that will alert the operator to the condition. An electronic service tool can be used to read the numerical code of the faulty component or condition. Intermittent faults are logged and stored in the ECM memory.

Starting the Engine

The ECM will automatically provide the correct amount of fuel that is necessary to start the engine. The throttle should not be held while the engine is being cranked. If the engine fails to start in 30 seconds, the starter switch should be released. The starting motor should be allowed to cool for two minutes before being used again.

NOTICE
Excessive ether (starting fluid) can cause piston and ring damage. Use ether for cold weather starting purposes only.

Cold Mode Operation

The ECM will set the cold start strategy when the coolant temperature is below 20 °C (68 °F).

When the cold start strategy is activated, low idle rpm will be increased and engine power will be limited.

Cold mode operation will be deactivated when any of the following conditions have been met:

- Coolant temperature reaches 20 °C (68 °F).
- The engine has been running for twelve minutes.

Cold mode operation uses a modified control map, that is stored in the ECM, in order to adjust the fuel injection timing and the injection duration for white smoke cleanup. The engine will usually exit the cold mode operation before the walk-around inspection is completed. During cold mode operation, the engine will remain at the elevated rpm that has been specified for the engine.

After the cold mode is completed, the engine should be operated at low rpm until normal operating temperature is reached. The engine will reach normal operating temperature faster when the engine is operated at low rpm and low power demand.

Customer Specified Parameters

The engine is capable of being programmed for several customer specified parameters. For a brief explanation of each of the customer specified parameters, refer to the Operation and Maintenance Manual for your engine.

i03384284

Electronic Control System Components

SMCS Code: 1900

The electronic control system is integrally designed into the engine's fuel system and the engine's air inlet and exhaust system in order to electronically control the fuel delivery. The electronic control system provides better timing control and fuel air ratio control in comparison to conventional mechanical engines. Injection timing is achieved by the precise control of the fuel injectors. Engine speed is controlled by adjusting the injection duration. The Electronic Control Module (ECM) energizes the unit injector solenoids in order to start the injection of fuel. Also, the ECM de-energizes the unit injector solenoids in order to stop the injection of fuel.

Refer to Systems Operation, “Fuel System” for a complete explanation of the fuel injection process.

The engine uses the following three types of electronic components:

- Input component
- Control component
- Output component

An input component is one that sends an electrical signal to the ECM. The signal that is sent varies in either of the following ways:

- Voltage

- Frequency
- Pulse width

The variation of the signal is in response to a change in some specific system of the engine. Some specific examples of an input component are the engine speed-timing sensors, and the coolant temperature sensor. The ECM interprets the signal from the input component as information about the condition, environment, or operation of the engine.

A control component (ECM) receives the input signals from the input components. Electronic circuits inside the control component evaluate the signals from the input components. These electronic circuits also supply electrical energy to the output components of the system. The electrical energy that is supplied to the output components is based on predetermined combinations of input signal values.

An output component is one that is operated by a control module. The output component receives electrical energy from the control group. The output component uses electrical energy to make an adjustment in one of the engine's systems. An output component may also provide information to the operator.

As an example, a moving solenoid plunger will perform work. By performing work, the component has functioned in order to regulate the engine.

As an example, a control panel light or an alarm will provide information to the operator of the engine.

These electronic components provide the ability to electronically control the engine operation. Engines with electronic controls offer the following advantages:

- Improvement in performance
- Improvement in fuel consumption
- Reduction in emissions levels

Various sensors feed data to the ECM. The following sensors are used by the ECM for data:

- Engine coolant temperature
- Boost pressure
- Engine oil temperature
- Engine oil pressure
- Engine speed
- Atmospheric pressure
- Injection actuation pressure
- Fuel temperature
- Fuel pressure
- Inlet air temperature

The ECM processes the data. Then, the ECM sends an electronic signal to the fuel injector. The signal will control the amount of fuel that is injected into the cylinder. This will optimize the efficiency and the performance of the engine.

Sensor Locations

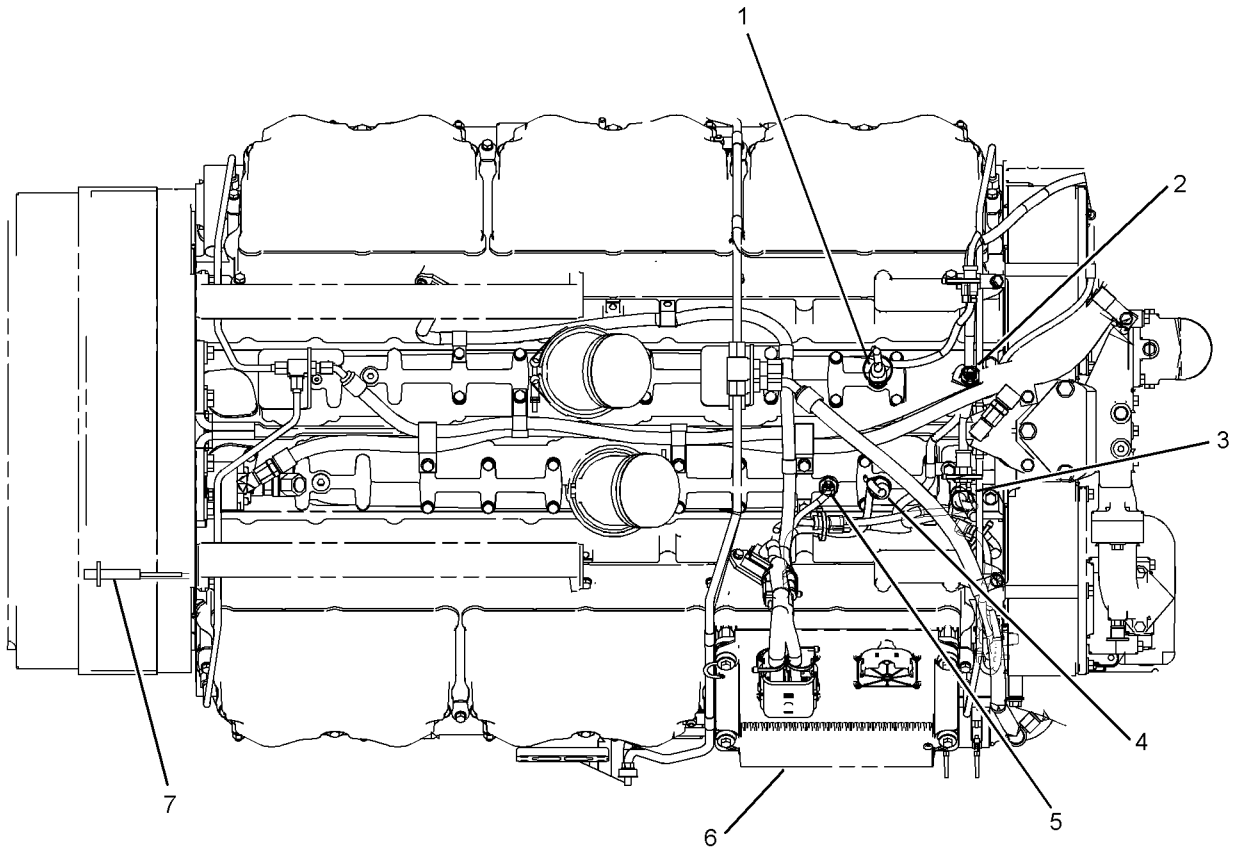


Illustration 1 g01084042

C27 Electronic control system components

(1) Left side inlet air pressure sensor
(2) Coolant temperature sensor
(3) Atmospheric pressure sensor
(4) Right side inlet air pressure sensor
(5) Inlet air temperature sensor
(6) ECM
(7) Speed/Timing sensor

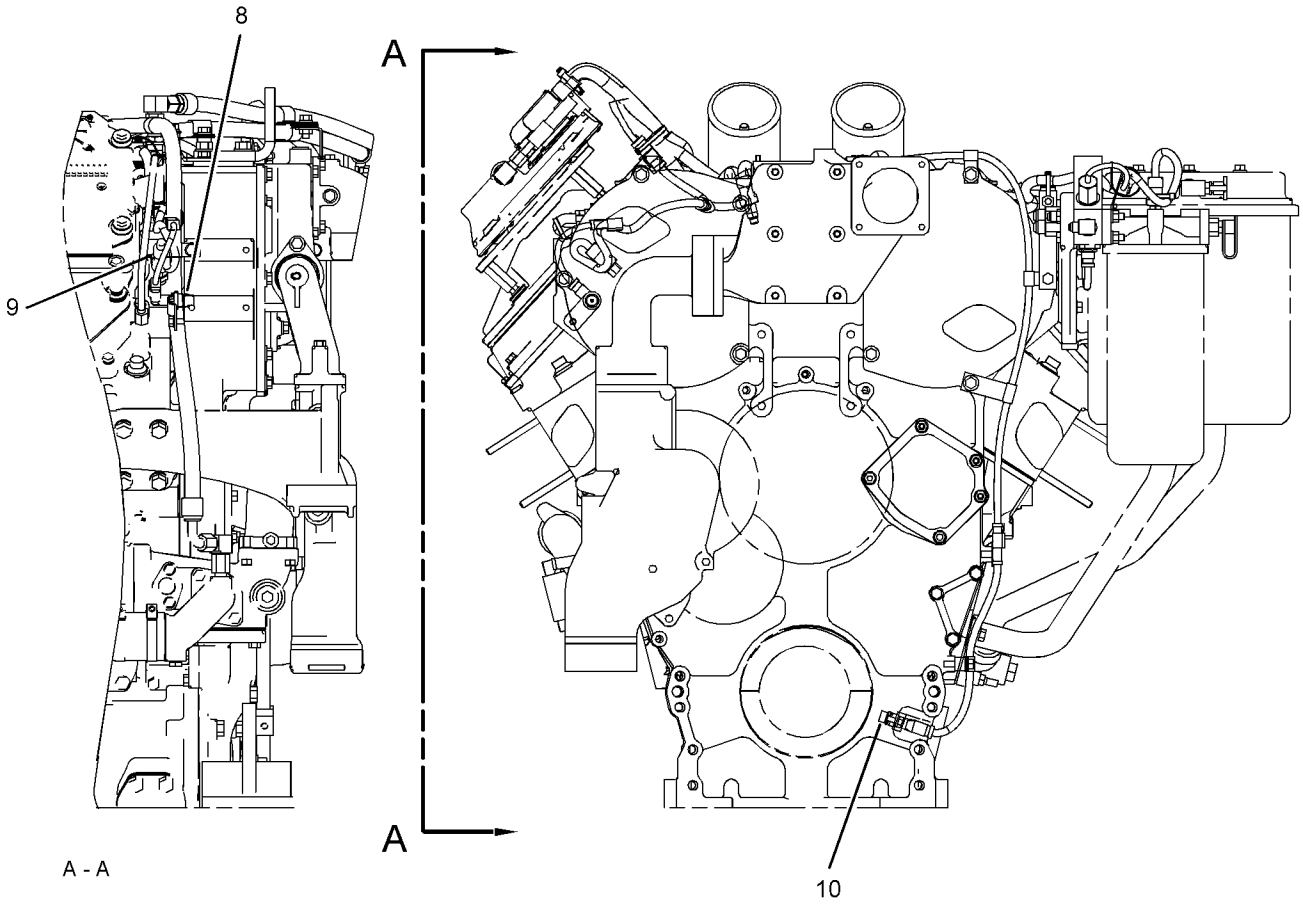


Illustration 2 g01749215

C27 Electronic control system components

(8) Camshaft sensor (9) Oil pressure sensor (10) Engine crankshaft sensor

Cat Data Link

A Cat data Link is used for the following items:

- Communicate engine information.
- Communicate with Caterpillar Electronic Technician (ET).
- Calibrate the electronic engine control system.
- Troubleshoot the electronic engine control system.
- Program the electronic engine control system.

The Cat Data Link is used to communicate engine information to other electronic control systems. Also, the Cat Data Link can interface with Cat ET.

The Cat Data Link monitors engine information. The engine information that is available on the Cat Data Link includes the following information:

- Boost pressure
- Engine identification
- Engine speed
- Oil pressure
- Status and diagnostic information
- Throttle position

Cat ET can be used to program the customer specified parameters. The tool is plugged into the connector for the Cat Data Link. This allows Cat ET to communicate with the ECM. Also, Cat ET can be used to display the real time values of all the information that is available on the Cat Data Link. This will help diagnose engine problems.

Electronic Control Module (ECM)

The engine uses an Electronic Control Module (ECM). The ECM is a microprocessor based device. The ECM is mounted on the right side of the engine.

The inputs and the outputs to the ECM are designed to withstand short circuits without damage to the control module. The electronic engine control system has the following features that are designed into the system.

- Resistance to radio frequency
- Resistance to electromagnetic interference

The system has passed tests for interference by two-way radios and by switching noise.

The ECM power supply provides electrical power to all engine mounted sensors and actuators. The following precautions have been designed into the ECM.

- Reverse voltage polarity protection
- Power swings or surges of voltage due to sudden alternator loads

The ECM also monitors all sensor inputs and the ECM provides the correct outputs in addition to acting as a power supply. Also, the ECM ensures the desired engine operation.

The ECM is programmed with a selected factory engine rating. The ECM memory contains a personality module identification code. This code is used to avoid unauthorized tampering or switching of personality modules and other pertinent manufacturing information.

The wiring harness provides communications to the following areas:

- ECM
- Various sensors
- Cat Data Link
- Engine connectors

The ECM is programmed to perform the following functions:

- Diagnostic tests on all inputs
- Diagnostic tests on all outputs
- Identify a faulty circuit.

Once a fault is detected, the fault can be displayed on a diagnostic lamp. The diagnostic code can be read by using Cat ET. A multimeter can be used to check most problems. Also, a multimeter can be used to troubleshoot most problems. The ECM will record most diagnostic codes that are generated during engine operation. These logged codes or intermittent codes can be read by Cat ET.

i03383343

Fuel System

SMCS Code: 1250

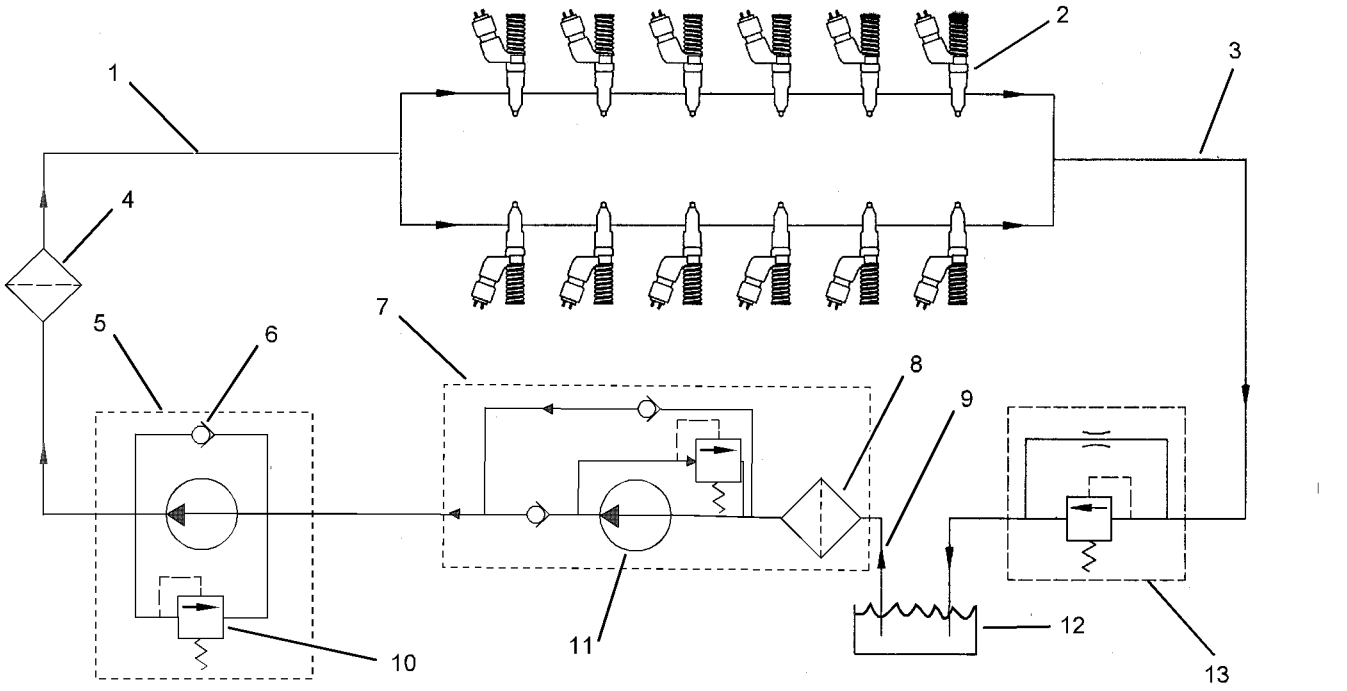


Illustration 3 g01087552

Fuel system schematic

(1) Fuel gallery
(2) Mechanical electronic unit injectors
(3) Fuel return line
(4) Secondary fuel filter
(5) Fuel transfer pump
(6) Check valve
(7) Fuel filter base
(8) Primary fuel filter
(9) Fuel supply line
(10) Pressure relief valve
(11) Electric fuel priming pump
(12) Fuel tank
(13) Regulating valve

The fuel supply circuit is a conventional design for unit injector diesel engines. The system consists of the following major components that are used to deliver low pressure fuel to the unit injectors:

Fuel tank – The fuel tank is used to store the fuel.

Fuel priming pump – The fuel priming pump is used to evacuate the air from the fuel system. As the air is removed the system fills with fuel.

Fuel filters – The primary fuel filter is used to remove abrasive material and contamination from the fuel system that may be large enough to damage the fuel transfer pump. The secondary fuel filter is used to remove abrasive material and contamination as small as two microns that could damage the injectors.

Supply lines and return lines – Supply lines and return lines are used to deliver the fuel to the different components.

The purpose of the low pressure fuel supply circuit is to supply fuel that has been filtered to the fuel injectors at a rate that is constant and a pressure that is constant. The fuel system is also utilized to cool components such as the fuel injectors.

Once the injectors receive the low pressure fuel, the fuel is pressurized again before the fuel is injected into the cylinder. The unit injector uses mechanical energy that is provided by the camshaft to achieve pressures that can be in excess of 200000 kPa (30000 psi).

Control of the fuel delivery is managed by the engine's Electronic Control Module (ECM). Data from several of the engine systems is collected by the ECM and processed in order to manage these aspects of fuel injection control:

- Injection timing

- Fuel injection timing advance
- Injection duration
- Engine cold mode status

The mechanical electronic fuel system relies on a large amount of data from the other engine systems. The data that is collected by the ECM will be used in order to provide optimum performance of the engine.

Low Pressure Fuel Supply Circuit

The flow of fuel through the system begins at fuel tank (12). Fuel is drawn from the tank by fuel transfer pump (5). The fuel transfer pump incorporates a check valve (6) that will allow fuel to flow around the gears of the pump during priming of the fuel system. The fuel transfer pump also incorporates a pressure relief valve (10). The pressure relief valve is used in order to protect the fuel system from extreme pressure.

The fuel transfer pump is engineered in order to produce an excess fuel flow throughout the fuel system. The excess fuel flow is used by the system to cool the fuel system components. The excess fuel flow also purges any air from the fuel system during operation. Air that can become trapped in the fuel system can cause cavitation that may damage the components of the unit injector.

The fuel priming pump (11) is located on the fuel filter base (7). The fuel filter base and primary fuel filter (8) also incorporates a siphon break that prevents fuel from draining from the fuel system when the engine is not in operation. The priming pump is an electric pump that directs the flow of fuel during the priming pump's operation. The filtered fuel then flows out of the fuel filter and returns to the passages in the fuel filter base. Prior to exiting the fuel filter base, the fuel pressure and the fuel temperature is sampled by the fuel pressure sensor and by the fuel temperature sensor. The signals that are generated by the sensors are used by the engine control in order to monitor the condition of the engine's components. The fuel flows through a secondary fuel filter (4) which is a two micron fuel filter. The fuel is filtered in order to remove small abrasive particles that will cause premature wear to fuel system components. This information is also used to adjust the fuel delivery of the engine in order to optimize efficiency.

The fuel is transfered by fuel supply lines (9) to the fuel gallery (1) in the cylinder head. Only a portion of the fuel that is supplied to the fuel injectors is used for engine operation. This unused fuel is discharged into the return passages of the fuel gallery. The fuel is returned to the fuel tank by the fuel return lines (3). A continuous flow of fuel is experienced within the low pressure fuel system.

During engine operation, fuel injectors (2) receive fuel from the low pressure fuel system. The injector pressurizes the fuel to high pressure. The fuel is then injected into the cylinder. The excess fuel is returned to the tank. Refer to Systems Operation, “Unit Injector” for a complete explanation of the injection process.

A pressure regulating valve (13) is located in the fuel return. The pressure regulating valve allows the low pressure fuel system to maintain a constant pressure. A flow control orifice is also located in the fuel return. The flow control orifice maintains a system back pressure that is constant. The orifice allows the flow of fuel through the system to be constant. This prevents excessive heating of the fuel.

Fuel Heaters

Fuel heaters prevent the waxing of the fuel, and the plugging of the fuel filters in cold weather. The engine does not dissipate enough heat in order to prevent waxing during cold weather conditions. There are two types of fuel heaters that can be used: thermostatically controlled and self-adjusting. Heaters that are not thermostatically controlled can heat the fuel in excess of 65 °C (149 °F). High fuel temperatures can have the following effects:

- Reduced engine efficiency
- Fuel pump damage
- Premature wear

Note: Never use fuel heaters without some type of temperature regulator. Ensure that fuel heaters are turned OFF during warm weather conditions.

Fuel System Electronic Control Circuit

The injection pump, the fuel lines, and the nozzles that are used in the traditional Caterpillar diesel engines have been replaced with an electronically controlled, mechanically actuated electronic unit injector in each cylinder. A solenoid on each injector controls the amount of fuel that is delivered by the injector. An Electronic Control Module (ECM) sends a signal to each injector solenoid in order to provide complete control of the engine.

There are two major components of the electronic control system that are necessary in order to provide control of the mechanical electronic unit injectors:

- ECM
- Personality module (storage for the ECM flash file)

The ECM is the computer that is used to provide control for all aspects of engine operation. The personality module contains the software that defines the characteristics of the engine control. The personality module contains the operating maps. The operating maps define the following characteristics of the engine:

- Horsepower
- Torque curves
- Engine speed (rpm)
- Other characteristics

The ECM, the personality module, the engine sensors, and the unit injectors work together in order to control the engine. Neither of the four can control the engine alone.

The ECM maintains the desired engine speed by sensing the actual engine speed. The ECM calculates the amount of fuel that needs to be injected in order to achieve the desired engine speed.

Fuel Injection

The ECM controls the amount of fuel that is injected by varying the signals that are sent to the injectors. The ECM sends a high voltage signal to the solenoid in order to energize the solenoid. The injectors will inject fuel only while the injector solenoid is energized. By controlling the timing and the duration of the high voltage signal, the ECM can control injection timing and the amount of fuel that is injected.

The ECM sets certain limits on the amount of fuel that can be injected. The Fuel Ratio Control (FRC) is an adjustment which controls the amount of air and of fuel for the purpose of emission control. This limit is based on the boost pressure. When the ECM senses a higher boost pressure, the ECM increases the FRC limit. Also, the Rated Fuel Position (RFP) is also a limit that is based on the horsepower rating of the engine. This is similar to the rack stops and to the torque spring on a mechanically governed engine. The RFP provides horsepower and torque curves for a specific engine family and for a specific engine rating. All of these limits are programmed into the personality module by the factory. These limits are not programmable by the service technician.

Injection timing depends on three factors: the engine speed (rpm), the engine load and the operational conditions of the engine. The ECM determines the top center position of No. 1 cylinder from the signal that is provided by the engine speed/timing sensor. The ECM decides when the injection should occur relative to the top center position. The ECM then provides the signal to the electronic unit injector at the desired time.

Electronic Unit Injector Mechanism

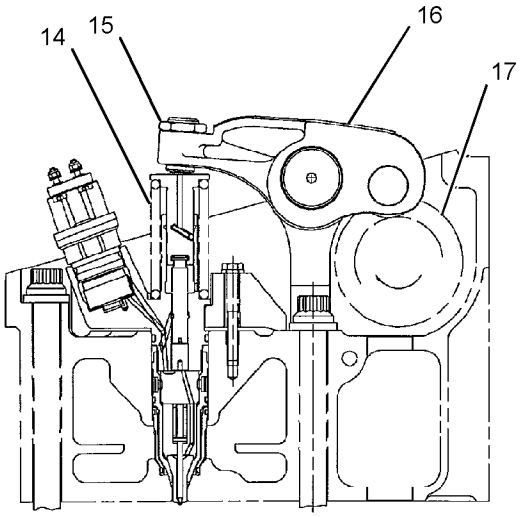


Illustration 4 g01748593

Electronic unit injector mechanism

(14) Electronic unit injector
(15) Adjusting nut
(16) Rocker arm assembly
(17) Camshaft lobe

The electronic unit injector mechanism provides the downward force that is required to pressurize the fuel in the electronic unit injector pump. The electronic unit injector (14) allows fuel to be injected into the combustion chamber with precise timing. Movement is transmitted from the camshaft lobe (17) for the electronic unit injector through the rocker arm assembly (16) to the top of the electronic unit injector. The adjusting nut (15) allows the injector lash to be adjusted. For the proper setting of the injector lash, refer to the topic on adjustment of the electronic unit injector in Testing and Adjusting, “Electronic Unit Injector - Adjust”.

Electronic Unit Injector

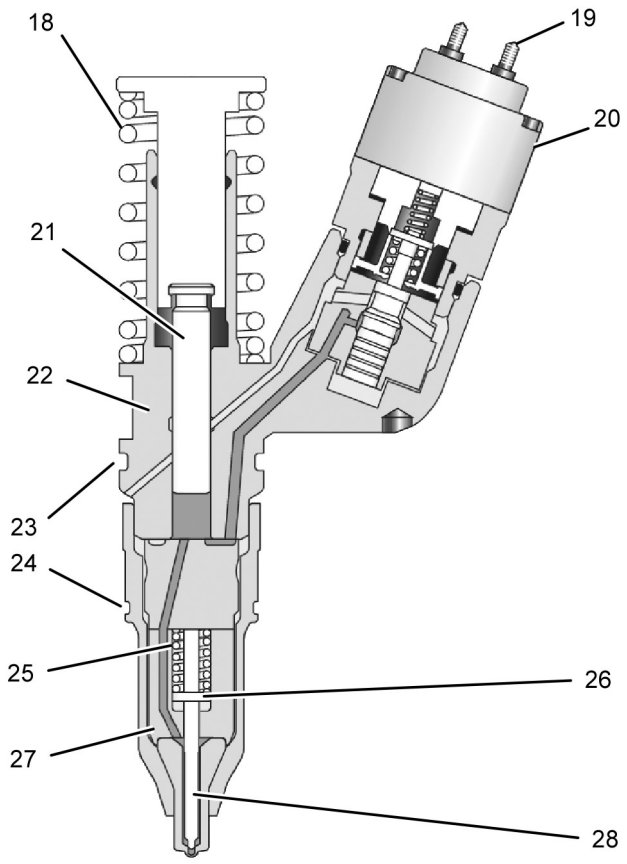


Illustration 5 g01748653

Electronic unit injector

(18) Spring
(19) Solenoid connection to the Electronic Control Module (ECM)
(20) Solenoid valve assembly
(21) Plunger assembly
(22) Barrel
(23) Seal
(24) Seal
(25) Spring
(26) Spacer
(10) Body
(11) Check valve

Fuel at low pressure from the fuel supply manifold enters the electronic unit injector at the fill port through drilled passages in the cylinder head.

As the electronic unit injector mechanism transfers the force to the top of the electronic unit injector, spring (18) is compressed and plunger (21) is driven downward. This action displaces fuel through the valve in solenoid valve assembly (20), and into the return manifold to the fuel tank. As the plunger travels downward, the passage in barrel (22) is closed by the outside diameter of the plunger. The passages within body (27) and along check valve (28) to the injector tip already contain fuel for injection. After the passage in the plunger barrel is closed, the injector is ready for injection at any time. The start of injection relies on the software in the ECM.

When the solenoid valve assembly is energized from a signal across solenoid connection (19), the valve closes and fuel pressure is elevated in the injector tip. Injection begins at 34500 ± 1900 kPa (5000 ± 275 psi) as the force of spring (25) above spacer (26) is overcome. The check valve begins to lift from the valve seat. The pressure continues to rise as the plunger cycles through a full stroke. After the correct amount of fuel has been discharged into the cylinder, the ECM removes the signal to the solenoid connection. The solenoid valve assembly is de-energized and the valve in the solenoid valve assembly is opened. The high pressure fuel is then dumped through the spill port and into the fuel return manifold. The fuel is then returned to the fuel tank. The check valve in the injector tip seats as the pressure in the tip decreases.

The duration of injection meters the fuel that is consumed during the fuel injection process. Injection duration is controlled by the governor logic that is programmed into the ECM.

As the camshaft lobe rotates past the point of maximum lobe lift, the force on top of the electronic unit injector is removed and the spring for the injector mechanism is allowed to expand. The plunger returns to the original position. This uncovers the fuel supply passage into the plunger barrel in order to refill the injector pump body. The fuel at low pressure is again allowed to circulate through the fuel injector body. After circulating through the fuel injector body, the fuel flows out of the spill port. This continues until the solenoid valve assembly is re-energized for another injection cycle.

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Air Inlet and Exhaust System

SMCS Code: 1050

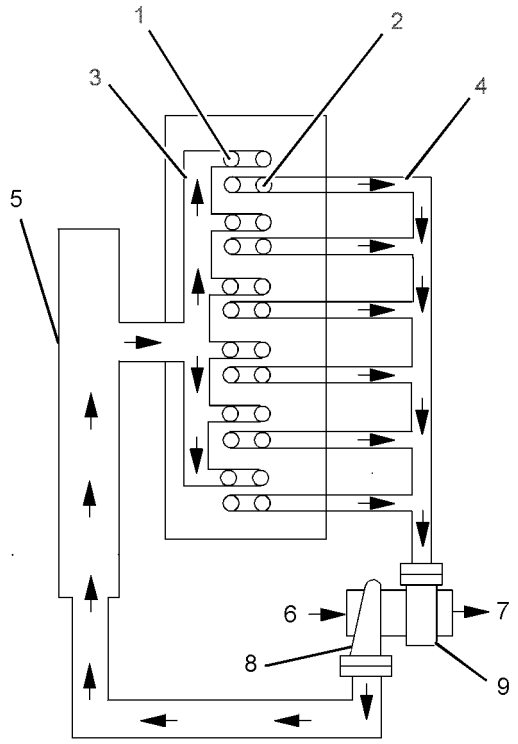


Illustration 6 g01107004

Basic air inlet and exhaust system

(1) Inlet valves
(2) Exhaust valves
(3) Inlet manifold
(4) Exhaust manifold
(5) Aftercooler
(6) Air inlet
(7) Exhaust outlet
(8) Compressor
(9) Turbine

The components of the air inlet and exhaust system control the quality of air and the amount of air that is available for combustion. The air inlet and exhaust system consists of the following components:

- Air cleaner
- Turbocharger
- Aftercooler
- Cylinder head
- Valves and valve system components
- Piston and cylinder
- Inlet manifold
- Exhaust manifold

Note: The following description of the operation of the air inlet and exhaust system assumes that the engine is developing boost pressure.

Inlet air passes through the air cleaner into the air inlet (6) of the turbocharger compressor (8). A turbocharger is used in order to increase the flow of air into the engine. This increase in air flow pressurizes the combustion air supply for the engine. The pressure that is placed on the inlet air allows a larger volume of air to be compressed into the cylinder. This compressing of the inlet air is referred to as engine boost.

The compressing of air causes the air temperature to rise to about 204 °C (400 °F). As the air flows through aftercooler (5), the temperature of the compressed air is cooled to about 46 °C (115 °F). The aftercooler utilizes a heat exchanger in order to cool the inlet air. Cooling the inlet air causes the air to become more dense. Compressing and cooling the inlet air increases the combustion efficiency of the engine. This also increases the horsepower output.

From the aftercooler, air enters the inlet manifold (3). Air flow from the inlet manifold to the cylinders is controlled by inlet valves (1). There are two inlet valves and two exhaust valves (2) for each cylinder. The inlet valves open at the top center position of the piston. When the inlet valves open, cooled compressed air enters the cylinder through the inlet ports. The inlet valves close as the piston reaches the bottom center position. This is called the inlet stroke of the engine. As the piston begins to travel back to the top center position on the compression stroke, the air in the cylinder is compressed to a high temperature. When the piston is near the end of the compression stroke, fuel is injected into the cylinder and mixes with the compressed air. This causes combustion to start in the cylinder. Once combustion starts, the combustion force pushes the piston toward the bottom center position. This is called the power stroke. The exhaust valves open when the piston moves toward the bottom center position and the exhaust gases are pushed through the exhaust port into exhaust manifold (4) as the piston travels toward top center on the exhaust stroke. The exhaust valves close and the cycle repeats. The complete cycle consists of four strokes:

- Inlet
- Compression
- Power
- Exhaust

The exhaust gases from the cylinder are forced into exhaust manifold (4). The flow of exhaust gases from the exhaust manifold enter the turbine side of the turbocharger. The flow of the exhaust gas and the heat of the exhaust gas causes the turbine wheel in the turbine (9) to spin. The turbine wheel is connected to a shaft that drives the compressor wheel. Exhaust gases from the turbine wheel then exit the turbocharger (8).

Turbocharger

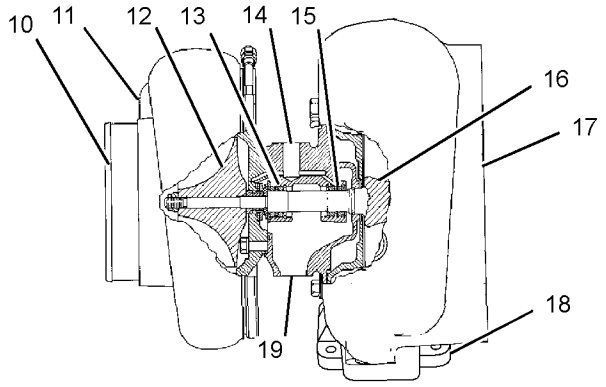


Illustration 7 g01748913

Water-cooled turbocharger

(10) Compressor inlet
(11) Compressor housing
(12) Compressor wheel
(13) Shaft bearing
(14) Oil Inlet port
(15) Shaft bearing
(16) Turbine wheel
(17) Turbine outlet
(18) Turbine inlet
(19) Oil outlet port

All of the air that enters the engine passes through the compressor. All of the exhaust gases from the engine pass through the turbine.

The exhaust gases enter through turbine inlet (18). The flow of the exhaust gas pushes on the blades of the turbine wheel (167) and exits through the turbine outlet (17). The turbine wheel is connected by a shaft to compressor wheel (12).

As the compressor wheel rotates, a vacuum is created in the compressor housing (11). Air is pulled through the air filters into the compressor housing through the compressor inlet (10). Impeller vanes are manufactured into the compressor wheel. The vanes are used to compress the incoming air. The compressed air is directed to the compressor outlet into the inlet piping. The air is then directed toward the inlet side of the engine. Boost pressure is created as the flow that is developed by the compressor wheel exceeds the needs of the engine. This results in a positive inlet manifold pressure that exceeds atmospheric pressure. The increased pressure allows the engine to burn more fuel during fuel combustion. Through optimum fuel efficiency, this strategy allows the engine to produce more power and lower emission levels.

When the throttle is opened, more fuel is injected into the cylinders. The combustion of this additional fuel produces an increased flow of exhaust and greater exhaust temperature. The additional flow and the increased temperature of the exhaust causes the turbine and the compressor wheels of the turbocharger to turn faster. As the compressor wheel turns faster, air flow into the air inlet system creates an increase in the pressure that is in the inlet manifold. This increased air pressure allows the engine to burn additional fuel with greater efficiency.

The shaft bearings (13) and (15) use pressurized oil from the engine for lubrication and for cooling. The oil comes in through oil inlet port (14). The oil then goes through passages in the center section in order to lubricate the bearings. This oil also cools the bearings. Oil from the turbocharger goes out through oil outlet port (13) in the bottom of the center section. The oil then flows back to the engine oil pan.

Valve System Components

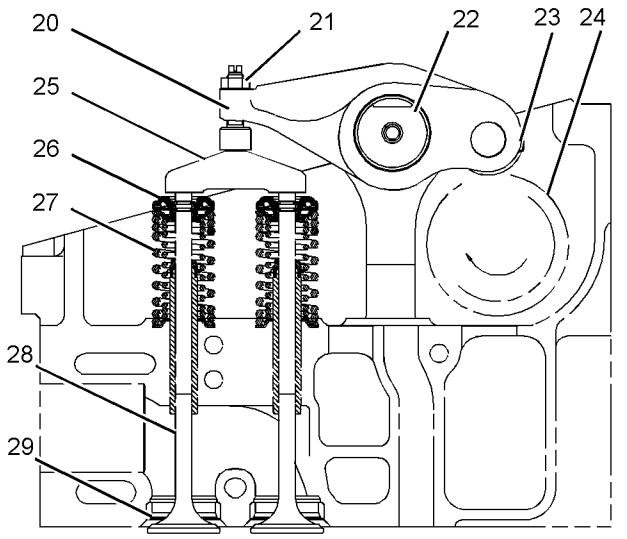


Illustration 8 g01748993

Valve system components

(20) Rocker arm
(21) Valve adjustment screw
(22) Rocker arm shaft
(23) Camshaft follower
(24) Camshaft
(25) Valve bridge
(26) Valve rotator
(27) Valve spring
(28) Valve
(29) Valve seat

The valve train controls the flow of inlet air into the cylinders and the flow of exhaust gases out of the cylinders during engine operation. Specifically machined lobes on the camshaft (24) control the following aspects of valve function:

- Height of valve lift
- Timing of valve lift
- Duration of valve lift

The crankshaft gear drives the camshaft gear through an idler gear. The camshaft must be timed to the crankshaft in order to get the correct relation between the piston position and the valve position.

The camshaft has three camshaft lobes for each cylinder. One camshaft lobe operates the inlet valves. One camshaft lobe operates the exhaust valves. There is also one camshaft lobe that operates the unit injector. Camshaft followers (23) roll against the surface of the camshaft lobes. The followers are used in order to transfer the lift that is machined into the camshaft lobe to the rocker arm (20).

The camshaft lobes lift the camshaft follower of the rocker arm which actuates the valves (28). As the camshaft lobe lifts the follower, the rocker arm pivots at the rocker shaft (22). This applies the lifting action to the valve bridge (25). The valve bridge is used to transfer the lift from the rocker arm to the valves. The valve adjustment screw (21) is used in order to adjust the valve lash.

Each cylinder has two inlet valves and two exhaust valves. Valve springs (27) are used to hold the valves in the closed position when lift is not being transferred from the camshaft lobe. The springs provide the force on the valve in order to ensure that the valves will close at high rpm and under high boost pressures.

Valve rotators (26) cause the valves to rotate while the engine is running. The rotation of the valves prevents the valves from burning by constantly changing the contact area of the valve face and the valve seat (29). This rotation gives the valves longer service life.

i04557118

Lubrication System

SMCS Code: 1300

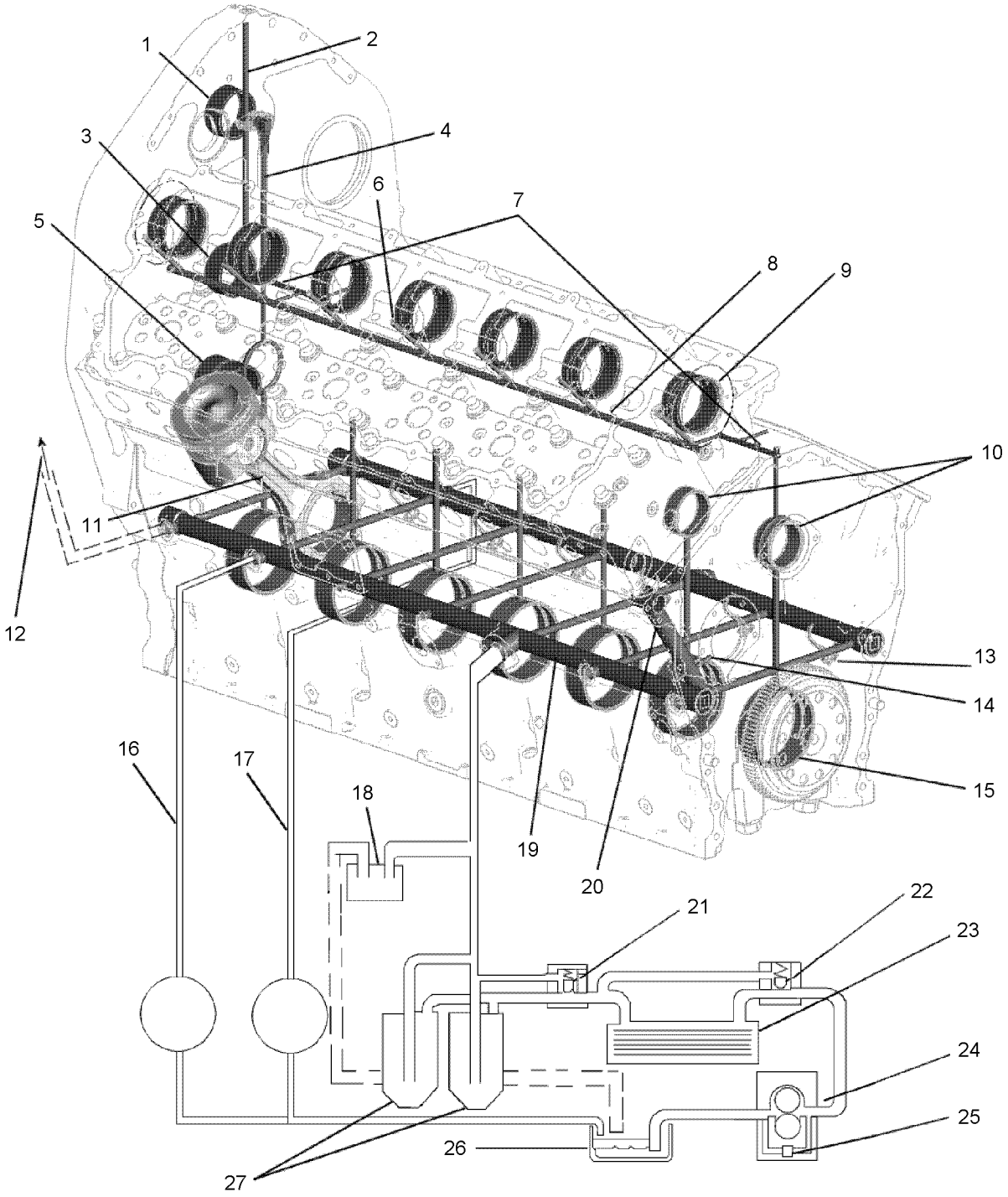


Illustration 9 g01087263

Lubrication system schematic

(1) Upper rear idler bearing
(2) Oil passage for the rear housing
(3) Middle rear idler bearing
(4) Rear oil line
(5) Lower rear idler
(6) Oil passage to rocker arms and camshaft bearings
(7) Oil passage to the heads
(8) Oil gallery in the head
(9) Camshaft bearings
(10) Shaft bearing for the live idler
(11) Connecting rod with drilled oil passage
(12) External oil line to rear gear train
(13) Piston cooling jets
(14) Lower front idler gear bearing

(15) Main bearings
(16) Right side turbocharger oil supply line
(17) Left side turbocharger oil supply line
(18) Auxiliary oil filter (if equipped)
(19) Main oil gallery
(20) Extension for the oil gallery
(21) Oil filter bypass valve
(22) Oil cooler bypass valve
(23) Oil cooler
(24) Oil pump
(25) Oil pump bypass valve
(26) Oil pan
(27) Oil filter

The oil pump (24) is mounted to the bottom of the cylinder block within the oil pan (26). The oil pump (24) pulls oil from the oil pan (26). The oil then flows through a passage to the oil cooler (23). Oil then flows through the oil filters (27). The oil can flow into the main oil gallery (19) from the right side or the left side of the block. The location of the incoming oil supply is dependent on the location of the oil filters which can be located on either side of the block. The oil then flows through a set of cross-drilled holes to the opposite side oil gallery.

The main oil gallery (19) distributes oil to the following components: the crankshaft main bearings (15), the piston cooling jets (13), the extension of the oil gallery (20), the turbocharger oil supply line (16), the turbocharger oil supply line (17) and the live front idler gear bearings (10). The main oil gallery (19) also distributes oil to the rear accessory drives through an external oil line (12).

Oil enters the crankshaft through holes in the bearing surfaces (journals) for the main bearing (15). Passages connect the bearing surface (journal) for the main bearing (15) with the bearing surface (journal) for the connecting rod (11). The oil flows upward through a drilled passage in the connecting rod to the piston pin bearing.

The extension for the oil gallery (20) is located in the front right corner of the engine block. The extension for the oil gallery (20) supplies oil to the lower front idler gear bearing (14).

The oil flows to the live front idler gear bearing (10) and around bearing (10) to the oil passage for the cylinder head (7). The oil then flows to the oil gallery in the cylinder head (8) and the oil flows to the oil passage (6) for the camshaft bearings (9) and the rocker arms.

The oil for the lower rear idler bearing (5) is feed from a passage that is connected to the last rear main crankshaft bearing (15). Oil is also feed from the rear main bearing to the rear oil line (4) and to the oil passage in the rear housing (2) for the middle rear idler gear bearing (3) and the upper rear idler gear bearing (1).

This oil circuit typically operates at a pressure of 214 kPa (31 psi) at low idle and at 400 kPa (58 psi) at rated speed.

The oil pump bypass valve (25) limits the pressure of the oil that comes from the oil pump (24). The oil pump (24) can put more oil into the system than oil that is needed. As the oil pressure increases, the oil pump bypass valve (25) will open. This allows the oil that is not needed to go back to the suction side of the oil pump (24).

Cold oil with high viscosity causes a restriction to the oil flow through the oil cooler (23) and the oil filter (27). The oil cooler bypass valve (22) and the oil filter bypass valve (21) will open if the engine is cold. This will give immediate lubrication to all components. The oil pump (24) sends the cold oil through the bypass valves, around the oil cooler (23), and the oil filter (27), and to the main oil gallery (19) in the cylinder block.

When the oil gets warm, the pressure difference in the bypass valves decreases. This closes the bypass valves. This creates a normal flow of oil through the oil cooler and through the oil filter.

The bypass valves will also open when there is a restriction in the oil cooler (23) or a restriction in the oil filter (27). This action lubricates the engine if the oil cooler (23) or the oil filter (27) are restricted. The bypass valve opening pressures vary with applications.

An oil cooling chamber is formed by the forged lip at the top of the skirt of the piston and the cavity behind the ring grooves in the piston crown. Oil flow from piston cooling jet (13) enters the cooling chamber through a drilled passage in the skirt and returns to the oil pan (26) through the clearance gap between the crown and the skirt. The four holes that have been drilled from the piston oil ring groove to the interior of the piston drain excess oil from the oil ring.

The oil breather allows blowby gases from the cylinders during engine operation to escape from the crankcase. The blowby gases discharge through the flywheel housing to a preformed tube that is routed to the atmosphere. This prevents pressure from building up that could cause seals or gaskets to leak.

Note: Engines that are equipped with an auxiliary oil filter (18) will pick up oil at a port. The filtered oil will be returned to the oil pan (26).

Oil Renewal System (If Equipped)

The purpose of the Oil Renewal System (ORS) is intended to increase the oil change interval. The purpose of the ORS is also intended to decrease the amount of used oil in need of disposal. The life of the engine is not shortened when this is accomplished.

General Description

The ORS meters engine oil that is introduced into the fuel supply of the machine. This oil will be consumed in the engine during the normal process of combustion. The amount of oil that is metered is calculated by the engine's Electronic Control Module (ECM). This amount is based on the actual load factor or on the fuel that is consumed by the engine. The ORS is equipped with a makeup oil tank. The makeup oil tank is an oil reservoir that will replenish the oil that is removed from the engine crankcase by the oil renewal valve. Normal oil consumption will continue to lower the oil in the crankcase. Continually adding new oil will allow the life of the oil to be extended. Reviewing the reports of the S·O·S Oil Analysis will determine if a problem has occurred and if the oil needs to be changed.

The ORS is integrated with the engine and with the electronic system of the machine. The electronic system consists of sensors, switches, the ECM, and the monitoring system. The electronic system will notify the operator of a system malfunction or of warning. The following warnings can be detected:

- Problem with the metering valve
- Low fuel level
- Plugging of the secondary fuel filter
- Low makeup tank oil level
- Low engine oil pressure

Note: The electronics of the engine will automatically turn off the system in order to avoid possible damage to the engine. The system can be restarted by correcting the problem and cycling the power.

i02193415

Cooling System

SMCS Code: 1350

This engine has a pressure type cooling system. A pressure type cooling system gives two advantages. First, the cooling system can be operated safely at a temperature that is higher than the boiling point of water. Also, cavitation in the water pump is prevented. It is more difficult for air or steam pockets to be made in the cooling system.

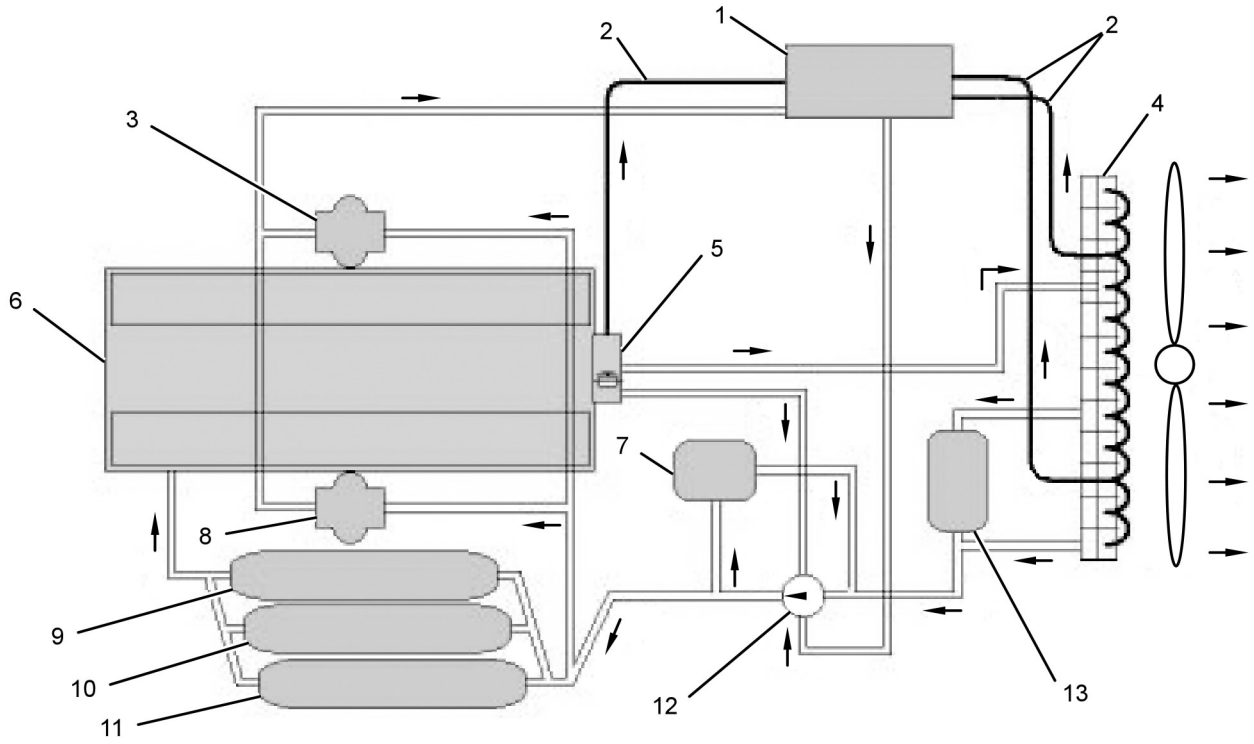


Illustration 10 g01112870

(1) Shunt tank
(2) Vent line
(3) Left side turbocharger
(4) Radiator
(5) Dual thermostat housing
(6) C27 engine
(7) Cab heater
(8) Right side turbocharger
(9) Secondary power train oil cooler
(10) Primary power train oil cooler
(11) Engine oil cooler
(12) Jacket water pump
(13) Hydraulic oil cooler

The jacket water pump (12) provides coolant to the engine oil cooler (11) and to the power train oil coolers (9) and (10). Coolant then flows through the engine block and into the cylinder heads. From the cylinder heads, the coolant flows into a thermostat housing (5). The thermostat then directs the coolant to either the jacket water pump (12) for recirculation or to the radiator (4) for cooling depending on the temperature of the coolant.

Coolant then flows through the radiator with a small amount of flow of the coolant to the hydraulic oil cooler (13) before returning the coolant to the jacket water pump (12). Also, a small amount of coolant flows to turbochargers (3) and (8) for cooling, and then back to the shunt tank (1). Coolant from the shunt tank then flows to the jacket water pump.

i04629667

Basic Engine

SMCS Code: 1200

Cylinder Block Assembly

The cylinders in the left side of the block form a 65 degree angle with the cylinders in the right side. The main bearing caps are fastened to the block with four bolts, two bolts through each bearing cap and two bolts through the side of the block.

The cylinder liners can be removed for replacement. The top surface of the block is the seat for the cylinder liner flange. Engine coolant flows around the liners in order to keep the liners cool. Three O-ring seals around the bottom of the liner make a seal between the liner and the cylinder block. A filler band goes under the liner flange. This makes a seal between the top of the liner and the cylinder block. A steel spacer plate is used between the cylinder head and the block. The spacer plate provides improved reusability and durability. A thin gasket is used between the plate and the block. This thin gasket seals water and oil. A thick gasket of metal and graphite is used between the plate and the head. This thick gasket seals the combustion gases, water and oil.

Cylinder Head Assembly

The cylinder heads are a one-piece cast iron head. The cylinder head supports the camshaft. Steel reinforced camshaft bearings are pressed into each bore for the camshaft. The bearings are lubricated under pressure. The cylinder head contains two inlet valves and two exhaust valves for each cylinder, which are controlled by the rotation of the camshaft. Bridge dowels have been eliminated as the valve train uses floating valve bridges.

The unit injector is mounted in a stainless steel adapter. This adapter has been pressed into the cylinder head injector bore.

Pistons, Rings And Connecting Rods

The piston is a one-piece design that consists of a forged steel crown and a skirt. The piston is retained by the piston pin to the small end of the connecting rod. The pistons have three rings that are located in grooves in the steel crown. These rings seal the combustion gas. The rings provide control of the oil. The top ring has a barrel face. This ring is a Keystone ring with a plasma face coating. The second ring has a tapered face and the ring has a coating of chrome finish for the face. The third ring is the oil ring. The third ring has a coil spring expander. There are four holes that are drilled from the piston oil ring groove to the interior of the piston. These holes return excess oil from the oil ring groove to the crankcase.

The connecting rod is a conventional design. The cap of the connecting rod is attached to the shank by four bolts that are threaded into the shank. Each side of the small end of the connecting rod is machined at an angle of 12 degrees in order to fit within the piston cavity.

Crankshaft

The crankshaft converts the combustion force in the cylinder into rotating torque. A vibration damper is used at the front of the crankshaft in order to reduce the torsional vibrations.

The crankshaft drives a group of gears on the front and the rear of the engine. These gear trains provide power for the following components: camshaft, water pump, oil pump, fuel transfer pump and accessory items that are specific to the application.

The cylinder block has seven main bearings that support the crankshaft. The cylinder block uses four bolts to hold each of the bearing caps into the block. Pressurized oil is supplied to all bearing surfaces through drilled holes in the webs of the cylinder block. The oil then flows through drilled holes in the crankshaft in order to provide oil to the connecting rod bearings.

Seals and wear sleeves are used at both ends of the crankshaft. The seals and wear sleeves are used for easy replacement and reduction of maintenance cost.

Camshaft

The camshaft has three lobes at each cylinder. These lobes allow the camshaft to operate the unit injector, the exhaust valves, and the inlet valves. The camshaft is supported in the cylinder head by seven journals which are fit with bearings. The camshaft gear contains integral roller dampers that counteract the torsional vibrations that are generated by the high fuel pressure during fuel injector operation. The design reduces gear train noise. The camshaft is driven by a fixed idler gear which is turned by another fixed idler gear which is turned by a cluster idler gear in the gear train. Each bearing journal is lubricated from the oil manifold in the cylinder head. A thrust plate that is located at the front controls the end play of the camshaft. Timing of the camshaft is accomplished by aligning marks on the crankshaft gear and idler gear, and camshaft gear with a mark on the front timing plate.

Vibration Damper

The twisting of the crankshaft is called torsional vibration. The torsional vibration is caused by the regular power impacts along the length of the crankshaft. The vibration damper is installed on the front end of the crankshaft. This vibration damper is used to reduce the torsional vibrations. This eliminates any damage that could occur to the crankshaft.

The rubber damper is made of an outer hub connected to an inner hub by a rubber ring. The rubber makes a flexible coupling between the outer hub and the inner hub.

The viscous damper consists of a casing that is welded to the inner hub. The casing contains a steel weight that is suspended in a viscous silicone lubricant. The silicone lubricant acts as a flexible coupling between the weight and the inner hub.

i04074189

Compression Brake (If Equipped)

SMCS Code: 1129

The CAT compression brake is controlled by the Engine Control Module (ECM). The CAT compression brake helps the operator to slow the vehicle speed on grades, or for a necessary speed reduction. The service brakes should not be used continuously on long descending grades. The service brakes are assisted by the CAT compression brake.

The engine crankshaft is turned by the drive train during downhill operation or during any slow down condition. The engine uses the rotation of the components of the drive train to dictate vehicle speed. A braking torque can be applied to the drive train of the vehicle in order to reduce the speed of the vehicle.

When the CAT compression brake is activated, braking power is accomplished by opening the exhaust valves of the engine. The exhaust valves are opened near the top of the compression stroke in order to release the highly compressed air into the exhaust system. The CAT compression brake can only be activated when the engine is in the no-fuel position. Thus, combustion does not occur and no positive force is produced on the piston. The compressed air pressure that is released to the atmosphere prevents the energy from returning to the engine piston on the power stroke. The result is a loss of energy since the work that is done by the compression of the cylinder charge is not returned by the expansion process. This loss of energy is taken from the drive train. The drive train provides the braking action for the vehicle.

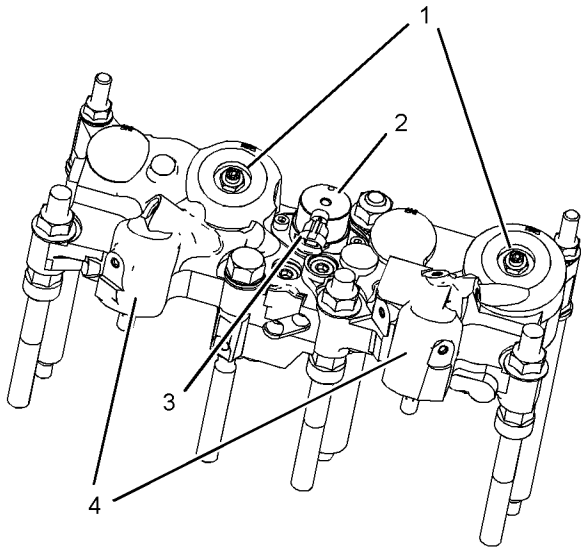


Illustration 11 g01165931

(1) Slave pistons
(2) Solenoid valve
(3) Valve connector
(4) Master cylinders

The CAT compression brake consists of identical housing assemblies. Each housing assembly is positioned over two cylinders. The housing assembly is mounted to the supports for the rocker arm shaft with studs and nuts. The rocker arm and the exhaust bridge assembly are used to transfer force from slave pistons (1) to the exhaust valves. Master cylinders (4) transfer lifting force from the fuel injector rocker arm to hydraulic force for the brake. The brake logic signal for the CAT compression brake is carried to solenoid valve (2) by signal wires that connects at valve connector (3). This is done in order to activate the CAT compression brake on the two cylinders of the engine.

The control circuit for the CAT compression brake permits the operation of either one or multiple compression brake housing assemblies. This provides progressive braking capabilities with the retarding effect of numerous cylinders in the engine.

Operation of the CAT Compression Brake

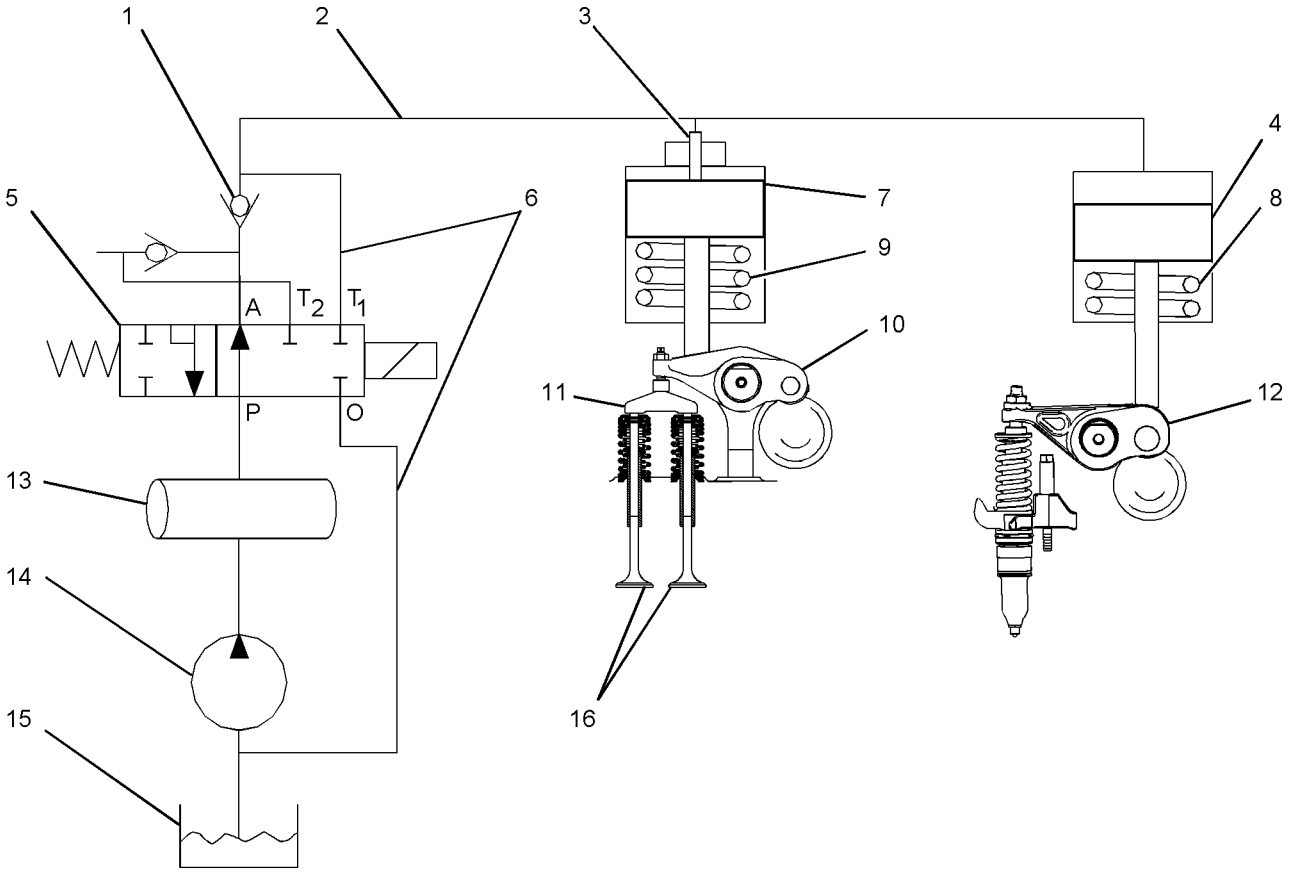


Illustration 12 g01103105

Schematic for master-slave circuit

(1) Check valve
(2) High-pressure oil passage
(3) Slave piston adjustment screw
(4) Master piston
(5) Actuator valve
(6) Oil drain passage
(7) Slave piston
(8) Master piston spring
(9) Spring for the slave piston
(10) Exhaust rocker arm
(11) Exhaust bridge
(12) Fuel injector rocker arm
(13) Rocker arm shaft oil passage
(14) Engine oil pump
(15) Engine oil pan
(16) Exhaust valve
(A) Actuation port
(T1) Drain port
(T2) Drain port
(P) Supply port for the actuator spool

The CAT compression brake is operated by engine oil from engine oil pan (15). The engine oil is pressurized by engine oil pump (14). The engine oil supply for the CAT compression brake is supplied through rocker arm shaft oil passage (13). Actuator valve (5) controls the flow of the supply oil in the compression brake housing.

When the actuator valve is activated by a signal from the ECM, low-pressure oil passes from the actuator spool supply port (P) to actuation port (A). The oil flow opens check valve (1) and flows into high-pressure oil passage (2). Oil is supplied to slave piston (7) and master piston (4).

This engine oil pressure overcomes master piston spring (8). The piston is forced downward toward fuel injector rocker arm (12). Oil fills the cylinder for the master piston and the high-pressure oil passage between the master piston and the slave piston. The master piston follows the movement of the fuel injector rocker arm. The master piston moves upward with the fuel injector rocker arm. The movement of the master piston causes a flow of high-pressure oil that closes the circuit check valve. The closed check valve causes pressure to increase in the hydraulic circuit of the master piston, the slave piston, and the high-pressure oil passage.

As the oil pressure in the high-pressure oil passage is increased by the movement of the master piston, the slave piston is forced downward in the bore. This compresses spring (9) for the slave piston. As the slave piston moves downward, the slave piston contacts exhaust valve rocker arm (10). The slave piston continues to apply a force to the exhaust valve rocker arm. This force causes exhaust valves (16) to open. As the exhaust valves open, the cylinder pressure that is created by the piston during the compression stroke is relieved through the open exhaust valves.

During compression brake operation, the ECM disables the signal to each of the fuel injectors that are selected for braking. The power stroke of the engine will not occur for the selected cylinders during the application of the compression brake. This creates a net braking force at the flywheel.

As the fuel injector rocker arm moves downward, the master piston is allowed to retract into the bore. As the master piston retracts, the hydraulic pressure in the circuit is decreased. This allows the slave piston to retract and control of the exhaust valves is returned to the engine valve train.

De-energizing the actuator valve allows the oil to drain from port (T1) and (T2) to the engine oil pan through oil drain passage (6).

i02500952

Electrical System

SMCS Code: 1400; 1550; 1900

Reference

Refer to the electrical system schematic that is in the Electrical Schematic for the complete electrical system schematic of the engine. Refer to the Electronic Troubleshooting manual for additional information.

Grounding Practices

Proper grounding for the machine electrical system and engine electrical systems is necessary for proper machine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and unreliable electrical circuit paths.

Uncontrolled engine electrical circuit paths can result in damage to main bearings, crankshaft bearing journal surfaces, and aluminum components.

To ensure proper functioning of the machine and engine electrical systems, an engine-to-frame ground strap with a direct path to the negative battery post must be used. This may be provided by way of a starting motor ground, a frame to starting motor ground, or a direct frame to engine ground.

An engine-to-frame ground strap must be used in order to connect the grounding stud of the engine to the frame of the machine and to the negative battery post.

The engine must have a wire ground to the battery.

Ground wires or ground straps should be combined at ground studs that are only for ground use. All of the grounds should be tight and free of corrosion.

All of the ground paths must be capable of carrying any likely current faults. An AWG #0 or larger wire is recommended for the grounding strap to the cylinder head.

The engine alternator should have a battery ground with a wire size that is capable of managing the full charging current of the alternator.

The engine has several input components which are electronic. These components require an operating voltage.

Unlike many electronic systems of the past, this engine is tolerant to common external sources of electrical noise. Buzzers that use electrical energy can cause disruptions in the power supply. If buzzers are used anywhere on the machine, the engine electronics should be powered directly from the battery system through a dedicated relay. The engine electronics should not be powered through a common power source with other activities that are related to the keyswitch.

Engine Electrical System

The electrical system has the following separate circuits:

- Charging
- Starting
- Accessories with low amperage

Some of the electrical system components are used in more than one circuit. The following components are common in more than one circuit:

- Battery or batteries
- Circuit breakers
- Battery cables
- Ammeter

The charging circuit is in operation when the engine is running. An alternator makes electricity for the charging circuit. A voltage regulator in the circuit controls the electrical output in order to keep the battery at full charge.

The starting circuit is activated only when the start switch is activated.

The accessory circuit with the low amperage and the charging circuit are connected through the ammeter. The starting circuit is not connected through the ammeter.

Charging System Components

Alternator

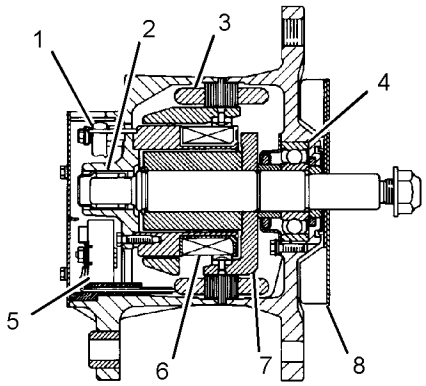


Illustration 13 g01250914

Alternator components

(1) Regulator
(2) Roller bearing
(3) Stator winding
(4) Ball bearing
(5) Rectifier bridge
(6) Field winding
(7) Rotor assembly
(8) Fan

The alternator is driven by a belt from the crankshaft pulley. This alternator is a three-phase, self-rectifying charging unit, and the regulator is part of the alternator.

The alternator design has no need for slip rings and the only part that has movement is the rotor assembly. All conductors that carry current are stationary. The following conductors are in the circuit:

- Field winding
- Stator windings
- Rectifying diodes
- Regulator circuit components

The rotor assembly has many magnetic poles that look like fingers with air space between each of the opposite poles. The poles have residual magnetism. The residual magnetism produces a small magnetic field between the poles. As the rotor assembly begins to turn between the field winding and the stator windings, a small amount of alternating current (AC) is produced. The AC current is produced in the stator windings from the small magnetic field. The AC current is changed to direct current (DC) when the AC current passes through the diodes of the rectifier bridge. The current is used for the following applications:

- Charging the battery
- Supplying the accessory circuit that has the low amperage
- Strengthening the magnetic field

The first two applications use the majority of the current. As the DC current increases through the field windings, the strength of the magnetic field is increased. As the magnetic field becomes stronger, more AC current is produced in the stator windings. The increased speed of the rotor assembly also increases the current and voltage output of the alternator.

The voltage regulator is a solid-state electronic switch. The voltage regulator senses the voltage in the system. The voltage regulator switches ON and OFF many times per second in order to control the field current for the alternator. The alternator uses the field current in order to generate the required voltage output.

NOTICE
Never operate the alternator without the battery in the circuit. Making or breaking an alternator connection with heavy load on the circuit can cause damage to the regulator.

Starting System Components

Starting Solenoid

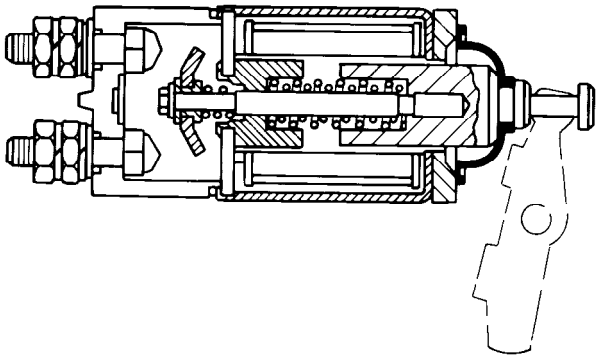


Illustration 14 g00317613

Starting solenoid

A solenoid is an electromagnetic switch that performs two basic functions:

- The starting solenoid closes the high current starting motor circuit with a low current start switch circuit.
- The starting solenoid engages the pinion for the starting motor with the ring gear.

The solenoid has windings (one set or two sets) around a hollow cylinder or a hollow housing. The solenoid housing has a plunger that is spring loaded. The plunger can move forward and backward. When the start switch is closed and electricity is sent through the windings, a magnetic field is created. The magnetic field pulls the plunger forward in the solenoid housing. This moves the shift lever in order for the pinion drive gear to engage with the ring gear. The front end of the plunger then makes contact across the battery and across the motor terminals of the solenoid. The starting motor then begins to turn the flywheel of the engine.

When the start switch is opened, current no longer flows through the windings. The spring now returns the plunger to the original position. At the same time, the spring moves the pinion gear away from the flywheel.

When two sets of windings in the solenoid are used, the windings are called the hold-in winding and the pull-in winding. Both of the windings wind around the cylinder for an equal amount of times. The pull-in winding uses a wire with a larger diameter in order to produce a stronger magnetic field. When the start switch is closed, part of the current flows from the battery through the hold-in winding. The remainder of the current flows through the pull-in windings, to the motor terminal, and then to the ground. When the solenoid is activated, the current is shut off through the pull-in windings. Only the smaller hold-in windings are in operation for the extended period of time that is necessary for the engine to be started. The solenoid will now take a smaller amount of current from the battery. Heat that is created by the solenoid will be kept at an acceptable level.

Starting Motor

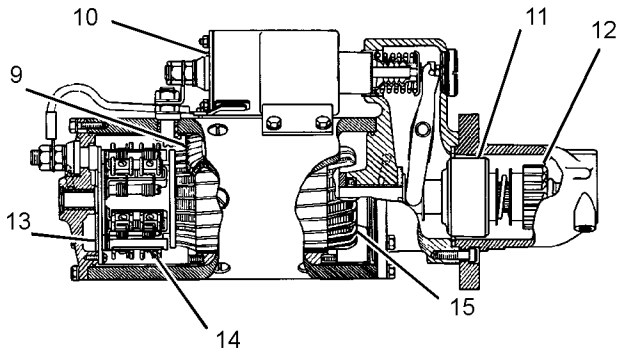


Illustration 15 g01250918

Starting motor components

(9) Field
(10) Solenoid
(11) Clutch
(12) Pinion
(13) Commutator
(14) Brush assembly
(15) Armature

The starting solenoid (10) is an electromagnetic switch that performs the following basic operations:

- The starting solenoid (10) closes the high current starting motor circuit with a low current start switch circuit.
- The starting solenoid (10) engages the starting motor pinion (12) with the ring gear.

Solenoid (10) has windings (one or two sets) around a hollow cylinder. The cylinder has a plunger that is spring loaded on the inside. The plunger can move forward and backward. When the start switch is closed and electricity is sent through the windings, a magnetic field (9) is made. The magnetic field (9) pulls the plunger forward in the cylinder. This moves the shift lever in order to engage the pinion drive gear with the ring gear. The front end of the plunger then makes contact across the battery and motor terminals of solenoid (10). Next, the starting motor begins to turn the flywheel of the engine.

When the start switch is opened, current no longer flows through the windings. The spring now pushes the plunger back to the original position. At the same time, the spring moves the pinion gear away from the flywheel.

When two sets of solenoid windings are used, the windings are called the hold-in winding and the pull-in winding. Both sets of windings have the same number of turns around the cylinder, but the pull-in winding uses a wire with a larger diameter. The wire with a larger diameter produces a greater magnetic field (9). When the start switch is closed, part of the current flows from the battery through the hold-in windings. The rest of the current flows through the pull-in windings to the motor terminal. The current then flows through the motor to ground. Solenoid (10) is fully activated when the connection across the battery and the motor terminal is complete. When solenoid (10) is fully activated, the current is shut off through the pull-in windings. At this point, only the smaller hold-in windings are in operation. The hold-in windings operate for the duration of time that is required in order to start the engine. Solenoid (10) will now draw less current from the battery, and the heat that is generated by solenoid (10) will be kept at an acceptable level.

Testing And Adjusting Section

Fuel System

i02486828

Fuel System - Inspect

SMCS Code: 1250-040

A problem with the components that send fuel to the engine can cause low fuel pressure. This can decrease engine performance.

1. Check the fuel level in the fuel tank. Ensure that the vent in the fuel cap is not filled with dirt.

2. Check all fuel lines for fuel leakage. The fuel lines must be free from restrictions and faulty bends. Verify that the fuel return line is not collapsed.

3. Install a new fuel filter.

4. Cut the old filter open with the 175-7546 Oil Filter Cutter Gp. Inspect the filter for excess contamination. Determine the source of the contamination. Make the necessary repairs.

5. Service the primary fuel filter (if equipped).

6. Operate the hand priming pump (if equipped). If excessive resistance is felt, inspect the fuel pressure regulating valve. If uneven resistance is felt, test for air in the fuel. Refer to Testing and Adjusting, “Air in Fuel - Test” for more information.

7. Remove any air that may be in the fuel system. Refer to Testing and Adjusting, “Fuel System - Prime”.

i04962789

Air in Fuel - Test

SMCS Code: 1280-081

⚠ WARNING

To avoid personal injury, always wear eye and face protection when using pressurized air.

Introduction

This procedure checks for air in the fuel. This procedure also assists in finding the source of the air.

Required Tools

Table 1

Required Tools
2P-8278 Tube As

Test Preparation

Examine the fuel system for leaks. Ensure that the fuel line fittings are properly tightened. Check the fuel level in the fuel tank. Air can enter the fuel system on the suction side between the fuel transfer pump and the fuel tank

Test Procedure

1. Install a 2P-8278 Tube As (SIGHT GAUGE) in the fuel return line. When possible, install the sight gauge in a straight section of the fuel line that is at least 304.8 mm (12 inches) long. Do not install the sight gauge near the following devices that create turbulence:

- Elbows
- Relief valves
- Check valves

Observe the fuel flow during engine cranking. Look for air bubbles in the fuel. If there is no fuel in the sight gauge, prime the fuel system. Refer to Testing and Adjusting, “Fuel System - Prime” for more information. If the engine starts, check for air in the fuel at varying engine speeds. When possible, operate the engine under the conditions which have been suspect of air in the fuel.

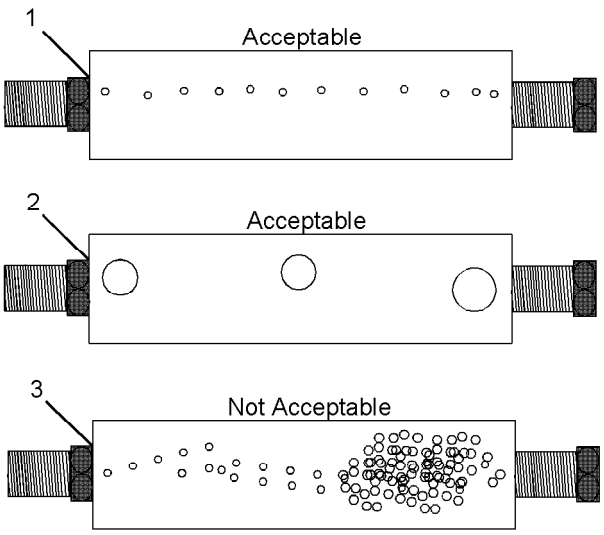


Illustration 16 g01096678

2P-8278 Tube As (SIGHT GAUGE)

(1) A steady stream of small bubbles with a diameter of approximately 1.60 mm (0.063 inch) is an acceptable amount of air in the fuel.
(2) Bubbles with a diameter of approximately 6.35 mm (0.250 inch) are also acceptable if there are 2 seconds to 3 seconds intervals between bubbles.
(3) Excessive air bubbles in the fuel are not acceptable.

2. If excessive air is seen in the sight gauge in the fuel return line, install a second sight gauge at the inlet to the fuel transfer pump. If a second sight gauge is not available, move the sight gauge from the fuel return line and install the sight gauge at the inlet to the fuel transfer pump. Observe the fuel flow during engine cranking. Look for air bubbles in the fuel. If the engine starts, check for air in the fuel at varying engine speeds.

If excessive air is not seen at the inlet to the fuel transfer pump, the air is entering the system after the fuel transfer pump. Proceed to Step 3 of “Adjustment Procedure”.

If excessive air is seen at the inlet to the fuel transfer pump, air is entering through the suction side of the fuel system.

Adjustment Procedure

NOTICE
To avoid damage, do not use more than 55 kPa (8 psi) to pressurize the fuel tank.

1. Pressurize the fuel tank to 35 kPa (5 psi). Do not use more than 55 kPa (8 psi) in order to avoid damage to the fuel tank. Check for leaks in the fuel lines between the fuel tank and the fuel transfer pump. Repair any leaks that are found. Check the fuel pressure in order to ensure that the fuel transfer pump is operating properly. For information about checking the fuel pressure, see Testing and Adjusting, “Fuel System Pressure - Test”.

2. If the source of the air is not found, disconnect the supply line from the fuel tank and connect an external fuel supply to the inlet of the fuel transfer pump. If this action corrects the problem, repair the fuel tank or the stand pipe in the fuel tank.

3. If the injector sleeve is worn or damaged, combustion gases may be leaking into the fuel system. Also, if the O-rings on the injector sleeves are worn, missing, or damaged, combustion gases may leak into the fuel system.

i06279407

Electronic Unit Injector - Adjust

SMCS Code: 1290-025

Fuel Injector Adjustment For MEUI A

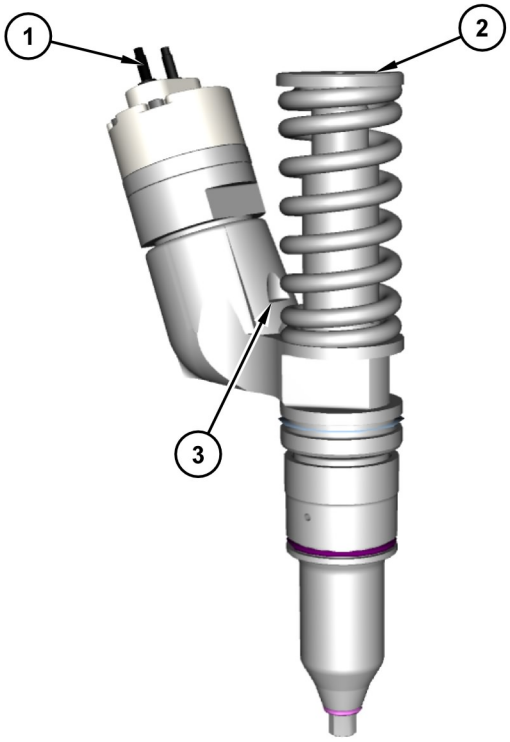


Illustration 17 g03882525

Typical MEUI A injector

(1) Solenoid prongs (2) Top of injector (3) Height adjustment tool ledge

Mechanical Electronic Unit Injectors (MEUI) A have the typical features that are shown in Illustration 17 . The injectors typically have solenoid prongs (1), a flat top to the injector (2), and a ledge for the height adjustment tool (3).

Table 2

Required Tools		
Part Number	**Part Name**	**Quantity**
9U-7227	Injector Height Gauge	1

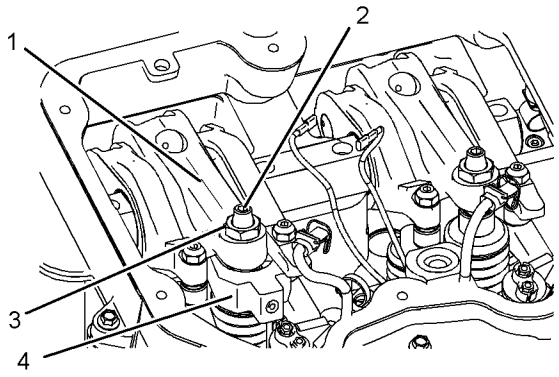


Illustration 18 g01385601

Injector Mechanism

(1) Rocker arm
(2) Adjustment screw
(3) Locknut
(4) 9U-7227 Injector Height Gauge

Adjust the unit injectors on cylinders 4, 5, 6, 9, 11, and 12 use the following procedure:

1. Put the No. 1 piston at the top center position on the compression stroke. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

2. Injector height gauge (4) is used in order to obtain a dimension of 78.0 ± 0.2 mm (3.07 ± 0.01 inch). The dimension is measured from the top of the unit injector to the machined ledge of the fuel injector body.

3. Turn unit injector adjustment screw (2) clockwise until the correct height is obtained.

4. Hold the adjustment screw in this position and tighten locknut (3) to a torque of 100 ± 10 N·m (75 ± 7 lb ft).

5. To adjust the unit injectors on cylinders 1, 2, 3, 7, 8, and 10 remove the timing bolt. Turn the flywheel by 360 degrees in the direction of engine rotation. The direction of engine rotation is counterclockwise, as the engine is viewed from the flywheel end. This will put the number 11 piston at the top center position on the compression stroke.

6. Repeat Steps 3 through 4.

7. Remove the timing bolt from the flywheel after all the unit injector adjustments have been made. Reinstall the valve mechanism covers.

Fuel Injector Adjustment For MEUI C

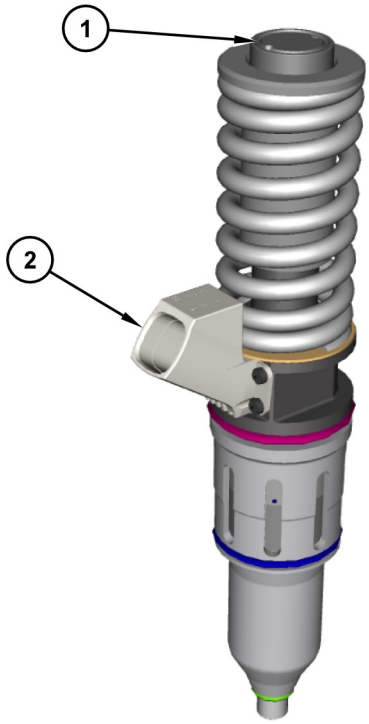


Illustration 19 g03882544
Typical MEUI C injector

(1) Tappet (2) Electrical connector

Mechanical Electronic Unit Injectors (MEUI) C have the typical features that are shown in Illustration 19 . The injectors typically have a raised tappet (1), and electrical connector (2).

1. Set the engine to Top Dead Center for piston number 1. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston” for the proper procedure.

2. Set injectors number 4, 5, 6, 9, 11, and 12.

a. Turn the injector adjustment screw clockwise until contact is made with the injector.

b. Turn the adjustment screw clockwise an additional 180°±20° (1/2 turn).

c. Hold the adjustment screw in this position and tighten the locknut to 100 ± 10 N·m (74 ± 7 lb ft).

3. Turn the engine a complete 360° to set the engine at TDC for piston 11.

4. Set injectors number 1, 2, 3, 7, 8, and 10.

a. Turn the injector adjustment screw clockwise until contact is made with the injector.

b. Turn the adjustment screw clockwise an additional 180°±20° (1/2 turn).

c. Hold the adjustment screw in this position and tighten the locknut to 100 ± 10 N·m (74 ± 7 lb ft).

i02875906

Electronic Unit Injector - Test

SMCS Code: 1290-081

This procedure assists in identifying the cause for an injector misfiring. Perform this procedure only after performing the Cylinder Cutout Test. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for more information.

1. Check for air in the fuel, if this procedure has not already been performed. Refer to Testing and Adjusting, “Air in Fuel - Test”.

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

2. Remove the valve cover and look for broken parts. Repair any broken parts or replace any broken parts that are found. Inspect all wiring for the solenoids. Look for loose connections. Also look for frayed wires or broken wires. Ensure that the connector for the unit injector solenoid is properly connected. Perform a pull test on each of the wires.

3. Look for signs of fuel leakage. Investigate the source of the leaking fuel. Remedy the cause of the fuel leak.

4. Check the valve lash setting for the cylinder of the suspect unit injector. Refer to Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust”.

5. Ensure that the bolts that hold the unit injector are tightened to the proper torque. In order to check the torque, loosen the bolts that hold the unit injector. Tighten the bolts to the proper torque. Refer to either the Disassembly and Assembly Manual , “Electronic Unit Injector - Install”.

6. Remove the suspect unit injector and check the unit injector for signs of exposure to coolant. Exposure to coolant will cause rust to form on the injector. If the unit injector shows signs of exposure to coolant, remove the injector sleeve and inspect the injector sleeve. Replace the injector sleeve if the injector sleeve is damaged. Refer to Disassembly and Assembly Manual, “Electronic Unit Injector Sleeve - Install”. Check the unit injector for an excessive brown discoloration that extends beyond the injector tip. If excessive discoloration is found, check the quality of the fuel. Refer to Testing and Adjusting, “Fuel Quality - Test”. Replace the seals on the injector and reinstall the injector. Refer to Disassembly and Assembly Manual, “Electronic Unit Injector - Install”. Inspect the injector for deposits of soot that are above the surface of the seat of the injector. Deposits of soot indicate combustion gas leakage. The source of the leak should be found, and the source of the leak should be remedied. The injector will not need to be replaced if combustion gas leakage was the problem.

7. If the problem is not resolved, replace the suspect injector with a new injector. In order to verify that the new injector is working properly, perform the Cylinder Cutout Test. Use the Caterpillar Electronic Technician (ET).

i03985671

Finding Top Center Position for No. 1 Piston

SMCS Code: 1105-531

Table 3

Needed Tools		
9S-9082	Engine Turning Tool	1

The No. 1 piston at Top Center (TC) on the compression stroke is the starting point of all timing procedures.

Note: Some engines have two threaded holes in the flywheel. These holes are in alignment with the holes with plugs in the left and right front of the flywheel housing. The two holes in the flywheel are at a different distance from the center of the flywheel. Therefore, the timing bolt cannot be put in the wrong hole.

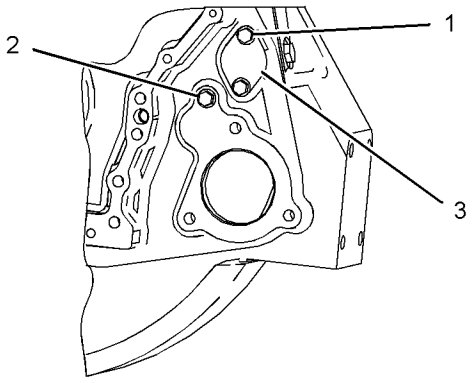


Illustration 20 g01123281

Locating Top Center on the left side of engine

(1) Timing bolt
(2) Timing bolt location
(3) Cover

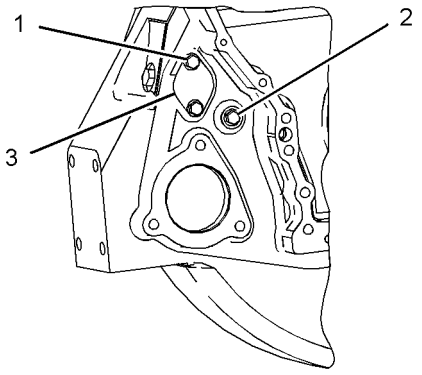


Illustration 21 g01123294

Locating Top Center on the right side of engine

(1) Timing bolt
(2) Timing bolt location
(3) Cover

1. Timing bolt (1) is a cover bolt. The timing bolt can be installed in either the left side of the engine at location (2) or in the right side of the engine at timing bolt location (2). Remove both bolts (1) and cover (3) from the flywheel housing. Remove the plug from the timing hole in the flywheel housing.

2. Put timing bolt (1) (long bolt that holds the cover on the flywheel housing) through the timing hole in the flywheel housing. The 9S-9082 Engine Turning Tool and a 1/2 inch drive ratchet wrench are used in order to turn the engine flywheel in the direction of normal engine rotation. Normal engine rotation is counterclockwise. Normal engine rotation is viewed from the flywheel end of the engine. Turn the engine flywheel until the timing bolt engages with the threaded hole in the flywheel.

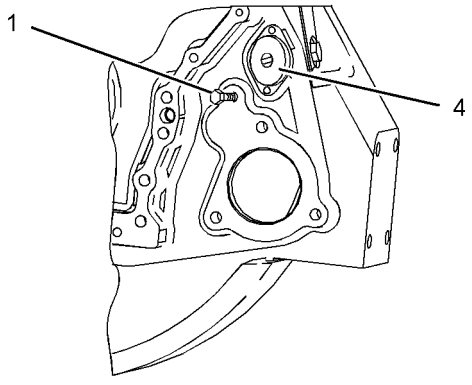


Illustration 22 g01123312

Using 9S-9082 Engine Turning Tool

(1) Timing bolt
(4) 9S-9082 Engine Turning Tool

Note: If the flywheel is turned beyond the point of engagement, the flywheel must be turned in the opposite direction of normal engine rotation approximately 45 degrees. Then turn the flywheel in the direction of normal rotation until the timing bolt engages with the threaded hole. The procedure will eliminate the backlash that will occur when the No. 1 piston is put on the top center.

3. Remove the front valve mechanism cover from the engine.

4. The inlet and exhaust valves for the No. 1 cylinder are fully closed if the No. 1 piston is on the compression stroke and the rocker arms can be moved by hand. The No. 1 piston is on the exhaust stroke, if the rocker arms cannot be moved and the valves are slightly open .

Note: After the actual stroke position is identified, and the other stroke position is needed, remove the timing bolt from the flywheel. The flywheel is turned 360 degrees in a counterclockwise direction. The timing bolt is reinstalled.

i03142863

Fuel Quality - Test

SMCS Code: 1280-081

This test checks for problems regarding fuel quality. Refer to Diesel Fuels and Your Engine, SEBD0717 for additional details.

Use the following procedure to test for problems regarding fuel quality:

1. Determine if water and/or contaminants are present in the fuel. Check the water separator (if equipped). If a water separator is not present, proceed to Step 2. Drain the water separator, if necessary. A full fuel tank minimizes the potential for overnight condensation.

Note: A water separator can appear to be full of fuel when the water separator is actually full of water.

2. Determine if contaminants are present in the fuel. Remove a sample of fuel from the bottom of the fuel tank. Visually inspect the fuel sample for contaminants. The color of the fuel is not necessarily an indication of fuel quality. However, fuel that is black, brown, and/or similar to sludge can be an indication of the growth of bacteria or oil contamination. In cold temperatures, cloudy fuel indicates that the fuel may not be suitable for operating conditions. The following methods can be used to prevent wax from clogging the fuel filter:

- Fuel heaters

- Blending fuel with additives
- Utilizing fuel with a low cloud point such as kerosene

Refer to Operation and Maintenance Manual, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” “Fuel Recommendations” for more information.

3. Check fuel API with a 9U-7840 Fluid and Fuel Calibration Gp for low power complaints. The acceptable range of the fuel API is 30 to 45 when the API is measured at 15 °C (60 °F), but there is a significant difference in energy within this range. Refer to Tool Operating Manual, NEHS0607 for API correction factors when a low power problem is present and API is high.

Note: A correction factor that is greater than “1” may be the cause of low power and/or poor fuel consumption.

4. If fuel quality is still suspected as a possible cause to problems regarding engine performance, disconnect the fuel inlet line, and temporarily operate the engine from a separate source of fuel that is known to be good. This will determine if the problem is caused by fuel quality. If fuel quality is determined to be the problem, drain the fuel system and replace the fuel filters. Engine performance can be affected by the following characteristics:

- Cetane number of the fuel
- Air in the fuel
- Other fuel characteristics

i02285479

Fuel System - Prime

SMCS Code: 1258-548

The Secondary Fuel Filter Has Been Replaced

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Note: Refer to Operation and Maintenance Manual, “Fuel System Secondary Filter - Replace” for information on replacing the filter.

1. Turn the keyswitch to the “OFF” position.

2. Open the air purge screw for the fuel filter by three full turns. Do not remove the air purge screw.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

3. Start the engine. The engine should start and the engine should run smoothly. If the engine does not start after 30 seconds, allow the starter motor to cool for two minutes before attempting to start the engine again.

Note: You may use the hand priming pump (if equipped) for the fuel filter instead of starting the engine and running the engine.

4. While the engine is running, observe the air purge screw. When a small drop of fuel appears at the threads of the air purge screw, close and tighten the air purge screw.

Note: There may be a noticeable change in the sound of the running engine when the air purge screw is tightened. The change in the sound of the engine is normal.

Note: Failure to tighten all fittings could result in serious fuel leaks.

5. Clean any residual fuel from the engine components.

The Engine Has Been Run Out of Fuel

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

1. Turn the keyswitch to the “OFF” position.

2. Fill the fuel tank(s) with clean diesel fuel.

3. Bleed the air from the system by opening the fuel pressure regulator valve by two turns and another half turn.

Note: Do not remove the regulating valve completely. Open the valve enough to allow the air that is trapped in the cylinder head to be purged from the fuel system.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starter motor to cool for two minutes.

Note: You may use the hand priming pump (if equipped) for the fuel filter instead of cranking the engine.

5. Crank the engine for 30 seconds. Allow the starter motor to cool for two minutes.

6. Close and tighten the fuel pressure regulating valve.

7. Crank the engine for 30 seconds. Allow the starter motor to cool for two minutes.

8. Repeat Step 7 until the engine starts and the engine runs.

Note: Failure to tighten all fittings could result in serious fuel leaks.

9. Clean any residual fuel from the engine components.

The Engine Has Been Rebuilt

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

1. Turn the keyswitch to the “OFF” position.

2. Fill the fuel tank(s) with clean diesel fuel.

3. Open the air purge screw for the fuel filter by three full turns. Do not remove the air purge screw.

4. Bleed the air from the system by opening the fuel pressure regulator valve by two turns and another half turn.

Note: Do not remove the regulating valve completely. Open the valve enough to allow the air that is trapped in the cylinder head to be purged from the fuel system.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

5. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starter motor to cool for two minutes.

Note: You may use the hand priming pump (if equipped) for the fuel filter instead of cranking the engine.

6. Crank the engine for 30 seconds. Allow the starter motor to cool for two minutes.

7. Close and tighten the air purge screw.

8. Crank the engine for 30 seconds. Allow the starter motor to cool for two minutes.

9. Close and tighten the fuel pressure regulating valve.

Note: Failure to tighten all fittings could result in serious fuel leaks.

10. Crank the engine for 30 seconds. Allow the starter motor to cool for two minutes.

11. Repeat Step 10 until the engine starts and runs.

12. Clean any residual fuel from the engine components.

i06859494

Fuel System Pressure - Test

SMCS Code: 1250-081; 1256-081

Low Fuel Pressure

Low fuel pressure can cause low power. Low fuel pressure can also cause cavitation of the fuel which can damage the fuel injectors. The following conditions can cause low fuel pressure:

- Plugged fuel filters
- Debris in the check valves for the fuel priming pump
- Debris in the fuel pressure regulating valve
- Partially open check valve
- Sticking or worn fuel pressure regulating valve in the fuel transfer pump
- Severe wear on return fuel pressure regulating valve in the fuel filter base
- Worn gears in the fuel transfer pump
- Pinched fuel lines or undersized fuel lines
- Old fuel lines that have a reduced interior diameter that was caused by swelling
- Fuel lines with deteriorating interior surfaces
- Pinched fuel line fittings or undersized fuel line fittings
- Debris in the fuel tank, fuel lines, or fuel system components that create restrictions

High Fuel Pressure

Excessive fuel pressure can cause fuel filter gaskets to rupture. The following conditions can cause high fuel pressure:

- Plugged orifices in the fuel pressure regulating valve
- Stuck fuel pressure regulating valve in the fuel transfer pump
- Pinched fuel return line

Fuel Pressure Readings

Different configurations are used for the low-pressure side of the fuel system. The different configurations cause different fuel pressure readings.

Lower Fuel Pressure Configuration

The typical fuel pressure of the engine at operating temperature can vary. With new fuel filters, the fuel pressure at the secondary fuel filter base must be within the following ranges. At cranking speed (100-135 rpm), the fuel pressure can be 75 kPa (11 psi). At low idle (700 to 900 rpm), the fuel pressure can be 450 ± 50 kPa (65 ± 7 psi). At high idle (1800 to 2000 rpm), the fuel pressure can be 500 ± 50 kPa (73 ± 7 psi).

The performance of the unit injector deteriorates when the fuel pressure drops below 390 kPa (57 psi). Low-power complaints and erratic operation can occur in this situation. Check for a plugged fuel filter or air in the fuel lines as possible causes for these complaints before replacing fuel system components.

Higher Fuel Pressure Configuration

The typical fuel pressure of the engine at operating temperature can vary. With new fuel filters, the fuel pressure at the secondary fuel filter base must be within the following ranges. At cranking speed (100-135 rpm), the fuel pressure can be 75 kPa (11 psi). At low idle (700 to 900 rpm), the fuel pressure can be 650 ± 50 kPa (94 ± 7 psi). At high idle (1800 to 2000 rpm), the fuel pressure can be 705 ± 50 kPa (102 ± 7 psi).

The performance of the unit injector deteriorates when the fuel pressure drops below 390 kPa (57 psi). Low-power complaints and erratic operation can occur in this situation. Check for a plugged fuel filter or air in the fuel lines as possible causes for these complaints before replacing fuel system components.

There are two available pressure regulator valves and there are two sets of pressures:

1. Equipped with 327-0376 Check Valve Gp. At cranking speed (100–135 rpm), The fuel pressure can be 500 kPa (72 psi). At low idle (700 to 900 rpm), the fuel pressure can be 500 to 700 kPa (72 to 101 psi). At high idle (1800 to 2000 rpm), the fuel pressure can be 600 to 900 kPa (87 to 131 psi).

2. Equipped with 228-7381 Check Valve Gp. At cranking speed (100–135 rpm), The fuel pressure can be 350 kPa (51 psi). At low idle (700 to 900 rpm), the fuel pressure can be 450 to 650 kPa (65 to 94 psi). At high idle (1800 to 2000 rpm), the fuel pressure can be 600 to 800 kPa (87 to 116 psi).

Checking Fuel Pressure

Table 4

Required Tools		
Part Number	**Part Name**	**Quantity**
1U-5470 or 198-4240	Engine Pressure Group or Digital Pressure Indicator	1

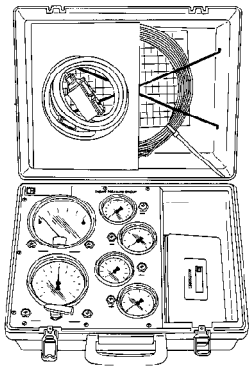


Illustration 23 g00294866

1U-5470 Engine Pressure Group

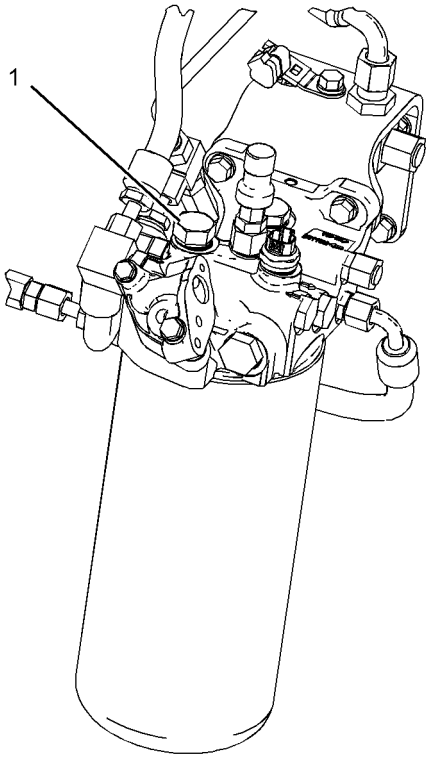


Illustration 24 g01124671

Location of fuel pressure tap

(1) Plug

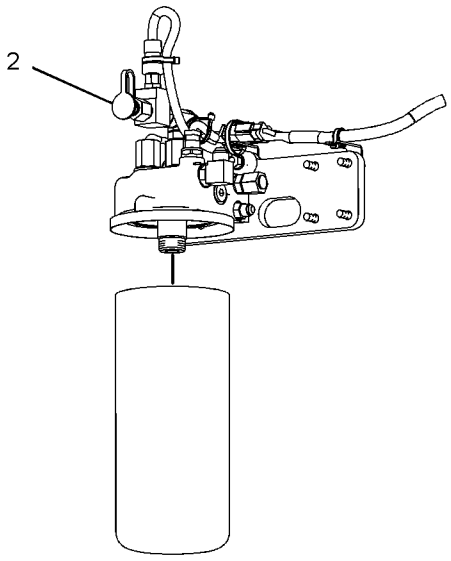


Illustration 25 g02124374

(2) Pressure tap

To check the fuel transfer pump pressure, remove the plug (1) from the fuel filter base. Install the pressure gauge and appropriate fittings from the 1U-5470 Engine Pressure Group and start the engine.

Check the fuel pressure of the engine with the 1U-5470 Engine Pressure Group. The engine pressure group includes Special Instruction, SEHS8907, “Using the 1U-5470 Engine Pressure Group”. This instruction provides information about the usage of the group.

i03842571

Rear Gear Group - Time

SMCS Code: 1206-531

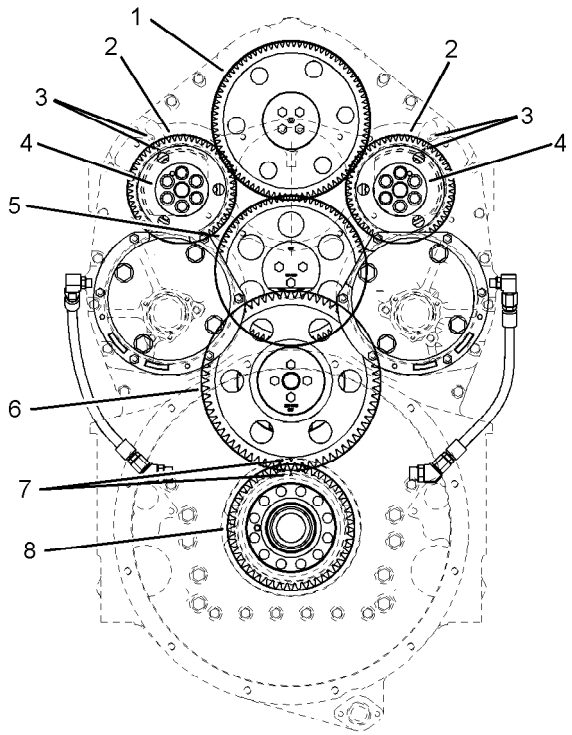


Illustration 26 g01073928

Rear gear group

(1) Cluster idler gear
(2) Camshaft gear
(3) Timing alignment marks
(4) Camshaft bolts
(5) Idler gear assembly
(6) Cluster idler gear
(7) Timing alignment marks
(8) Crankshaft gear

Position the number one piston in the top center position (TC). Align the “V” mark on the cam gear (2) with the mark in the flywheel housing.

Note: If one or more of the gears need to be removed for repair, refer to Disassembly and Assembly, “Gear Group (Rear) - Remove” in order to properly remove the gears. Refer to Disassembly and Assembly, “Gear Group (Rear) - Install” in order to properly install the gears.

Inspect the gears for wear or for damage. If the gears are worn or damaged, use new parts for replacement.

Air Inlet and Exhaust System

i02814214

Air Inlet and Exhaust System - Inspect

SMCS Code: 1050-040

Air Inlet Restriction

There will be a reduction in the performance of the engine if there is an excess restriction in the air inlet system or the exhaust system.

Table 5

Required Tools		
Part Number	**Part Name**	**Quantity**
1U-5470 or 198-4240	Engine Pressure Group or Digital Pressure Indicator	1

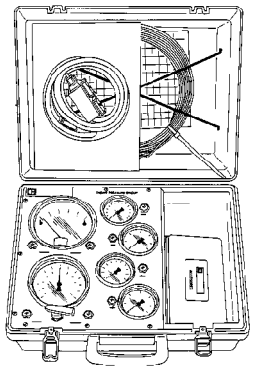


Illustration 27 g00293196

1U-5470 Engine Pressure Group

Refer to Special Instruction, SEHS8907, “Using the 1U-5470 Engine Pressure Group” for the instructions that are needed to use the 1U-5470 Engine Pressure Group. Refer to Operation Manual, NEHS0818, “Using the 198-4240 Digital Pressure Indicator” for the instructions that are needed to use the 198-4240 Digital Pressure Indicator.

1. Check the Air Filter Change Indicator Group on the air inlet for a reading of the restriction.

2. Inspect the engine air cleaner inlet and ducting in order to ensure that the passageway is not blocked or collapsed.

3. Check for dirt tracks on the clean side of the engine air cleaner element, the air inlet hose, and the clamps. If dirt tracks are observed, contaminants are flowing past the engine air cleaner element, the seal for the air cleaner, and/or the air inlet hose.

4. Inspect the engine air cleaner element. Replace a dirty engine air cleaner element with a clean engine air cleaner element.

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

⚠ WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

5. Use the differential pressure gauge of the 1U-5470 Engine Pressure Group or the 198-4240 Digital Pressure Indicator.

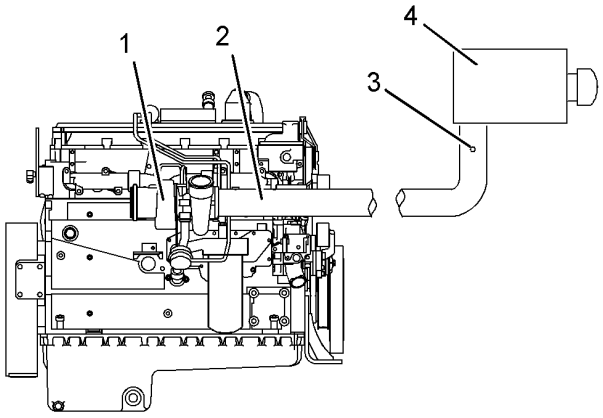


Illustration 28 g01176673

Air inlet system (typical example)

(1) Turbocharger
(2) Air Inlet Piping
(3) Test location
(4) Air cleaner

a. Connect the vacuum port of the differential pressure gauge to the test location (3). Test

location (3) can be located anywhere along air inlet piping (2) after engine air cleaner (4) but before turbocharger (1).

The air flow through a new engine air cleaner element must not have a system restriction of more than the following amount:

Maximum restriction . . 3.7 kPa ((15 inch of H_2O))

The air flow through a used engine air cleaner may have an additional restriction. The air flow through a plugged engine air cleaner will be restricted to some magnitude. In either case, the restriction must not be more than the following amount:

Maximum restriction . . 6.2 kPa ((25 inch of H_2O))

Exhaust Restriction

⚠ WARNING

The muffler, catalytic converter/muffler, and diesel particulate filter will become extremely hot during engine operation. A hot muffler, catalytic converter/muffler and diesel particulate filter can cause serious burns. Allow adequate cooling time before working on or near the muffler, catalytic converter/muffler and diesel particulate filter.

Excessive idling can cause the muffler, the catalytic converter/muffler, or the diesel particulate filter to plug. A plugged muffler, a plugged catalytic converter/muffler, or a plugged diesel particulate filter will lead to an increase in exhaust back pressure. Operating the engine in extremely cold conditions may cause the muffler, the catalytic converter/muffler, or the diesel particulate filter to plug. One indication of a plugged muffler, catalytic converter, or diesel particulate filter is poor engine response.

Exhaust Back Pressure for Mufflers and Catalytic Converters

Back pressure is the difference in the pressure between the exhaust and the atmospheric air.

Table 6

Tools Needed		
Part Number	**Part Name**	**Quantity**
1U-5470 or 198-4240	Engine Pressure Group or Digital Pressure Indicator	1

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

⚠ WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

If the exhaust is not equipped with a back pressure tap, the following procedure may be use in order to install a pressure tap. Refer to Truck Engine News, SEBD6729, “Measuring Exhaust Back Pressure” for measuring the back pressure at a proper test location.

Use the differential pressure gauge of the 1U-5470 Engine Pressure Group or the 198-4240 Pressure Indicator Tool Gp in order to measure back pressure from the exhaust. Use the following procedure in order to measure back pressure from the exhaust:

High Idle Plugging Test

Note: Do not try to burn out a plugged muffler. The muffler can become severely overheated. This will cause other system components to fail.

1. Inspect the system components for any noticeable damage that would cause a restriction.
2. Connect the pressure port of the differential pressure gauge to test location. Refer to Truck Engine News, SEBD6729, “Measuring Exhaust Back Pressure” for measuring the back pressure at a proper test location.
3. Leave the vacuum port of the differential pressure gauge open to the atmosphere.
4. Start the engine. Run the engine in the no-load condition at high idle until the engine reaches normal operating temperature.
5. Record the value.
6. Multiply the value from Step 5 by 1.8.
7. Compare the result from Step 6 to the value that follows.

Back pressure from the exhaust must not be more than the following amount:

Maximum back pressure for engines with a standard muffler . . . . 10.0 kPa ((40 inch of H_2O))

Maximum back pressure for engines with a catalytic converter/muffler . . . . . 12.4 kPa ((50 inch of H_2O))

If the maximum back pressure is within the allowable limits, refer to Troubleshooting, “Low/Power/Poor or No Response to Throttle”.

If the back pressure exceeds 12.4 kPa (50 inch of H_2O), replace the muffler.

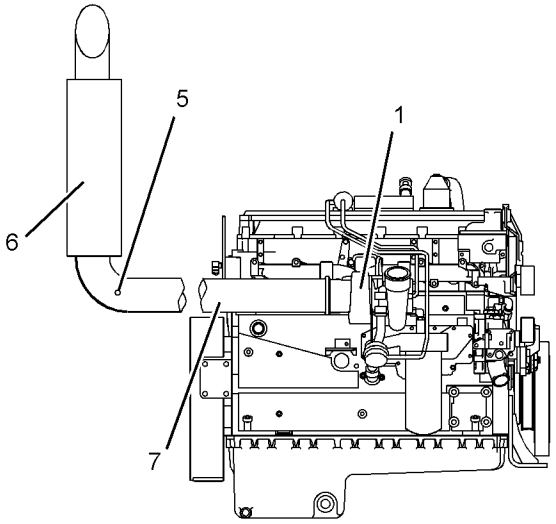


Illustration 29 g01403351

Exhaust system (typical example)

(1) Turbocharger
(5) Test location
(6) Muffler
(7) Exhaust piping

Full Load Test

Note: Do not try to burn out a plugged muffler. The muffler can become severely overheated. This will cause other system components to fail.

1. Check the arrangement number of the engine and verify that all components are correct.

Note: Run the vehicle on a dyno up to 30 minutes in order to reach operating temperature. Monitor all of the engine components for any signs of overheating.

2. Measure the back pressure at a full load and full speed.

3. Record the results.

4. The back pressure for the catalytic converter/ muffler is at 12.4 kPa (50 inch of H_2O).

5. Replace any components that have been proven damaged.

Exhaust Back Pressure for Diesel Particulate Filters (If Equipped)

High Idle Plugging Test

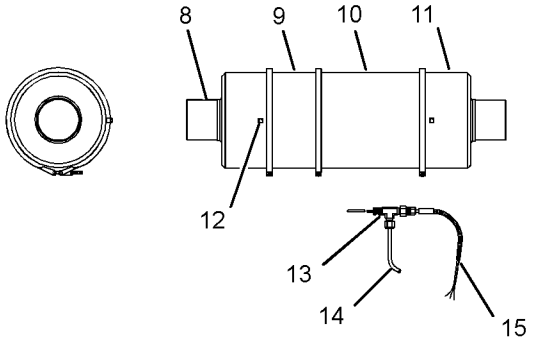


Illustration 30 g01403354

diesel particulate filter (typical example)

(8) Inlet section
(9) Catalyst section
(10) Filter section
(11) Outlet section
(12) Test location
(13) Tee fitting
(14) Copper tubing
(15) Thermocouple

Note: Limit the idle time of the engine to 20 minutes. If large quantities of soot are accumulated in the diesel particulate filter, running the engine can permanently damage the filter and other components.

Note: Do not test the exhaust back pressure if the red warning light has been activated. Clean the diesel particulate filter immediately.

Note: Refer to Special Instruction, REHS1807, “Installation Guide for Particulate Trap Exhaust Filters” for properly cleaning the diesel particulate filter.

1. Inspect the system components for any noticeable damage that would cause a restriction.

2. Connect the pressure port of the differential pressure gauge to test location. Refer to Truck Engine News, SEBD6729, “Measuring Exhaust Back Pressure” for measuring the back pressure at a proper test location.

3. Leave the vacuum port of the differential pressure gauge open to the atmosphere.

4. Start the engine. Run the engine in the no-load condition at high idle until the engine reaches normal operating temperature.

5. Record the value.

6. Multiply the value from Step 5 by 1.8.

7. Compare the test result to the value that follows.

Clean the diesel particulate filter if the back pressure exceeds the following value.

Maximum back pressure for engines with a diesel particulate filter . . . . . .25 kPa ((100 inch of H_2O))

Full Load Test

Limit the idle time of the engine to 20 minutes. If large quantities of soot are accumulated in the diesel particulate filter, running the engine can permanently damage the filter and other components.

Note: Do not test the exhaust back pressure if the red warning light has been activated. Clean the diesel particulate filter immediately.

Note: Refer to Special Instruction, REHS1807, “Installation Guide for Particulate Trap Exhaust Filters” for properly cleaning the diesel particulate filter.

1. Check the arrangement number of the engine and verify that all components are correct.

Note: Run the vehicle on a dyno up to 30 minutes in order to reach operating temperature. Monitor all of the engine components for any signs of overheating.

2. Measure the back pressure at full load and full speed.

3. Record the results.

4. The back pressure for the diesel particulate filter is at 24.9 kPa (100 inch of H_2O).

5. Replace any components that cannot be cleaned. Replace any components that are proven faulty.

Data Sheet for Testing Catalytic Converters or Diesel Particulate Filter

S/N_____

Miles _____

Date _____

Type of pressure gauge_____

Mark the pressure test location with an “X” on the Illustration.

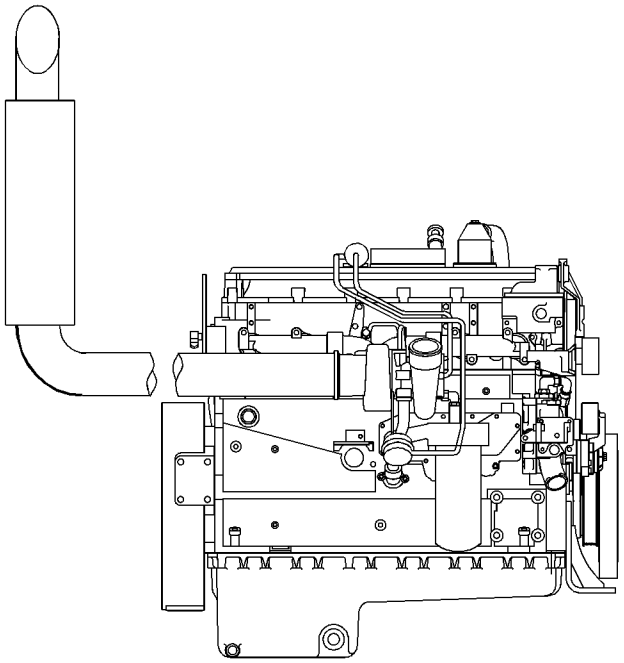


Illustration 31 g01183535

Engine speed _____ rpm

Engine load _____ percent

Back pressure _____ inches of water

i02500648

Turbocharger - Inspect

SMCS Code: 1052-040

WARNING

Disconnect batteries before performance of any service work.

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

⚠ WARNING

Personal injury can result from rotating and moving parts.

Stay clear of all rotating and moving parts.

Never attempt adjustments while the machine is moving or the engine is running unless otherwise specified.

The machine must be parked on a level surface and the engine stopped.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before you begin inspection of the turbocharger, be sure that the inlet air restriction is within the specifications for your engine. Be sure that the exhaust system restriction is within the specifications for your engine. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System - Inspect”.

The condition of the turbocharger will have definite effects on engine performance. Use the following inspections and procedures to determine the condition of the turbocharger.

- Inspection of the Compressor and the Compressor Housing
- Inspection of the Turbine Wheel and the Turbine Housing

Inspection of the Compressor and the Compressor Housing

Remove air piping from the compressor inlet.

1. Inspect the compressor wheel for damage from a foreign object. If there is damage, determine the source of the foreign object. As required, clean the inlet system and repair the inlet system. Replace the turbocharger. If there is no damage, go to Step 3.
2. Clean the compressor wheel and clean the compressor housing if you find buildup of foreign material. If there is no buildup of foreign material, go to Step 3.
3. Turn the rotating assembly by hand. While you turn the assembly, push the assembly sideways . The assembly should turn freely. The compressor wheel should not rub the compressor housing. Replace the turbocharger if the compressor wheel rubs the compressor wheel housing. If there is no rubbing or scraping, go to Step 4.
4. Inspect the compressor and the compressor wheel housing for oil leakage. An oil leak from the compressor may deposit oil in the aftercooler. Drain and clean the aftercooler if you find oil in the aftercooler.
   a. Check the oil level in the crankcase. If the oil level is too high, adjust the oil level.
   b. Inspect the air cleaner element for restriction. If restriction is found, correct the problem.
   c. Inspect the engine crankcase breather. Clean the engine crankcase breather or replace the engine crankcase breather if the engine crankcase breather is plugged.
   d. Remove the oil drain line on the turbocharger. Inspect the drain opening. Inspect the oil drain line. Inspect the area between the bearings of the rotating assembly shaft. Look for oil sludge. Inspect the oil drain hole for oil sludge. Inspect the oil drain line for oil sludge in the drain line. If necessary, clean the rotating assembly shaft. If necessary, clean the oil drain hole. If necessary, clean the oil drain line.
   e. If Steps 4a through 4d did not reveal the source of the oil leakage, the turbocharger has internal damage. Replace the turbocharger.

Inspection of the Turbine Wheel and the Turbine Housing

Remove the air piping from the turbine outlet casing.

1. Inspect the turbine for damage by a foreign object. If there is damage, determine the source of the foreign object. Replace the turbocharger. If there is no damage, go to Step 2.

2. Inspect the turbine wheel for buildup of carbon and other foreign material. Inspect the turbine housing for buildup of carbon and foreign material. Clean the turbine wheel and clean the turbine housing if you find buildup of carbon or foreign material. If there is no buildup of carbon or foreign material, go to Step 3.

3. Turn the rotating assembly by hand. While you turn the assembly, push the assembly sideways. The assembly should turn freely. The turbine wheel should not rub the turbine wheel housing. Replace the turbocharger if the turbine wheel rubs the turbine wheel housing. If there is no rubbing or scraping, go to Step 4.

4. Inspect the turbine and the turbine wheel housing for oil leakage. Inspect the turbine and the turbine wheel housing for oil coking. Some oil coking may be cleaned. Heavy oil coking may require replacement of the turbocharger. If the oil is coming from the turbocharger center housing go to Step 4a.

a. Remove the oil drain line on the turbocharger. Inspect the drain opening. Inspect the area between the bearings of the rotating assembly shaft. Look for oil sludge. Inspect the oil drain hole for oil sludge. Inspect the oil drain line for oil sludge. If necessary, clean the rotating assembly shaft. If necessary, clean the drain opening. If necessary, clean the drain line.

b. If crankcase pressure is high, or if the oil drain is restricted, pressure in the center housing may be greater than the pressure of the turbine housing. Oil flow may be forced in the wrong direction and the oil may not drain. Check the crankcase pressure and correct any problems.

c. If the oil drain line is damaged, replace the oil drain line.

d. Check the routing of the oil drain line. Eliminate any sharp restrictive bends. Make sure that the oil drain line is not too close to the engine exhaust manifold.

e. If Steps 4a through 4d did not reveal the source of the oil leakage, the turbocharger has internal damage. Replace the turbocharger.

i02227890

Inlet Manifold Pressure - Test

SMCS Code: 1058-081

Table 7

Required Tools		
Part Number	**Part Name**	**Quantity**
1U-5470 or 198-4240	Engine Pressure Group or Digital Pressure Indicator	1

The efficiency of an engine can be checked by making a comparison of the pressure in the inlet manifold with the information given in the Technical Marketing Information (TMI). This test is used when there is a decrease of horsepower from the engine, yet there is no real sign of a problem with the engine.

The correct pressure for the inlet manifold is listed in the TMI. Development of this information is performed under the following conditions:

- 99 kPa (29.7 in Hg) dry barometric pressure
- 29 °C (85 °F) outside air temperature
- 35 API rated fuel

On a turbocharged, aftercooled engine, a change in the fuel rating will change the horsepower. A change in the fuel rating will change the inlet manifold pressure. If the fuel is rated above 35 API, the inlet manifold pressure can be less than the pressure given in the TMI. If the fuel is rated below 35 API, the inlet manifold pressure can be more than the pressure listed in the TMI.

Note: Ensure that the air inlet and the exhaust are not restricted when you check the inlet manifold pressure. Refer to Testing and Adjusting, “Air Inlet and Exhaust System - Inspect” for more information.

Use the following procedure in order to use an electronic service tool to measure the inlet manifold pressure:

1. Connect the Caterpillar Electronic Technician (ET).

2. Operate the engine under the suspect conditions.

3. Record the value.

4. Compare the value that was recorded in Step 3 to the pressure that is given in the TMI.

Use the following procedure in order to use the 1U-5470 Engine Pressure Group to measure the inlet manifold pressure:

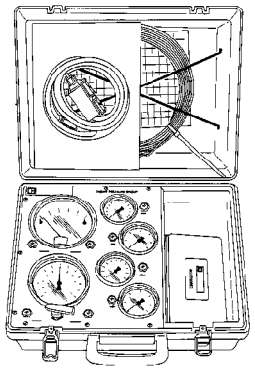


Illustration 32 g00293196

1U-5470 Engine Pressure Group

1. Remove the pipe plug from the inlet manifold. It is not necessary to remove the air temperature sensor from the inlet manifold.

2. Connect the 1U-5470 Engine Pressure Group to the inlet manifold at the pressure test location.

Refer to Special Instruction, SEHS8907, “Using the 1U-5470 Engine Pressure Group” for more information on using the tool.

3. Operate the engine under the suspect conditions.

4. Record the value.

5. Compare the value that was recorded in Step 4 to the pressure that is given in the TMI.

i04525210

Exhaust Temperature - Test

SMCS Code: 1088-081

Table 8

Required Tools		
Part Number	**Part Name**	**Qty**
349-4200	Thermometer	1

When the engine runs at low idle, the temperature of an exhaust manifold port can indicate the condition of a fuel injection nozzle.

A low temperature indicates that no fuel is flowing to the cylinder. An inoperative fuel injection nozzle or a problem with the fuel injection pump could cause this low temperature.

A high temperature can indicate that too much fuel is flowing to the cylinder. A malfunctioning fuel injection nozzle could cause this high temperature.

Use the 349-4200 Thermometer to check exhaust temperature. The manual that comes with the 349-4200 Thermometer contains the complete operating and maintenance instructions.

i03355915

Aftercooler - Test

SMCS Code: 1063-081

Table 9

Tools Needed		
Part Number	**Part Name**	**Quantity**
1U-5470	Engine Pressure Group	1
FT-1984	Aftercooler Testing Group	1
FT-1438	Aftercooler Gp (Dynamometer Test)	1

Visual Inspection

Inspect the following parts at each oil change:

- Air lines
- Hoses
- Gasket joints

⚠ WARNING

Pressurized air can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes.

Ensure that the constant torque hose clamps are tightened to the correct torque. Refer to Specifications, SENR3130, “Torque Specifications” in order to locate the proper torque. Check the welded joints for cracks. Ensure that the brackets are tightened in the correct positions. Ensure that the brackets are in good condition. Use compressed air to clean any debris or any dust from the aftercooler core assembly. Inspect the fins in the aftercooler core for the following conditions:

- Damage
- Debris
- Corrosion

Use a stainless steel brush to remove any corrosion.

Note: When parts of the air-to-air aftercooler system are repaired or replaced, a leak test is recommended.

Inlet Manifold Pressure

Normal inlet manifold pressure with high exhaust temperature can be caused by blockage of the fins of the aftercooler core. Clean the fins of the aftercooler core. Refer to “Visual Inspection” under this topic for the cleaning procedure.

Low inlet manifold pressure and high exhaust manifold temperature can be caused by any of the following conditions:

Plugged air cleaner – Clean the air cleaner or replace the air cleaner, as required. Refer to the Operation and Maintenance Manual, “Engine Air Cleaner Element - Clean/Replace”.

Blockage in the air lines – Blockage in the air lines between the air cleaner and the turbocharger must be removed.

Aftercooler core leakage – Aftercooler core leakage should be pressure tested. Refer to “Aftercooler Core Leakage” under this topic for the testing procedure.

Inlet manifold leak – An inlet manifold leak can be caused by the following conditions: loose fittings and plugs, missing fittings and plugs, damaged fittings and plugs and leaking inlet manifold gasket.

Aftercooler Core Leakage

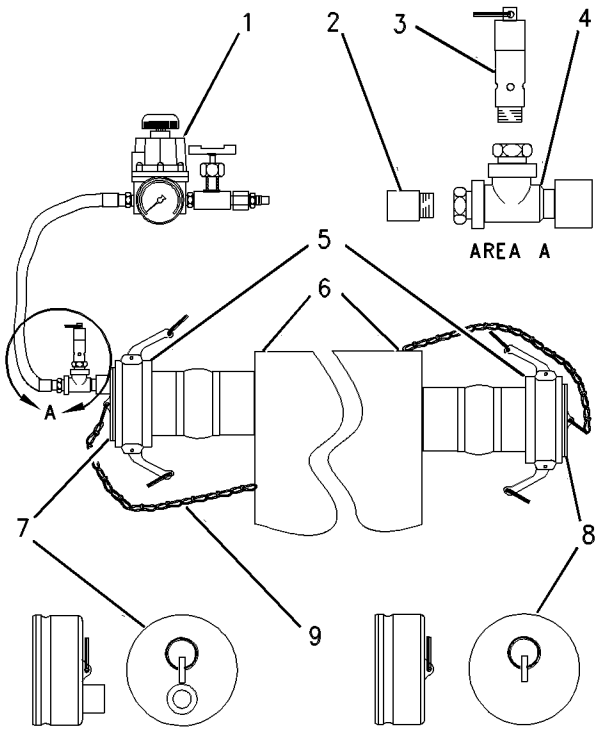


Illustration 33 g01134323

FT-1984 Aftercooler Testing Group

(1) Regulator and valve assembly
(2) Nipple
(3) Relief valve
(4) Tee
(5) Coupler
(6) Aftercooler
(7) Dust plug
(8) Dust plug
(9) Chain

A low power problem in the engine can be the result of aftercooler leakage. Aftercooler system leakage can result in the following problems:

- Low power
- Low boost pressure
- Black smoke
- High exhaust temperature

NOTICE
Remove all air leaks from the system to prevent engine damage. In some operating conditions, the engine can pull a manifold vacuum for short periods of time. A leak in the aftercooler or air lines can let dirt and other foreign material into the engine and cause rapid wear and/or damage to engine parts.

A large leak of the aftercooler core can often be found by making a visual inspection. To check for smaller leaks, use the following procedure:

1. Disconnect the air pipes from the inlet and outlet side of the aftercooler core.

⚠ WARNING

Dust plug chains must be installed to the aftercooler core or to the radiator brackets to prevent possible injury while you are testing. Do not stand in front of the dust plugs while you are testing.

2. Install couplers (5) on each side of the aftercooler core. Also, install dust plugs (7) and (8).

These items are included with the FT-1984 Aftercooler Testing Group.

Note: Installation of additional hose clamps on the hump hoses is recommended in order to prevent the hoses from bulging while the aftercooler core is being pressurized.

NOTICE
Do not use more than 240 kPa (35 psi) of air pressure or damage to the aftercooler core can be the result.

3. Install the regulator and valve assembly (1) on the outlet side of the aftercooler core assembly. Also, attach the air supply.

4. Open the air valve and pressurize the aftercooler to 205 kPa (30 psi). Shut off the air supply.

5. Inspect all connection points for air leakage.

6. The pressure in the aftercooler system should not drop more than 35 kPa (5 psi) in 15 seconds.

7. If the pressure drop is more than the specified amount, use a solution of soap and water to check all areas for leakage. Look for air bubbles that will identify possible leaks. Replace the aftercooler core, or repair the aftercooler core, as needed.

⚠ WARNING

To help prevent personal injury when the tooling is removed, relieve all pressure in the system slowly by using an air regulator and a valve assembly.

8. After the testing, remove the FT-1984 Aftercooler Testing Group. Reconnect the air pipes on both sides of the aftercooler core assembly.

Air System Restriction

Pressure measurements should be taken at the inlet manifold and the turbocharger outlet.

Use the differential pressure gauge of the 1U-5470 Engine Pressure Group. Use the following procedure in order to measure the restriction of the aftercooler:

1. Connect the vacuum port of the differential pressure gauge to a port on the inlet manifold.

2. Connect the pressure port of the differential pressure gauge to a port on the turbocharger outlet.

3. Record the value.

The air lines and the cooler core must be inspected for internal restriction when both of the following conditions are met:

- Air flow is at a maximum level.
- Total air pressure drop of the charged system exceeds 13.5 kPa (4 in Hg) for engines with a 14.6 L (890 cu in) displacement.
- Total air pressure drop of the charged system exceeds 15.2 kPa (4.5 in Hg) for engines with a 15.8 L (964 cu in) displacement.

If a restriction is discovered, proceed with the following tasks, as required:

- Clean
- Repair
- Replacement

Turbocharger Failure

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

If a turbocharger failure occurs, remove the air-to-air aftercooler core. Internally flush the air-to-air aftercooler core with a solvent that removes oil and other foreign substances. Shake the air-to-air aftercooler core in order to eliminate any trapped debris. Wash the aftercooler with hot, soapy water. Thoroughly rinse the aftercooler with clean water and blow dry the aftercooler with compressed air. Blow dry the assembly in the reverse direction of normal air flow. To make sure that the whole system is clean, carefully inspect the system.

NOTICE
Do not use caustic cleaners to clean the air-to-air aftercooler core.

Caustic cleaners will attack the internal metals of the core and cause leakage.

Dynamometer Test

In hot ambient temperatures, dynamometer tests for models with an air-to-air aftercooler can add a greater heat load to the jacket water cooling system. Therefore, the jacket water cooling system's temperature must be monitored. The following measurements may also need a power correction factor:

- Inlet air temperature
- Fuel API rating
- Fuel temperature
- Barometric pressure

With dynamometer tests for engines, use the FT - 1438 Aftercooler Gp (Dynamometer Test). This tool provides a water cooled aftercooler in order to control the inlet air temperature to 43 °C (110 °F).

i04643912

Engine Crankcase Pressure (Blowby) - Test

SMCS Code: 1215; 1317

Table 10

Tools Needed		
Part Number	**Part Name**	**Quantity**
348 - 5430	Multi-Tool Gp	1
285 - 0900	Blowby Tool Group	1
NETG5049	Software License	1

Damaged pistons or rings can cause too much pressure in the crankcase. This condition will cause the engine to run rough. There will be more than a normal amount of blowby fumes rising from the crankcase breather. The breather can then become restricted in a short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.



Illustration 34 g02709261

348 - 5430 Multi-Tool Gp

The 348 - 5430 Multi-Tool Gp, or the 285 - 0900 Blowby Tool Group is used to check the amount of blowby. Refer to Tool Operating Manual, NEHS1087, “348 - 5430 Multi-Tool Gp” for the test procedure for checking the blowby.

i04698835

Compression - Test

SMCS Code: 1215

An engine that runs roughly can have a leak at the valves. An engine that runs roughly can also have valves that need an adjustment. Remove the head and inspect the valves and valve seats. This action is necessary to find those small defects that would not normally cause problems. Repairs of these problems are normally performed when you are reconditioning the engine.

This Caterpillar engine uses Keystone piston rings. Keystone piston rings are designed to expand during the compression stroke of the engine. At engine cranking speed, the Keystone piston rings do not fully expand. This results in unstable readings for cylinder compression. As a result Caterpillar does not recommend performing compression tests on engines that use Keystone piston rings.

i02774006

Engine Valve Lash - Inspect/ Adjust

SMCS Code: 1102-025

WARNING

To prevent possible injury, do not use the starter to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring valve clearance.

WARNING

This engine uses high voltage to control the fuel injectors.

Disconnect electronic fuel injector enable circuit connector to prevent personal injury.

Do not come in contact with the fuel injector terminals while the engine is running.

Note: Valve lash is measured between the rocker arm and the valve bridge. All measurements and adjustments must be made with the engine stopped and the valves fully closed.

Valve Lash Check

An adjustment is not necessary if the measurement of the valve lash is in the acceptable range. Check the valve lash while the engine is stopped. The range is specified in Table 11 .

Table 11

Quick Reference for Engine Valve Lash Setting		
	Inlet Valves	**Exhaust Valves**
Valve Lash Setting	0.38 ± 0.08 mm (0.015 ± 0.003 inch)	0.76 ± 0.08 mm (0.030 ± 0.003 inch)
TC Compression Stroke of No. 1 Piston	**1-2-3-7-8-10**	1-2-5-6-9-10

(continued)

(Table 11, contd)

Quick Reference for Engine Valve Lash Setting		
	Inlet Valves	**Exhaust Valves**
TC Compression Stroke of No. 11 Piston(1)	4-5-6-9-11-12	3-4-7-8-11-12
Firing Order	1-10-9-6-5-12-11-4-3-8-7-2(2)	

(1) 360° from TC compression stroke
(2) Refer to Illustration 35 in order to locate the No. 1 cylinder.

If the measurement is not within this range adjustment is necessary. Refer to “Valve Lash Adjustment”.

Valve Lash Adjustment

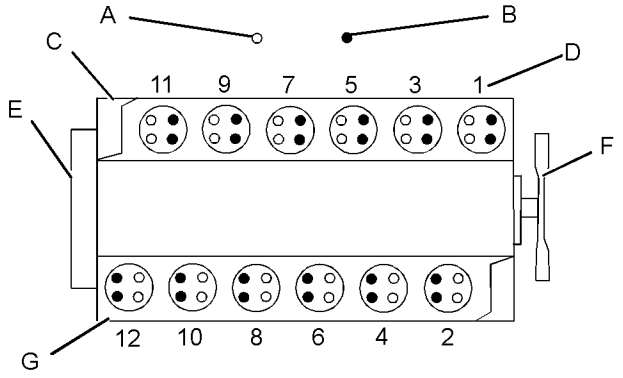


Illustration 35 g01386737

(A) Inlet valves
(B) Exhaust valves
(C) Left side of the engine
(D) Cylinder number
(E) Flywheel end of the engine
(F) Front of the engine
(G) Right side of the engine

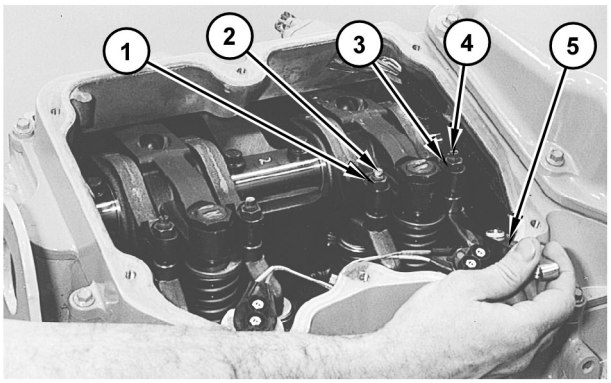


Illustration 36 g01386742

Typical example

(1) Valve adjustment locknut
(2) Exhaust adjustment screw
(3) Valve adjustment locknut
(4) Inlet adjustment screw
(5) Feeler gauge

Table 12

Valve Lash	
Valves	Thickness of Gauge
Inlet	0.38 mm (0.015 inch)
Exhaust	0.76 mm (0.030 inch)

Adjust the valve lash while the engine is stopped. Use the following procedure in order to adjust the valves:

1. Put the No. 1 piston at the top center position.

Note: See Testing and Adjusting, “Finding Top Center Position for the No. 1 Piston” for further details.

2. With No. 1 piston at the top center position of the compression stroke, an adjustment can be made to the valves.

Before any adjustments are made, lightly tap each rocker arm at the top of the adjustment screw. Use a soft mallet to ensure that the lifter roller seats against the camshaft's base circle.

3. Make an adjustment to the valve lash on the inlet valves for cylinders 1, 2, 3, 7, 8, and 10.

a. Loosen valve adjustment locknut (3).

b. Place the appropriate feeler gauge (5) between the inlet rocker arm and the inlet valve bridge. Turn inlet adjustment screw (4) while valve adjustment locknut (3) is being held from turning. Adjust the valve lash until the correct specification is achieved. Refer to Table 12 .

c. After each adjustment, tighten valve adjustment locknut (3) while valve adjustment screw (4) is being held from turning. Tighten to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Recheck each adjustment.

4. Make an adjustment to the valve lash on the exhaust valves for cylinders 1, 2, 5, 6, 9, and 10.

a. Loosen valve adjustment locknut (1).

b. Place the appropriate feeler gauge (5) between the exhaust rocker arm and the exhaust valve bridge. Turn exhaust adjustment screw (2) while valve adjustment locknut (1) is being held from turning. Adjust the valve lash until the correct specification is achieved. Refer to Table 12 .

c. After each adjustment, tighten valve adjustment locknut (1) while valve adjustment screw (2) is being held from turning. Tighten to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Recheck each adjustment.

5. Remove the timing bolt, and turn the flywheel by 360 degrees in the direction of engine rotation. This will position the No. 11 piston at the top center at the beginning of the compression stroke. Install the timing bolt in the flywheel.

6. Make an adjustment to the valve lash on the inlet valves for the following cylinders 4, 5, 6, 9, 11, and 12.

a. Loosen valve adjustment locknut (3).

b. Place the appropriate feeler gauge (5) between the inlet rocker arm and the inlet valve bridge. Turn inlet adjustment screw (4) while valve adjustment locknut (3) is being held from turning. Adjust the valve lash until the correct specification is achieved. Refer to Table 12 .

c. After each adjustment, tighten valve adjustment locknut (3) while valve adjustment screw (4) is being held from turning. Tighten to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Recheck each adjustment.

7. Make an adjustment to the valve lash on the exhaust valves for cylinders 3, 4, 7, 8, 11, and 12.

a. Loosen valve adjustment locknut (1).

b. Place the appropriate feeler gauge (5) between the exhaust rocker arm and the exhaust valve bridge. Turn exhaust adjustment screw (2) while valve adjustment locknut (1) is being held from turning. Adjust the valve lash until the correct specification is achieved. Refer to Table 12 .

c. After each adjustment, tighten valve adjustment locknut (1) while valve adjustment screw (2) is being held from turning. Tighten to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Recheck each adjustment.

8. Remove the timing bolt from the flywheel after all valve lash adjustments have been made.

Lubrication System

i02881010

Engine Oil Pressure - Test

SMCS Code: 1304-081

Measuring Engine Oil Pressure

⚠ WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Table 13

Tools Needed		
Part Number	**Part Name**	**Quantity**
1U-5470	Engine Pressure Group	1

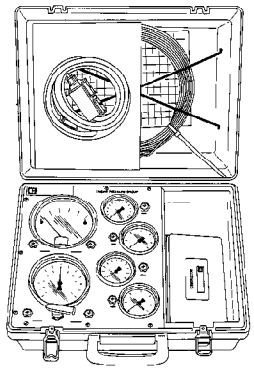


Illustration 37 g00296486
1U-5470 Engine Pressure Group

The 1U-5470 Engine Pressure Group measures the oil pressure in the system. This engine tool group can read the oil pressure inside the oil manifold.

Note: Refer to Special Instruction, SEHS8907, “Using the 1U-5470 Engine Pressure Group” for more information on using the 1U-5470 Engine Pressure Group.

Note: The engine oil pressure can also be measured by using an electronic service tool. Refer to Troubleshooting for information on the use of the Caterpillar Electronic Technician (Cat ET).

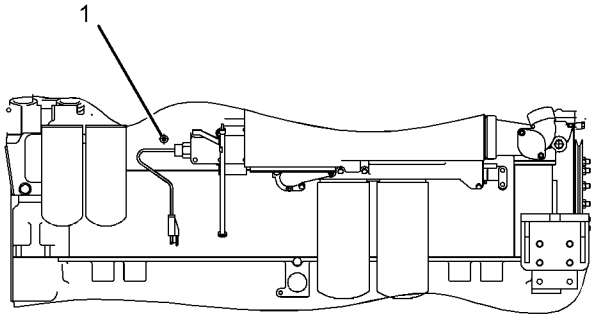


Illustration 38 g01144415
Typical example
(1) Pressure test location

1. Install the 1U-5470 Engine Pressure Group into oil gallery plug (1).
2. Start the engine. Run the engine with SAE 10W30 or SAE 15W40 oil. The information in the engine oil pressure graph is invalid for other oil viscosities. Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the recommendations of engine oil.

Note: Allow the engine to reach operating temperature before you perform the pressure test.

Note: The engine oil temperature should not exceed 115 °C (239 °F).

3. Record the value of the engine oil pressure when the engine has reached operating temperature.

4. Locate the point that intersects the lines for the engine rpm and for the oil pressure on the engine oil pressure graph.

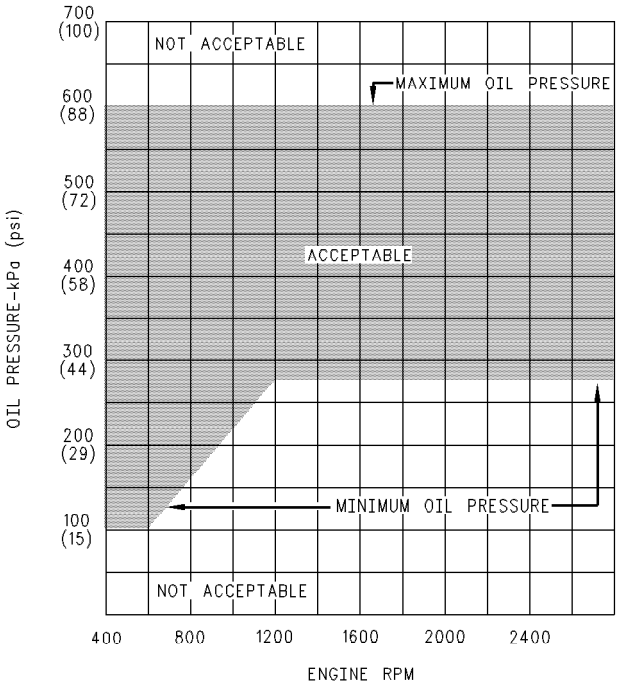


Illustration 39 g00293198

Engine Oil Pressure Graph

5. The results must fall within the “ACCEPTABLE” range on the chart. A problem exists when the results fall within the “NOT ACCEPTABLE” range on the chart. The problem needs to be corrected. Engine failure or a reduction in engine life can be the result if engine operation is continued with oil manifold pressure outside this range.

Note: A record of engine oil pressure can be used as an indication of possible engine problems or damage. A possible problem could exist if the oil pressure suddenly increases or decreases 70 kPa (10 psi) and the oil pressure is in the “ACCEPTABLE” range. The engine should be inspected and the problem should be corrected.

6. Compare the recorded engine oil pressure with the oil pressure indicators on the instrument panel and the engine oil pressure that is displayed on the electronic service tool.

7. An engine oil pressure indicator that has a defect or an engine oil pressure sensor that has a defect can give a false indication of a low oil pressure or a high oil pressure. If there is a notable difference between the engine oil pressure readings make necessary repairs.

8. Refer to “Reasons for Low Engine Oil Pressure” if you determine that the engine oil pressure is low.

9. Refer to “Reasons for High Engine Oil Pressure” if you determine that the engine oil pressure is high.

Reasons for Low Engine Oil Pressure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

- Engine oil level is low. Refer to Step 1.
- Engine oil is contaminated. Refer to Step 2.
- The engine oil bypass valves are open. Refer to Step 3.
- The engine lubrication system is open. Refer to Step 4.
- The oil suction tube has a leak or a restricted inlet screen. Refer to Step 5.
- The engine oil pump is faulty. Refer to Step 6.
- Engine Bearings have excessive clearance. Refer to Step 7.

1. Check the engine oil level in the crankcase. The oil level can possibly be too far below the oil pump supply tube. This will cause the oil pump not to have the ability to supply enough lubrication to the engine components. If the engine oil level is low add engine oil in order to obtain the correct engine oil level. Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the recommendations of engine oil.

2. Engine oil that is contaminated with fuel or coolant will cause low engine oil pressure. High engine oil level in the crankcase can be an indication of contamination. Determine the reason for contamination of the engine oil and make the necessary repairs. Replace the engine oil with the approved grade of engine oil. Also replace the engine oil filter. Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the recommendations of engine oil.

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

3. If the engine oil bypass valves are held in the open position, a reduction in the oil pressure can be the result. This may be due to debris in the engine oil. If the engine oil bypass valves are stuck in the open position, remove each engine oil bypass valve and clean each bypass valve in order to correct this problem. You must also clean each bypass valve bore. Install new engine oil filters.

4. An oil line or an oil passage that is open, broken, or disconnected will cause low engine oil pressure. An open lubrication system could be caused by a piston cooling jet that is missing or damaged.

Note: The piston cooling jets direct engine oil toward the bottom of the piston in order to cool the piston. This also provides lubrication for the piston pin. Breakage, a restriction, or incorrect installation of the piston cooling jets will cause seizure of the piston.

5. The inlet screen of the oil suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure. Check the inlet screen on the oil pickup tube and remove any material that may be restricting engine oil flow. Low engine oil pressure may also be the result of the oil pickup tube that is drawing in air. Check the joints of the oil pickup tube for cracks or a damaged O-ring seal. Remove the engine oil pan in order to gain access to the oil pickup tube and the oil screen. Refer to Disassembly and Assembly, “Engine Oil Pan - Remove and Install” for more information.

6. Check the following problems that may occur to the engine oil pump.

a. Air leakage in the supply side of the oil pump will also cause cavitation and loss of oil pressure. Check the supply side of the oil pump and make necessary repairs. For information on the repair of the engine oil pump, refer to Disassembly and Assembly, “Engine Oil Pump - Remove”.

b. Oil pump gears that have too much wear will cause a reduction in oil pressure. Repair the engine oil pump. For information on the repair of the engine oil pump, refer to Disassembly and Assembly, “Engine Oil Pump - Remove”.

7. Excessive clearance at engine bearings will cause low engine oil pressure. Check the engine components that have excessive bearing clearance and make the necessary repairs.

Reasons for High Engine Oil Pressure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Engine oil pressure will be high if the engine oil bypass valves become stuck in the closed position and the engine oil flow is restricted. Foreign matter in the engine oil system could be the cause for the restriction of the oil flow and the movement of the engine oil bypass valves. If the engine oil bypass valves are stuck in the closed position, remove each bypass valve and clean each bypass valve in order to correct this problem. You must also clean each bypass valve bore. Install new engine oil filters. New engine oil filters will prevent more debris from causing this problem.

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

i01126690

Excessive Bearing Wear - Inspect

SMCS Code: 1203-040; 1211-040; 1219-040

When some components of the engine show bearing wear in a short time, the cause can be a restriction in an oil passage.

An engine oil pressure indicator may show that there is enough oil pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the oil supply to the component. A restriction in an oil supply passage will not allow enough lubrication to reach a component. This will result in early wear.

i03993149

Excessive Engine Oil Consumption - Inspect

SMCS Code: 1348-040

Engine Oil Leaks on the Outside of the Engine

Check for leakage at the seals at each end of the crankshaft. Look for leakage at the gasket for the engine oil pan and all lubrication system connections. Look for any engine oil that may be leaking from the crankcase breather. This can be caused by combustion gas leakage around the pistons. A dirty crankcase breather will cause high pressure in the crankcase. A dirty crankcase breather will cause the gaskets and the seals to leak.

Engine Oil Leaks into the Combustion Area of the Cylinders

Engine oil that is leaking into the combustion area of the cylinders can be the cause of blue smoke. There are several possible ways for engine oil to leak into the combustion area of the cylinders:

- Leaks between worn valve guides and valve stems
- Worn components or damaged components (pistons, piston rings, or dirty return holes for the engine oil)
- Incorrect installation of the compression ring and/or the intermediate ring
- Leaks past the seal rings in the turbocharger shaft
- Overfilling of the crankcase
- Wrong oil level gauge or guide tube
- Sustained operation at light loads

Excessive consumption of engine oil can also result if engine oil with the wrong viscosity is used. Engine oil with a thin viscosity can be caused by increased engine temperature.

i02286625

Increased Engine Oil Temperature - Inspect

SMCS Code: 1348-040

When the engine is at operating temperature and the engine is using SAE 10W30 or SAE 15W40 oil, the maximum oil temperature should be 110 °C (230 °F). This is the temperature of the oil after passing through the oil cooler.

If the oil temperature is high, then check for a restriction in the oil passages of the oil cooler. A restriction in the oil cooler will not cause low oil pressure in the engine.

Determine if the oil cooler bypass valve is held in the open position. This condition will allow the oil to pass through the valve instead of the oil cooler. The oil temperature will increase.

Cooling System

i02881357

Cooling System - Check (Overheating)

SMCS Code: 1350-535

Above normal coolant temperatures can be caused by many conditions. Use the following procedure to determine the cause of above normal coolant temperatures:

⚠ WARNING

Personal injury can result from escaping fluid under pressure.

If a pressure indication is shown on the indicator, push the release valve in order to relieve pressure before removing any hose from the radiator.

1. Check the coolant level in the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant Level - Check”. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow and bubbles in the coolant. Air bubbles will keep coolant away from the engine parts, which will prevent the transfer of heat to the coolant. Low coolant level is caused by leaks or incorrectly filling the radiator.
2. Check the mixture of antifreeze and water. The mixture should be approximately 50 percent water and 50 percent antifreeze with 3 to 6 percent coolant conditioner. Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities”. If the coolant mixture is incorrect, drain the system. Put the correct mixture of water, antifreeze and coolant conditioner in the cooling system.
3. Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are not filling the cooling system correctly and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket. Air in the cooling system causes a reduction in coolant flow and bubbles in the coolant. Air bubbles keep coolant away from the engine parts, which prevents the transfer of heat to the coolant.
4. Check the fan clutch. A fan clutch that is not turning at the correct speed can cause improper air speed across the radiator core. The lack of proper air flow across the radiator core can cause the coolant not to cool to the proper temperature differential.
5. Check the water temperature gauge. A water temperature gauge which does not work correctly will not show the correct temperature. Refer to Testing and Adjusting, “Cooling System - Inspect”.
6. Check the sending unit. In some conditions, the temperature sensor in the engine sends signals to a sending unit. The sending unit converts these signals to an electrical impulse which is used by a mounted gauge. If the sending unit malfunctions, the gauge can show an incorrect reading. Also if the electric wire breaks or if the electric wire shorts out, the gauge can show an incorrect reading.
7. Check the radiator.
   a. Check the radiator for a restriction to coolant flow. Check the radiator for debris, dirt, or deposits on the inside of the radiator core. Debris, dirt, or deposits will restrict the flow of coolant through the radiator.
   b. Check for debris or damage between the fins of the radiator core. Debris between the fins of the radiator core restricts air flow through the radiator core. Refer to Testing and Adjusting, “Cooling System - Inspect”.
   c. Ensure that the radiator size is according to the specifications of the Original Equipment Manufacturer (OEM). An undersized radiator does not have enough area for the effective release of heat. This may cause the engine to run at a temperature that is higher than normal. The normal temperature is dependent on the ambient temperature.
8. Check the filler cap. A pressure drop in the radiator can cause the boiling point to be lower. This can cause the cooling system to boil. Refer to Testing and Adjusting, “Cooling System - Test”.
9. Check the fan and/or the fan shroud.
   a. The fan must be large enough to send air through most of the area of the radiator core. Ensure that the size of the fan and the position of the fan are according to the OEM specifications.
   b. The fan shroud must be the proper size and the fan shroud must be positioned correctly. Ensure that the size of the fan shroud and the position of the fan shroud are according to the OEM

specifications.

10. Check for loose drive belts.

a. A loose fan drive belt will cause a reduction in the air flow across the radiator. Check the fan drive belt for proper belt tension. Adjust the tension of the fan drive belt, if necessary. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

b. Worn gears within the water pump will cause a reduction in coolant flow through the radiator. Check the gears within the water pump for any worn edges.

11. Check the cooling system hoses and clamps. Damaged hoses with leaks can normally be seen. Hoses that have no visual leaks can soften during operation. The soft areas of the hose can become kinked or crushed during operation. These areas of the hose can cause a restriction in the coolant flow. Hoses become soft and/or get cracks after a period of time. The inside of a hose can deteriorate, and the loose particles of the hose can cause a restriction of the coolant flow.

12. Check for a restriction in the air inlet system. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures require higher than normal temperatures in the cooling system. Refer to Testing and Adjusting, “Air Inlet and Exhaust System - Inspect”.

a. If the measured restriction is higher than the maximum permissible restriction, remove the foreign material from the engine air cleaner element or install a new engine air cleaner element. Refer to Operation and Maintenance Manual, “Engine Air Filter Primary Element - Clean/Replace”.

b. Check for a restriction in the air inlet system again.

c. If the measured restriction is still higher than the maximum permissible restriction, check the air inlet piping for a restriction.

13. Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

a. Make a visual inspection of the exhaust system. Check for damage to exhaust piping or for a damaged muffler. If no damage is found, check the exhaust system for a restriction. Refer to Testing and Adjusting, “Air Inlet and Exhaust System - Inspect”.

b. If the measured restriction is higher than the maximum permissible restriction, there is a restriction in the exhaust system. Repair the exhaust system, as required.

14. Check the shunt line. The shunt line must be submerged in the expansion tank. A restriction of the shunt line from the radiator top tank to the engine water pump inlet will cause a reduction in water pump efficiency. A reduction in water pump efficiency will result in low coolant flow and overheating.

15. Check the water temperature regulator. A water temperature regulator that does not open, or a water temperature regulator that only opens part of the way can cause overheating. Refer to Testing and Adjusting, “Water Temperature Regulator - Test”.

16. Check the water pump. A water pump with a damaged impeller does not pump enough coolant for correct engine cooling. Remove the water pump and check for damage to the impeller. Refer to Testing and Adjusting, “Water Pump - Test”.

17. Check the air flow through the engine compartment. The air flow through the radiator comes out of the engine compartment. Ensure that the filters, air conditioner, and similar items are not installed in a way that prevents the free flow of air through the engine compartment.

18. Check the aftercooler. A restriction of air flow through the air to air aftercooler (if equipped) can cause overheating. Check for debris or deposits which would prevent the free flow of air through the aftercooler. Refer to Testing and Adjusting, “Aftercooler - Test”.

19. Consider high outside temperatures. When outside temperatures are too high for the rating of the cooling system, there is not enough of a temperature difference between the outside air and coolant temperatures.

20. Consider high altitude operation. The cooling capacity of the cooling system goes down as the engine is operated at higher altitudes. A pressurized cooling system that is large enough to keep the coolant from boiling must be used.

21. The engine may be running in the lug condition. When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in air flow through the radiator. This lower engine rpm also causes a reduction in coolant flow through the system. This combination of less air and less coolant flow during high input of fuel will cause above normal heating.

i07176231

Cooling System - Inspect

SMCS Code: 1350-040

Cooling systems that are not regularly inspected are the cause for increased engine temperatures. Make a visual inspection of the cooling system before any tests are performed.

⚠ WARNING

Personal injury can result from escaping fluid under pressure.

If a pressure indication is shown on the indicator, push the release valve in order to relieve pressure before removing any hose from the radiator.

1. Check the coolant level in the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant Level - Check”.

2. Check the quality of the coolant. The coolant should have the following properties:

- Color that is similar to new coolant
- Odor that is similar to new coolant
- Free from dirt and debris

If the coolant does not have these properties, drain the system and flush the system. Refill the cooling system with the correct mixture of water, antifreeze, and coolant conditioner. Refer to the Operation and Maintenance Manual for your engine in order to obtain coolant recommendations.

3. Look for leaks in the system.

Note: A small amount of weepage across the surface of the water pump seals is normal. This weepage is required to provide lubrication for this type of seal. A weep hole is provided in the water pump housing to allow coolant weepage to drain from the pump housing and not accumulate in the water seal and oil seal chamber.

The following coolant leakage criteria is provided as a guideline to determine if the water pump should be replaced.

- Intermittent drip for a period of 3 days, wetness, or discoloration (dried coolant) around the weep hole.

Action: Do not replace pump. Continue to monitor water pump and coolant level till dripping stops

- Constant stream or/and intermittent drip for a period greater than 3 days.

Action: Replace pump

4. Ensure that the air flow through the radiator does not have a restriction. Look for bent core fins between the folded cores of the radiator. Also, look for debris between the folded cores of the radiator.

5. Inspect the drive belts for the fan.

6. Check for damage to the fan blades.

7. Look for air or combustion gas in the cooling system.

8. Inspect the filler cap, and check the surface that seals the filler cap. This surface must be clean.

i02881432

Cooling System - Test

SMCS Code: 1350-040; 1350-081

This engine has a pressurized cooling system. A pressurized cooling system has two advantages. The cooling system can be operated in a safe manner at a temperature higher than the normal boiling point (steam) of water.

This type of system prevents cavitation in the water pump. Cavitation is the forming of low pressure bubbles in liquids that are caused by mechanical forces. A pressurized cooling system helps to prevent pockets of air from forming.

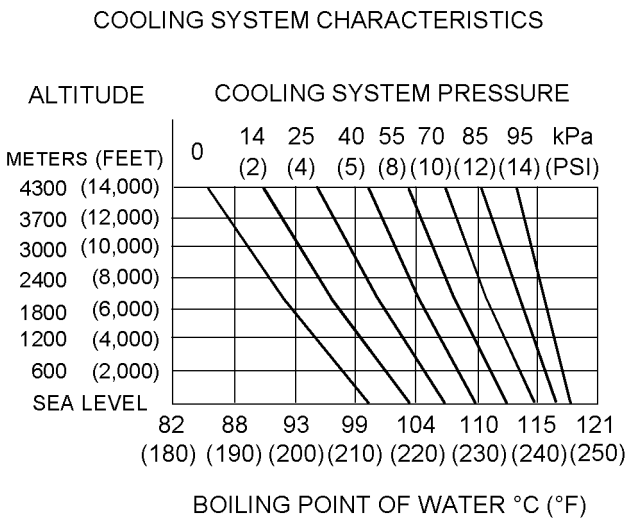


Illustration 40 g01106438

Boiling point of water

Remember that temperature and pressure work together. When a diagnosis is made of a cooling system problem, temperature and pressure must be checked. Cooling system pressure will have an effect on the cooling system temperature. For an example, refer to Illustration 40 . This will show the effect of pressure on the boiling point (steam) of water. This will also show the effect of height above sea level.

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

The coolant level must be to the correct level in order to check the coolant system. The engine must be cold and the engine must not be running.

After the engine is cool, loosen the pressure cap in order to relieve the pressure out of the cooling system. Then remove the pressure cap.

The level of the coolant should not be more than 13 mm (0.5 inch) from the bottom of the filler pipe. If the cooling system is equipped with a sight glass, the coolant should be to the proper level in the sight glass.

Tools for Testing the Cooling System

Table 14

Required Tools		
Part Number	**Part Name**	**Quantity**
4C-6500	Digital Thermometer	1
285-0910	Multi-Tool Gp	1
9S-8140	Pressurizing Pump	1
9U-7400	Multitach Tool Gp	1
245-5829	Coolant/Battery Tester	1

⚠ WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

⚠ WARNING

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

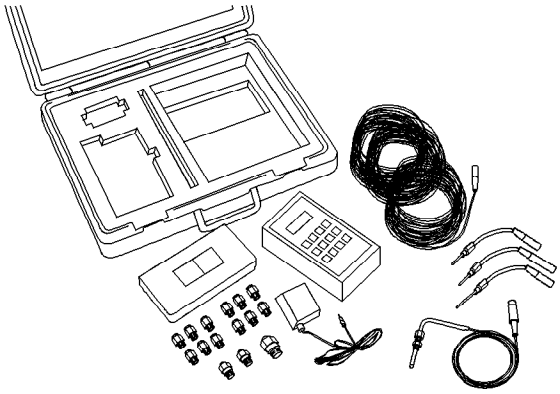


Illustration 41 g00876179

4C-6500 Digital Thermometer

The 4C-6500 Digital Thermometer is used in the diagnosis of overheating conditions and in the diagnosis of overcooling conditions. This group can be used to check temperatures in several different parts of the cooling system. Refer to the tool's Operating Manual for the testing procedures.



Illustration 42 g01311364

285-0910 Multi-Tool Gp

The 285-0910 Multi-Tool Gp is used to check the air flow through the radiator core. Refer to the 285-0910 Multi-Tool Gp manual for instructions in order to check the air flow.

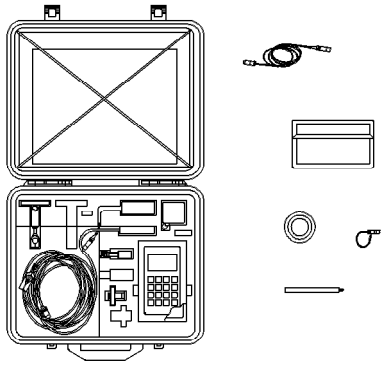


Illustration 43 g00286276

9U-7400 Multitach

The 9U-7400 Multitach Tool Group is used to check the fan speed for an engine. Refer to Operating Manual for the testing procedure.

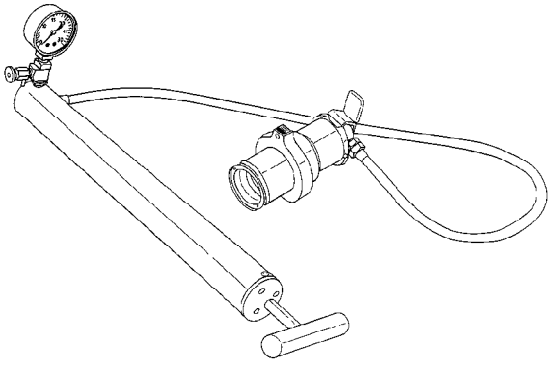


Illustration 44 g00286369

9S-8140 Pressurizing Pump

The 9S-8140 Pressurizing Pump is used to pressure test the radiator's filler cap. This pressurizing pump is also used to pressure test the cooling system for leaks.

Check the coolant frequently in cold weather for the proper glycol concentration. Use the 245-5829 Coolant/Battery Tester Gp in order to ensure adequate freeze protection. The tester gives immediate, accurate readings. The tester can be used for antifreeze or coolants that contain ethylene or propylene glycol.

Making the Correct Coolant Mixtures

Adding pure antifreeze as a makeup solution for the cooling system top-off is an unacceptable practice. Adding pure antifreeze increases the concentration of coolant in the cooling system. This increases the concentration of the dissolved solids and the undissolved chemical inhibitors in the cooling system. Add the antifreeze and water mixture in the same concentration as your cooling system. The following chart assists in determining the correct concentration of antifreeze and water. Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities”.

Table 15

Concentrations of Coolant	
Temperature	**Concentration**
Protection to −15 °C (5 °F)	30% antifreeze and 70% water
Protection to −23 °C (−10 °F)	40% antifreeze and 60% water
Protection to −37 °C (−34 °F)	50% antifreeze and 50% water
Protection to −51 °C (−60 °F)	60% antifreeze and 40% water

Test and Inspect the Filler Cap

Table 16

Required Tools		
Part Number	**Part Name**	**Quantity**
9S-8140	Pressurizing Pump	1

One cause for a pressure loss in the cooling system can be a damaged seal on the radiator filler cap.

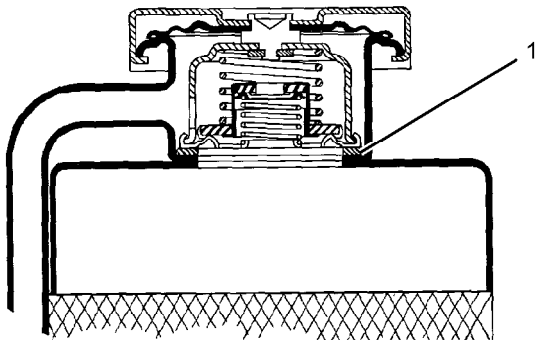


Illustration 45 g01096114

Cutaway view of a filler cap and radiator

(1) Sealing surface of both filler cap and radiator

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

To check for the amount of pressure that opens the filler cap, use the following procedure:

1. After the engine cools, carefully loosen the filler cap. Slowly release the pressure from the cooling system. Then, remove the filler cap.

Carefully inspect the filler cap. Look for any damage to the seals and to the sealing surface. Inspect the following components for any foreign substances:

- Filler cap
- Seal
- Surface for seal

Remove any deposits that are found on these items, and remove any material that is found on these items.

2. Install the filler cap on the 9S-8140 Pressurizing Pump.

3. Look at the gauge for the exact pressure that opens the filler cap.

4. Compare the gauge reading with the opening pressure that is listed on the filler cap.

5. If the filler cap is damaged, replace the filler cap.

Test the Radiator and the Cooling System for Leaks

Table 17

Required Tools		
Part Number	**Part Name**	**Quantity**
9S-8140	Pressurizing Pump	1

Use the following procedure in order to check the cooling system for leaks:

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

1. Ensure that the engine is cool. Loosen the filler cap slowly and allow pressure out of the cooling system. Then remove the filler cap from the radiator.

2. Ensure that the coolant level is above the top of the radiator core.

3. Install the 9S-8140 Pressurizing Pump onto the radiator.

4. Take the pressure reading on the gauge to 20 kPa (3 psi) more than the pressure on the filler cap.

5. Check the radiator for leakage on the outside.

6. Check all connection points for leakage, and check the hoses for leakage.

The following conditions exist if the cooling system does not have external leakage:

- You do not observe any outside leakage.
- The pressure reading on the cooling system remains steady after five minutes.

The following conditions exist if the cooling system has internal leakage:

- The pressure reading on the cooling system decreases in a five minute period.
- You do not observe any outside leakage.

Repair the cooling system, as required.

Test for the Water Temperature Gauge

Table 18

Required Tools		
Part Number	**Part Name**	**Quantity**
4C-6500	Digital Thermometer	1

Note: Caterpillar Electronic Technician (ET) can also be used in order to display the engine's coolant temperature.

⚠ WARNING

Personal injury can result from escaping fluid under pressure.

If a pressure indication is shown on the indicator, push the release valve in order to relieve pressure before removing any hose from the radiator.

⚠ WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

Check the accuracy of the water temperature indicator or water temperature sensor if you find either of the following conditions:

- The engine runs at a temperature that is too hot, but a normal temperature is indicated. A loss of coolant is found.
- The engine runs at a normal temperature, but a hot temperature is indicated. No loss of coolant is found.

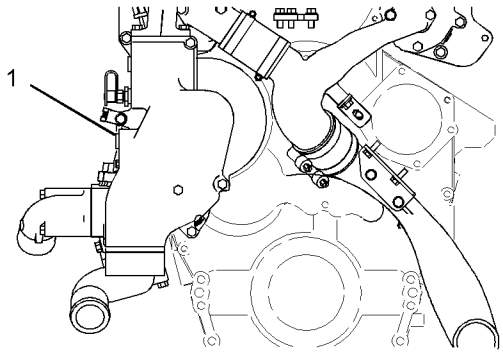


Illustration 46 g01117659

Typical example

(1) Water manifold assembly

Remove a plug from water manifold assembly (1). Install the 4C-6500 Digital Thermometer into the open port.

A temperature indicator of a known accuracy can also be used to make this check.

Start the engine. Run the engine until the temperature reaches the desired range according to the test thermometer. If necessary, place a cover over part of the radiator in order to cause a restriction of the air flow. The reading on the water temperature indicator should agree with the test thermometer within the tolerance range of the water temperature indicator.

i07814425

Water Temperature Regulator - Test

SMCS Code: 1355-081-ON; 1355-081

⚠ WARNING

Personal injury can result from escaping fluid under pressure.

If a pressure indication is shown on the indicator, push the release valve in order to relieve pressure before removing any hose from the radiator.

References

Reference: Refer to Specifications, “Water Temperature Regulator” for information on the water temperature regulator.

Introduction

Use this procedure to test the water temperature regulator.

Test Preparation

1. Remove the water temperature regulator from the engine.

2. Heat water in a pan until the temperature of the water is equal to the fully open temperature of the water temperature regulator. Refer to Specifications, “Water Temperature Regulator” for the fully open temperature of the water temperature regulator.

3. Stir the water in the pan. This will distribute the temperature throughout the pan.

Test Procedure

1. Hang the water temperature regulator in the pan of water. The water temperature regulator must be below the surface of the water. The water temperature regulator must be away from the sides and the bottom of the pan.

2. Keep the water at the correct temperature for 10 minutes.

3. After 10 minutes, remove the water temperature regulator. Immediately measure the opening of the water temperature regulator. Refer to Specifications, “Water Temperature Regulator” for the minimum opening distance of the water temperature regulator at the fully open temperature.

If the distance is less than the amount listed in the manual, replace the water temperature regulator.

i02169116

Water Pump - Test

SMCS Code: 1361-081

Table 19

Tools Needed		
Part Number	**Part Name**	**Quantity**
6V - 7775	Air Pressure Gauge	1

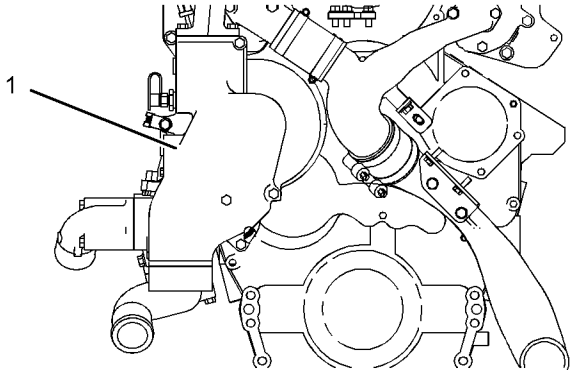


Illustration 47 g01105967

(1) Water manifold assembly

⚠ WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

Perform the following procedure in order to determine if the water pump is operating correctly:

1. Remove a plug from water manifold assembly (1).

2. Install the 6V - 7775 Air Pressure Gauge in the port.

3. Start the engine. Run the engine until the coolant is at operating temperature.

4. Note the water pump pressure. The water pump pressure should be at least 100 kPa (15 psi) at rated speed.

Basic Engine

i02287898

Piston Ring Groove - Inspect

SMCS Code: 1214-040

The piston rings may have a Keystone design, which is tapered or the piston rings may have a square cut design. The 1U-6431 Piston Ring Groove Gauge Gp is used for checking pistons with the Keystone design. A 5P-3519 Piston Ring Groove Gauge Gp is available for checking ring grooves with straight sides. For instructions on the use of the gauge, refer to Guideline For Reusable Parts and Salvage Operations, SEBF8049, “Piston Visual Inspection”.

i03506721

Main Bearings - Inspect

SMCS Code: 1203-040

Main bearings are available with smaller inside diameters than the original size bearings. These bearings are for crankshafts that have been ground.

Main bearings are available with larger outside diameters than the original size bearings. These bearings are used for the cylinder blocks with the main bearing bore that is made larger than the bore's original size.

Refer to the Reuse And Salvage Guidelines , SEBF8009, “Visual Inspection of Main Bearings and Connecting Rod Bearings” for reuse information.

Refer to Special Instruction, SMHS7606, “Use of 1P-4000 Line Boring Tool Group” for the instructions that are needed to use the tool group. This tool is used in order to check the alignment of the main bearing bores. The 1P-3537 Dial Bore Gauge Group can be used to check the size of the bore.

i02487145

Cylinder Block - Inspect

SMCS Code: 1201-040

Table 20

Required Tools		
Part Number	**Part Name**	**Quantity**
1P-3537	Dial Bore Gauge Group	1

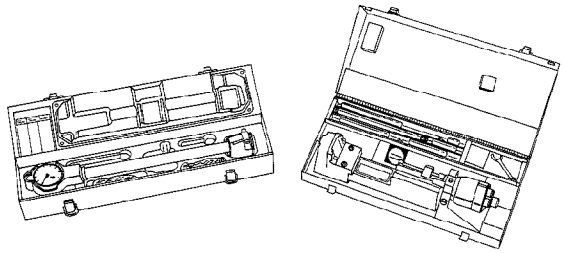


Illustration 48 g00285686

1P-3537 Dial Bore Gauge Group

If the main bearing caps are installed without bearings, the bore in the block for the main bearings can be checked. Tighten the nuts on the bearing caps to the torque that is given in Specifications, “Cylinder Block”. Alignment error in the bores must not be more than 0.08 mm (0.003 inch).

The 1P-3537 Dial Bore Gauge Group can be used to check the size of the bore.

i05053831

Cylinder Liner Projection - Inspect

SMCS Code: 1216-040

Note: The following procedure does not require the use of an “H” bar to hold the liners while the liner projection measurements are taken.

The 8T-0455 Liner Projection Tool Group can be used to check the liner projection. Refer to Special Instruction, “Use of the 8T-0455 Liner Projection Tool Group” for more information on the use of the tool.

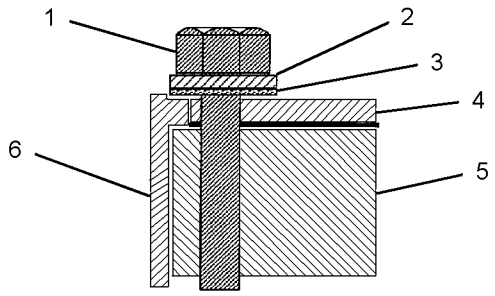


Illustration 49 g01388332

Liner Projection Components

(1) Bolt
(2) Washer
(3) Washer
(4) Spacer plate
(5) Block
(6) Cylinder liner

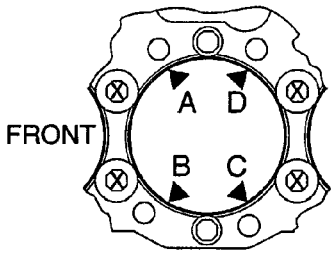
Table 21

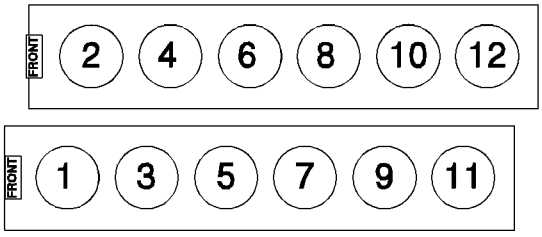
Needed Components			
Item	**Part Number**	**Description**	**Quantity For One Cylinder**
1	7H-3598	Track Bolt	6
2	8F-1484 C27 or 7X-0564 C32	Washer or Hard Washer	6
3	7K-1977 C27 or 126-1454 C32	Washer or Washer	6

Note: The 7K-1977 Washer and the 126-1454 Washer are fabric washers. These washers are a disposable item. You may wish to order more washers than the amount that is indicated.

Liner Projection Measurements

Date _____ Miles, Km / Hours _____ Engine Serial Number _____ Vehicle Serial Number _____





Liner Projection
Max 0.15 mm (.006 in)
Min 0.03 mm (.001 in)

1A		2A	
1B		2B	
1C		2C	
1D		2D	
SUM 1		SUM 2	
AVG 1		AVG 2	
3A		4A	
3B		4B	
3C		4C	
3D		4D	
SUM 3		SUM 4	
AVG 3		AVG 4	
5A		6A	
5B		6B	
5C		6C	
5D		6D	
SUM 5		SUM 6	
AVG 5		AVG 6	
7A		8A	
7B		8B	
7C		8C	
7D		8D	
SUM 7		SUM 8	
AVG 7		AVG 8	
9A		10A	
9B		10B	
9C		10C	
9D		10D	
SUM 9		SUM 10	
AVG 9		AVG 10	
11A		12A	
11B		12B	
11C		12C	
11D		12D	
SUM 11		SUM 12	
AVG 11		AVG 12	

Max Variation Each Cylinder
Max 0.051 mm (.002 in)

Max 1A-1D		Max 2A-2D	
Min 1A-1D		Min 2A-2D	
Variation		Variation	
Max 3A-3D		Max 4A-4D	
Min 3A-3D		Min 4A-4D	
Variation		Variation	
Max 5A-5D		Max 6A-6D	
Min 5A-5D		Min 6A-6D	
Variation		Variation	
Max 7A-7D		Max 8A-8D	
Min 7A-7D		Min 8A-8D	
Variation		Variation	
Max 9A-9D		Max 10A-10D	
Min 9A-9D		Min 10A-10D	
Variation		Variation	
Max 11A-11D		Max 12A-12D	
Min 11A-11D		Min 12A-12D	
Variation		Variation	

Max Variation of AVG Under One Cylinder Head
Max 0.051 mm (.002 in)

AVG 1		AVG 2	
AVG 3		AVG 4	
Variation		Variation	
AVG 3		AVG 4	
AVG 5		AVG 6	
Variation		Variation	
AVG 5		AVG 6	
AVG 7		AVG 8	
Variation		Variation	
AVG 7		AVG 8	
AVG 9		AVG 10	
Variation		Variation	
AVG 9		AVG 10	
AVG 11		AVG 12	
Variation		Variation	

Max Variation of AVG Under One Cylinder Head
Max 0.102 mm (.004 in)

Max AVG 1-11		Max AVG 2-12	
Min AVG 1-11		Min AVG 2-12	
Variation		Variation	

Illustration 50 g01086418

1. Install a new spacer plate gasket and a clean spacer plate.

2. Install the cylinder liners in the cylinder block without seals or bands.

3. Install the washers.

4. Install all bolts or the six bolts around the liner.

Torque for bolts . . . . . 95 N·m ((70 lb ft))

5. Use the 8T-0455 Liner Projection Tool Group to measure the liner projection at “A” , “B” , “C” and “D” .

6. Record measurements for each cylinder.

7. Add the four readings for each cylinder. Divide the sum by four in order to find the average.

Table 22

Specifications	
Liner Projection	0.025 to 0.152 mm (0.0010 to 0.0060 inch)
Maximum Variation In Each Liner	0.051 mm (0.0020 inch)
Maximum Average Variation Between Adjacent Liners	0.051 mm (0.0020 inch)
Maximum Variation Between All Liners	0.102 mm (0.0040 inch)

Note: If the liner projection changes around the liner, turn the liner to a new position within the bore. If the liner projection is not within specifications, move the liner to a different bore. Inspect the top face of the cylinder block.

A thinner spacer plate should be installed if the liner projection measurements are below the specifications. The spacer plate should also be installed if the liner projection measurements are low within a range. These plates are 0.076 mm (0.0030 inch) thinner than the regular plate. The plates will increase the liner projection. This will increase the crush of the fire ring. Use these spacer plates to compensate for low liner projections that are less than the 0.076 mm (0.0030 inch). Use these spacer plates if the inspection of the top deck reveals no measurable damage directly under the liner flanges but the average liner projection is less than 0.076 mm (0.0030 inch).

Do not exceed the maximum liner projection of 0.152 mm (0.0060 inch). The excessive liner projection will contribute to cracking of the liner flange.

When the liner projection is correct, put a temporary mark on the liner and the spacer plate. Set the liners aside.

Note: Refer to Disassembly and Assembly, “Cylinder Liner - Install” for the correct final installation procedure for the cylinder liners.

When the engine is ready for final assembly, the following items must be lubricated before installation.

- O-ring seals
- Cylinder block
- Upper filler band

Note: Apply liquid soap and/or clean engine oil immediately before assembly. Avoid applying the liquid soap and/or clean engine oil to the seals too early. The seals may swell. This will cause the seals to be pinched underneath the liners during the liner installation.

i02501179

Flywheel - Inspect

SMCS Code: 1156-040

Face Runout (Axial Eccentricity) of the Flywheel

Table 23

Tools Needed		Quantity
8T-5096	Dial Indicator Gp	1

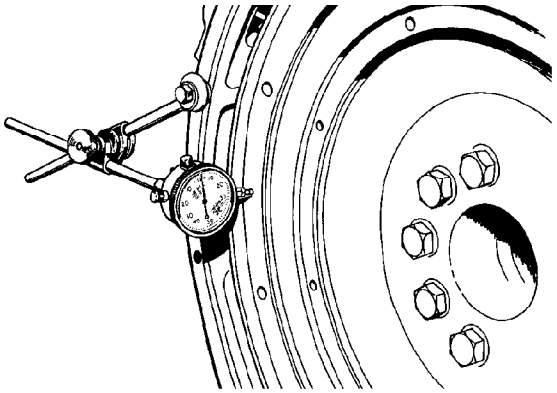


Illustration 51 g00812156

Checking face runout of the flywheel

1. Refer to Illustration 51 and install the dial indicator. Always put a force on the crankshaft in the same direction before the dial indicator is read. This will remove any crankshaft end clearance.

2. Set the dial indicator to read 0.0 mm (0.00 inch).

3. Turn the flywheel at intervals of 90 degrees and read the dial indicator.

4. Take the measurements at all four points. The difference between the lower measurements and the higher measurements that are performed at all four points must not be more than 0.43 mm (0.017 inch), which is the maximum permissible face runout (axial eccentricity) of the flywheel.

Bore Runout (Radial Eccentricity) of the Flywheel

Table 24

Tools Needed		Quantity
8T - 5096	Dial Indicator Gp	1

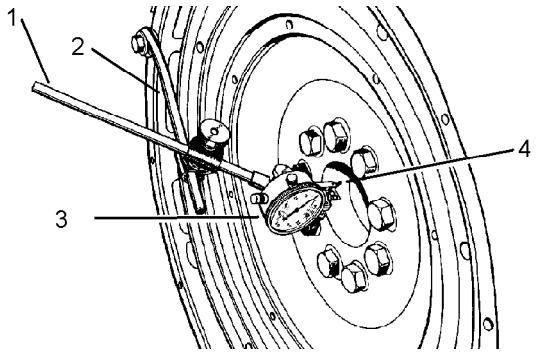


Illustration 52 g01086572

Checking bore runout of the flywheel

(1) 7H-1945 Holding Rod
(2) 7H-1645 Holding Rod
(3) 7H-1942 Dial Indicator
(4) 7H-1940 Universal Attachment

1. Install 7H - 1942 Dial Indicator (3). Make an adjustment of 7H - 1940 Universal Attachment (4) so the dial indicator makes contact on the ID of the flywheel.

2. Set the dial indicator to read 0.0 mm (0.00 inch).

3. Turn the flywheel at intervals of 90 degrees and read the dial indicator.

4. Take the measurements at all four points. The difference between the lower measurements and the higher measurements that are performed at all four points must not be more than 0.23 mm (0.009 inch) which is the maximum permissible drive hub pilot bore (radial eccentricity) of the flywheel.

5. The runout (eccentricity) of the coupling pilot diameter is not required for the flywheel.

i07815969

Flywheel Housing - Inspect

SMCS Code: 1157-040

WARNING

Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (−) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

Specifications

Table 25

Parameter	Value
Face Runout (Axial Eccentricity) of the Flywheel Housing	0.38 mm (0.015 inch)

Introduction

Use this procedure to check the axial and radial runout of the flywheel housing.

Required Tools

Table 26

Item		Qty	Part Number	Part Name
T1		1	8T-5096	Tool Gp
	T1a	1	7H-1942	Dial Indicator
	T1b	1	7H-1945	Holding Rod
	T1c	1	7H-1948	Swivel Clamp
	T1d	1	8S-2327	Post
	T1e	1	8S-2329	Base

Face Runout (Axial Eccentricity) of the Flywheel Housing

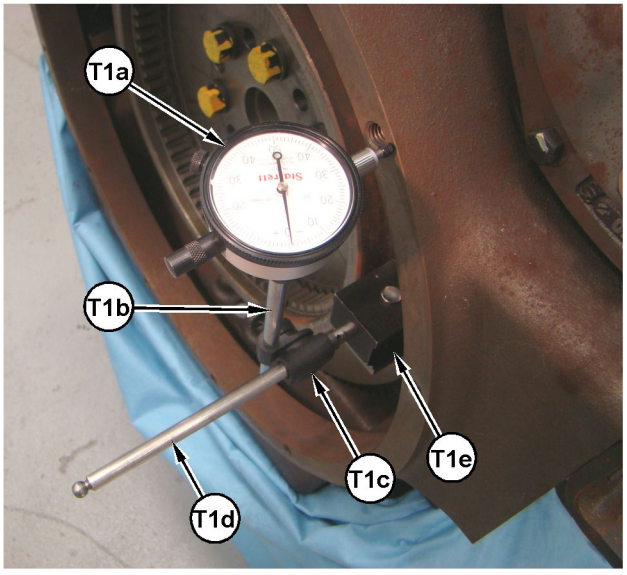


Illustration 53 g06442987

8T-5096 Dial Indicator Gp

(T1a) 7H-1942 Dial Indicator
(T1b) 7H-1945 Holding Rod
(T1c) 7H-1948 Swivel Clamp
(T1d) 8S-2327 Post
(T1e) 8S-2329 Base

If you use any other method except the method that is given here, always remember that the bearing clearance must be removed to receive the correct measurements.

1. Fasten Tooling (T1e) to the flywheel so the anvil of Tooling (T1a) will contact the face of the flywheel housing.
2. Use a rubber mallet and tap the crankshaft toward the rear before the dial indicator is read at each point.

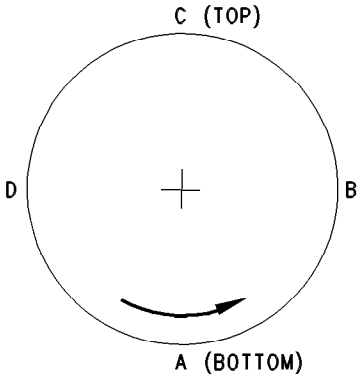


Illustration 54 g00285932

Checking face runout of the flywheel housing

3. Turn the flywheel while the dial indicator is set at 0.0 mm (0.00 inch) at location (A). Read the dial indicator at locations (B), (C), and (D).
4. The difference between the lower measurements and the higher measurements that are performed at all four points must not be more than 0.38 mm (0.015 inch), which is the maximum permissible face runout (axial eccentricity) of the flywheel housing.

Bore Runout (Radial Eccentricity) of the Flywheel Housing

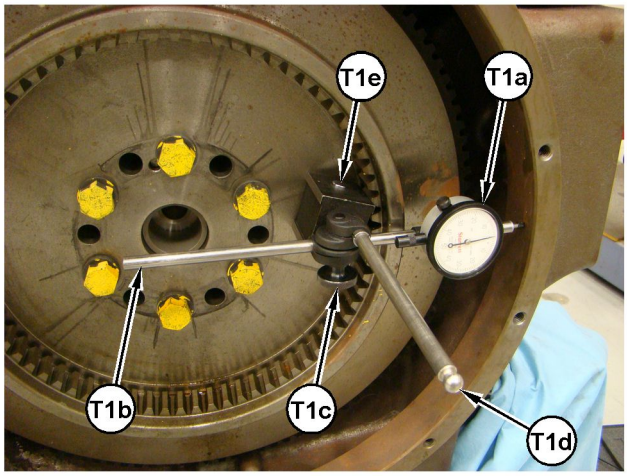


Illustration 55 g06442992

8T-5096 Dial Indicator Gp

(T1a) 7H-1942 Dial Indicator
(T1b) 7H-1945 Holding Rod
(T1c) 7H-1948 Swivel Clamp
(T1d) 8S-2327 Post
(T1e) 8S-2329 Base

1. Fasten Tooling (T1e) to the flywheel so the anvil of Tooling (T1a) will contact the bore of the flywheel housing.

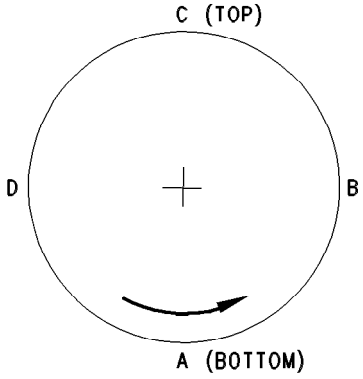


Illustration 56 g00285932

Checking bore runout of the flywheel housing

CHART FOR DIAL INDICATOR MEASUREMENTS					
	Position of dial indicator				
	Line No.	A	B	C	D
Correction for bearing clearance	1	0			
Dial Indicator Reading	2	0			
Total of Line 1 & 2	3	0			
the total horizontal eccentricity.					

Illustration 57 g00763974

2. While the dial indicator is in the position at location (C), adjust the dial indicator to 0.0 mm (0.00 inch). Push the crankshaft upward against the top of the bearing. Refer to Illustration 57 . Write the measurement for bearing clearance on line 1 in column (C).

Note: Write the measurements for the dial indicator with the correct notations. This notation is necessary for making the calculations in the chart correctly.

3. Divide the measurement from Step 2 by two. Write this number on line 1 in columns (B) and (D).

4. Turn the flywheel to put the dial indicator at position (A). Adjust the dial indicator to 0.0 mm (0.00 inch).

5. Turn the flywheel counterclockwise to put the dial indicator at position (B). Write the measurements in the chart.

6. Turn the flywheel counterclockwise to put the dial indicator at position (C). Write the measurement in the chart.

7. Turn the flywheel counterclockwise to put the dial indicator at position (D). Write the measurement in the chart.

8. Subtract the smaller number from the larger number in column B and column D. Place this number on line III. The result is the horizontal eccentricity (out of round). Line III in column C is the vertical eccentricity.

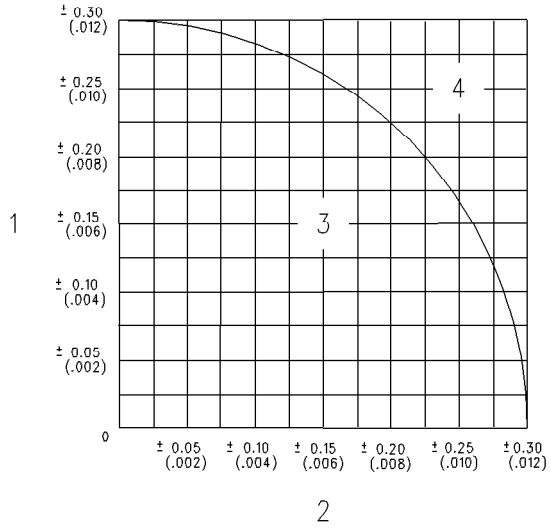


Illustration 58 g00286046

Graph for total eccentricity

(1) Total vertical eccentricity
(2) Total horizontal eccentricity
(3) Acceptable value
(4) Unacceptable value

9. Find the intersection of the eccentricity lines (vertical and horizontal) in Illustration 58 .

10. If the point of the intersection is in the “Acceptable” range, the bore is in alignment. If the point of intersection is in the “Not acceptable” range, the flywheel housing must be changed.

i02140382

Vibration Damper - Check

SMCS Code: 1205-535

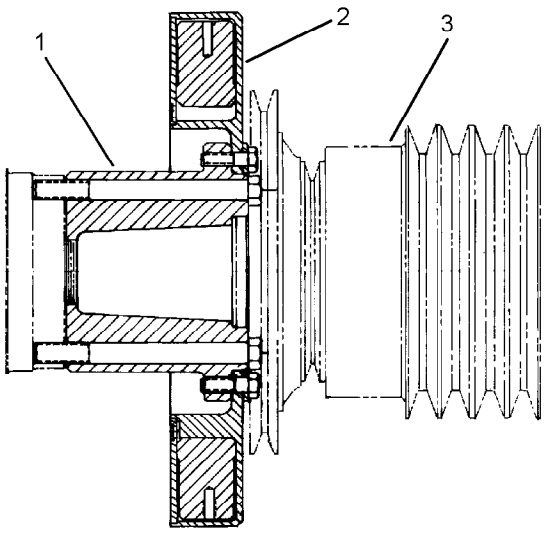


Illustration 59 g01086801

Viscous vibration damper

(1) Crankshaft hub
(2) Damper assembly
(3) Crankshaft pulley

NOTICE
Inspect the viscous vibration damper for signs of leaking and for signs of damage to the case. Either of these conditions can cause the weight to contact the case. This contact can affect damper operation.

The vibration damper is installed on the front of the crankshaft. Damage to the vibration damper or failure of the vibration damper will increase engine vibrations. This will result in damage to the crankshaft.

Replace the damper if any of the following conditions exist:

- The damper is dented, cracked, or fluid is leaking from the damper.
- The paint on the damper is discolored from excessive heat.
- The damper is bent.
- The bolt holes are worn or there is a loose fit for the bolts.
- The engine has had a crankshaft failure due to torsional forces.

Compression Brake

i02882057

Compression Brake Lash - Adjust
(If Equipped)

SMCS Code: 1129-025

⚠ WARNING

To prevent possible injury, do not use the starter to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring valve clearance.

⚠ WARNING

This engine uses high voltage to control the fuel injectors.

Disconnect electronic fuel injector enable circuit connector to prevent personal injury.

Do not come in contact with the fuel injector terminals while the engine is running.

The engine valve lash and the injector lash must be within specifications prior to adjusting the lash for the CAT compression brake. Refer to Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust” for the correct procedure for inspection of the engine valve lash. Refer to Testing and Adjusting, “Electronic Unit Injector - Adjust” for the proper procedure for inspection of the injector lash adjustment.

Note: Adjustment of the lash for the CAT compression brake must be performed while the engine is cold. If the engine is warm, allow the engine to cool prior to performing the following adjustments.

Note: The lash is measured between the rod for the CAT compression brake and the exhaust rocker arm. Make all adjustments while the engine is stopped and the exhaust valves are closed.

Use the following procedure to adjust the slave piston lash on cylinders 1, 2, 5, 6, 9, and 10:

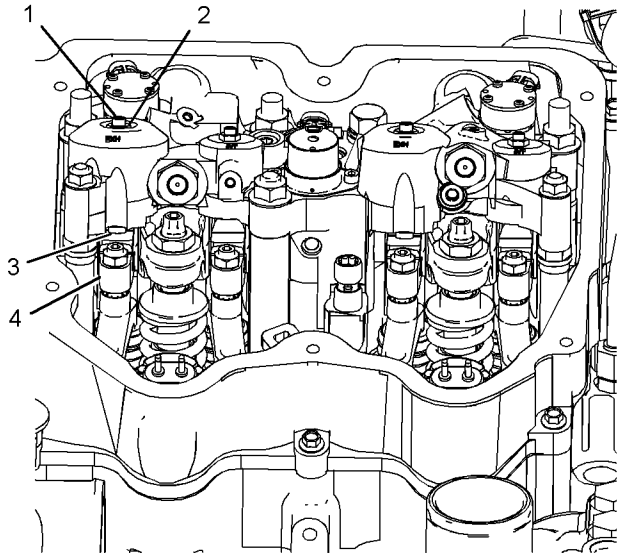


Illustration 60 g01434918

Exhaust rocker arm and actuator piston

(1) Adjustment screw
(2) Adjustment screw locknut
(3) Rod for the CAT compression brake
(4) Exhaust rocker arm

1. Put the No. 1 piston at the top center position on the compression stroke. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.
2. Loosen adjustment screw locknut (2) and back out adjustment screw (1) until the CAT Compression Brake rod is not in contact with the exhaust rocker arm.
3. Make sure that the rod for the CAT compression brake is centered in the housing. Set the lash to 0.76 ± 0.08 mm (0.030 ± 0.003 inch). Place the appropriate feeler gauge between the rod for the CAT compression brake and the exhaust rocker arm. Turn the adjustment screw in a clockwise direction. Slide the feeler gauge between the rod for the CAT compression brake and the exhaust rocker arm. Continue turning the adjustment screw until a slight drag is felt on the feeler gauge. Remove the feeler gauge.
4. Torque the adjustment screw locknut. Tighten the locknut to 15 ± 3 N·m (11 ± 2 lb ft).
5. Recheck the lash setting after you torque the locknut.

6. Remove the timing bolt and turn the flywheel by 360 degrees in the direction of engine rotation. This will put the No. 11 piston at the top center position on the compression stroke. Install the timing bolt in the flywheel. To adjust the slave piston lash on cylinders 3, 4, 7, 8, 11, and 12, perform Steps 2 through 5.

7. Remove the timing bolt from the flywheel after all adjustments have been performed. Reinstall the timing cover.

Electrical System

i06709144

Battery - Test

SMCS Code: 1401-081

Most of the tests of the electrical system can be done on the engine. The wiring insulation must be in good condition. The wire and cable connections must be clean, and both components must be tight.

⚠ WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery.

NOTICE
The charging unit will be damaged if the connections between the battery and the charging unit are broken while the battery is being charged. Damage occurs because the load from the battery is lost and because there is an increase in charging voltage. High voltage will damage the charging unit, the regulator, and other electrical components.

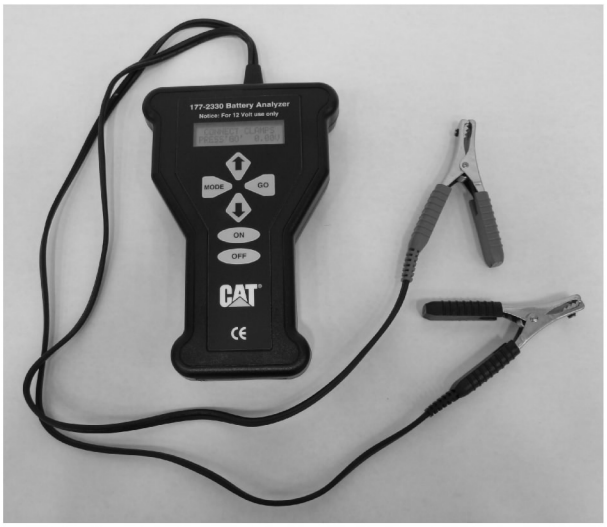


Illustration 61 g02231076

177-2330 Battery Analyzer

Refer to Operating Manual, NEHS0764, “Using the 177-2330 Battery Analyzer” for detailed instruction on the use of the 177-2330 Battery Analyzer



Illustration 62 g02231156

4C-4911 Battery Load Tester

Refer to Operating Manual, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6 V, 8 V, and 12 V Lead Acid Batteries” for detailed instruction on the use of the 4C-4911 Battery Load Tester.

Use the 4C-4911 Battery Load Tester or the 177-2330 Battery Analyzer to test a battery that does not maintain a charge when the battery is active. The 4C-4911 Battery Load Tester and the 177-2330 Battery Analyzer are portable units. The 4C-4911 Battery Load Tester or the 177-2330 Battery Analyzer can be used under field conditions and under high temperatures.

1. Check the voltage of the battery.

a. If the voltage is above 12.45 V, then the battery is good.

b. If the voltage of the battery is below 12 V, then the battery needs replaced.

c. If the voltage of the battery is between 12 V to 12.3 V, then run the machine at mid-throttle for 60 minutes and recheck the battery voltage. If the voltage is not above 12.45 V, then replace the battery.

d. If the voltage of the battery is between 12.3 V to 12.45 V, then run the machine at mid-throttle for 30 minutes and recheck the battery voltage. If the voltage is not above 12.45 V, then replace the battery.

i04035716

Charging System - Test

SMCS Code: 1406-081

The condition of charge in the battery at each regular inspection will show if the charging system is operating correctly. An adjustment is necessary when the battery is constantly in a low condition of charge or a large amount of water is needed. A large amount of water would be more than 1 oz of water per a cell per a week or per every 100 service hours.

Testing of the charging system components on the engine is preferred, including the wiring and other components that are a permanent part of the system. Off-engine testing or bench testing of the operation of the charging system components is acceptable as a last resort. This testing will give an indication of needed repair. After repairs are made, test the charging system in order to verify that the charging system meets specifications.

Test Tools For The Charging System

Table 27

Tools Needed		
Part Number	**Part Name**	**Quantity**

(continued)

(Table 27, contd)

225-8266	Ammeter Tool Gp	1
237-5130 or 146-4080	Digital Multimeter Gp or Digital Multimeter Gp	1

225-8266 Ammeter Tool Gp

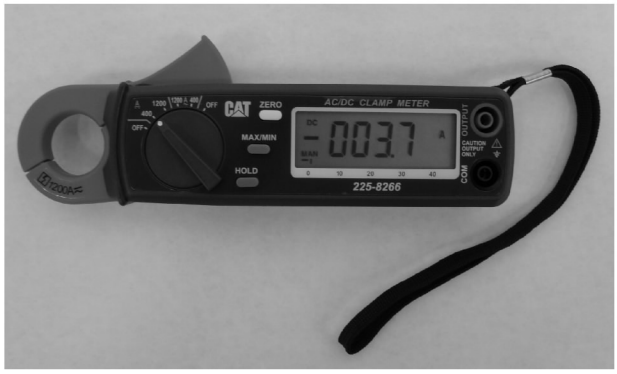


Illustration 63 g02231196

225-8266 Ammeter Tool Gp

The 225-8266 Ammeter Tool Gp is portable. This ammeter is a self-contained instrument that measures electrical currents without breaking the circuit and without disturbing the conductor insulation.

The ammeter contains a digital display that is used to monitor current directly within a range between 1 A and 1200 A. In order to view current readings of less than 1 A use the multimeter display. In order to read the multimeter display connect a 6V-6014 Cable between the digital multimeter and the ammeter. The ammeter then sends the current measurement to the multimeter display.

A lever opens the ammeter jaws over a conductor. The conductor diameter cannot be larger than 19 mm (0.75 inch).

The spring loaded jaws close around the conductor for measuring the current. A trigger switch controls the ammeter. The trigger switch can be locked into the ON position or into the OFF position.

After the trigger is turned to the OFF position, the reading appears in the digital display for 5 seconds. This meter accurately measures currents in areas with a limited access. For example, these areas include areas that are beyond the sight of the operator. For DC operation, the ammeter contains a zero control. Batteries inside the handle supply the power.

Note: Refer to the user manual for more information about using the 225-8266 Ammeter Tool Gp.

237-5130 Digital Multimeter Gp or 146-4080 Digital Multimeter Gp



Illustration 64 g02231214

237-5130 Digital Multimeter Gp or 146-4080 Digital Multimeter Gp

The 237-5130 Digital Multimeter Gp or the 146-4080 Digital Multimeter Gp is a portable, hand-held service tool with a digital display. This multimeter is built with extra protection against damage in field applications. The multimeter is equipped with 7 functions and 29 ranges. The 237-5130 Digital Multimeter Gp or the 146-4080 Digital Multimeter Gp has an instant ohms indicator. This indicator permits checking continuity for a fast inspection of the circuits. The multimeter can also be used for troubleshooting capacitors that have small values.

Note: Refer to the manual that is provided by the supplier for more information on the use of the 237-5130 Digital Multimeter Gp. Refer to Operation Manual, NEHS0678 for complete information for the use of the 146-4080 Digital Multimeter Gp.

Charging System

To check for correct output of the alternator, see the Specifications module. Refer to Special Instruction, REHS0354, “Charging System Troubleshooting”. If the part number for the alternator to be tested is not listed in the Special Instruction, refer to the appropriate Specifications manual for the information needed to test the alternator.

Before the start of on-engine testing, the charging system and the battery must be checked according to the following steps.

1. The battery must be at least 75 percent (1.225 Sp Gr) of the full charge. The battery must be held tightly in place. The battery holder must not put too much stress on the battery.
2. Cables between the battery, the starter, and the engine ground must be the correct size. Wires and cables must be free of corrosion. Wires and cables must have cable support clamps in order to prevent stress on battery connections (terminals).
3. Leads, junctions, switches, and panel instruments that have direct relation to the charging circuit must give correct circuit control.
4. Inspect the drive components for the charging unit in order to be sure that the components are free of grease and oil. Be sure that the drive components can operate the charging unit.
5. Check the tension of the belt for the alternator pulley. Refer to the Belt Tension Chart for the correct tension of the belt.

Alternator

The charging rate of the alternator should be checked when an alternator is charging the battery too much. The charging rate of the alternator should be checked when an alternator is not charging the battery enough. Make reference to the Specifications module in order to find all testing specifications for the alternators and regulators.

No adjustment can be made in order to change the rate of charge on the alternator regulators. If the rate of charge is not correct, a replacement of the regulator is necessary.

Tightening The Alternator Pulley Nut

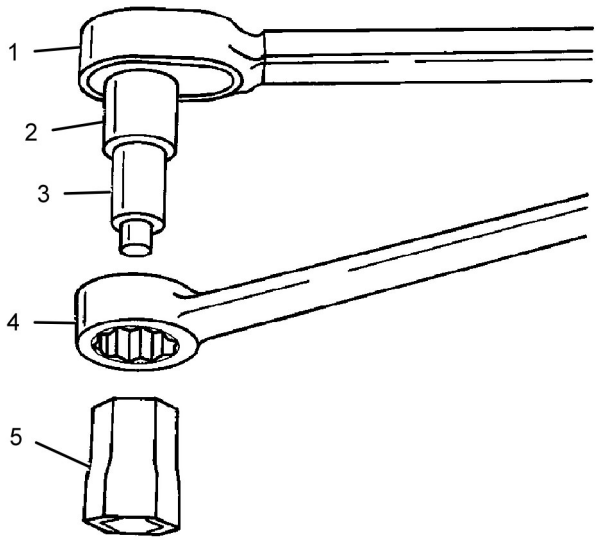


Illustration 65 g01247292

Tools for tightening the alternator pulley nut

(1) 8T-9293 Torque Wrench
(2) 261-0444 Adapter
(3) 2P-8267 Hex Bit Socket
(4) 8H-8517 Combination Wrench (1-1/8 inch)
(5) 8T-5314 Adapter Socket

Tighten the nut that holds the pulley with the tools shown. Refer to the Specifications manual for the torque.

Regulator

The voltage regulator is a solid-state electronic switch. The regulator senses the voltage of the system and controls the field current to the alternator. The output voltage from the alternator will supply the needs of the battery. The output voltage will also supply the other components in the electrical system.

i02883375

Electric Starting System - Test

SMCS Code: 1450-081

Most of the tests of the electrical system can be done on the engine. The wiring insulation must be in good condition. The wire and cable connections must be clean, and both components must be tight. The battery must be fully charged. If the on-engine test shows a defect in a component, remove the component for more testing.

The starting system consists of the following components:

- Keyswitch
- Starting motor solenoid
- Starting motor

Table 28

Tools Needed		
Part Number	**Part Name**	**Qty**
237-5130 or 146-4080	Digital Multimeter	1

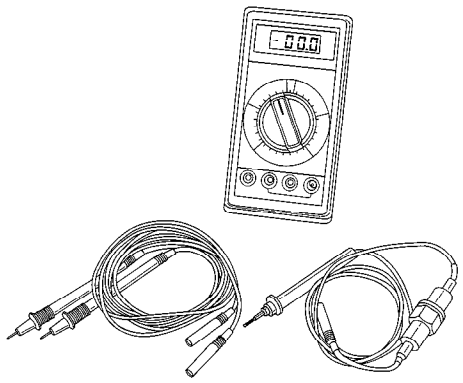


Illustration 66 g00283566

237-5130 Digital Multimeter or the 146-4080 Digital Multimeter

The 237-5130 Digital Multimeter or the 146-4080 Digital Multimeter is a hand-held service tool with a digital display, that is completely portable. This multimeter is built with extra protection against damage in field applications. The multimeter is equipped with 7 functions and 29 ranges. The 237-5130 Digital Multimeter or the 146-4080 Digital Multimeter has an instant ohms indicator. This indicator permits checking continuity for a fast inspection of the circuits. The multimeter can also be used for troubleshooting capacitors that have small values.

Note: Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for information about the 237-5130 Digital Multimeter. Refer to Operation Manual, NEHS0678 for complete information for the use of the 146-4080 Digital Multimeter.

Use the multimeter in the DCV range to find starting system components which do not function.

Move the start control switch in order to activate the starting solenoids. The starting solenoid's operation can be heard as the pinions of the starting motors are engaged with the ring gear on the engine flywheel.

If a solenoid for a starting motor will not operate, it is possible that the current from the battery did not reach the solenoid. Fasten one lead of the multimeter to the terminal connection for the battery cable on the solenoid. Touch the other lead to a good ground. A zero reading indicates that there is a broken circuit from the battery. More testing is necessary when there is a voltage reading on the multimeter.

The solenoid operation also closes the electric circuit to the motor. Connect one lead of the multimeter to the terminal connection of the solenoid that is fastened to the motor. Touch the other lead to a good ground. Activate the starting solenoid and look at the multimeter. A reading of the battery voltage shows that the problem is in the motor. The motor must be removed for further testing. A zero reading on the multimeter shows that the solenoid contacts do not close. This is an indication of the need for repair to the solenoid or an adjustment to be made to the pinion clearance for the starting motor.

Perform a test. Fasten one multimeter lead to the terminal connection for the small wire at the solenoid and fasten the other lead to the ground. Look at the multimeter and activate the starting solenoid. A voltage reading shows that the problem is in the solenoid. A zero reading indicates that the problem is in the start switch or the wires for the start switch.

Fasten one multimeter lead to the start switch at the terminal connection for the wire from the battery. Fasten the other lead to a good ground. A zero reading indicates a broken circuit from the battery. Make a check of the circuit breaker and wiring. If there is a voltage reading, the problem is in the start switch or in the wires for the start switch.

Starting motors that operate too slowly can have an overload because of too much friction in the engine that is being started. Slow operation of the starting motors can also be caused by a short circuit, loose connections and/or dirt in the motors.

Trouble with the starting system could be caused by the battery or by charging system problems. If the starting system is suspect, refer to Service Manual, SENR3860, “50-MT Series Starting Motors”. This publication contains troubleshooting for the starting system, test procedures, and specifications.

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SENR9937
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RENR9317-10 (en-us)
August 2019

Troubleshooting

C27, C32 Engines for Caterpillar Built Machines

E9Z 1-UP (Machine)
4YC 1-UP (Machine)
4XJ 1-UP (Machine)
3PR 1-UP (Machine)
AGC 1-UP (Machine)
BTW 1-UP (Machine)
EHX 1-UP (Engine)
221 1-UP (Machine)
FKR 1-UP (Machine)
DR2 1-UP (Machine)
DR4 1-UP (Machine)
DS7 1-UP (Machine)
DS6 1-UP (Machine)
DT6 1-UP (Machine)
DT7 1-UP (Machine)
DT4 1-UP (Machine)
DT9 1-UP (Machine)
DN2 1-UP (Machine)
DN3 1-UP (Machine)
9TR 1-UP (Machine)
9XR 1-UP (Machine)
7PZ 1-UP (Machine)
AAF 1-UP (Machine)
KNW 1-UP (Machine)
NNW 1-UP (Machine)
BWX 1-UP (Machine)
Z9K 1-UP (Machine)
H4C 1-UP (Machine)
DHL 1-UP (Machine)
DHJ 1-UP (Machine)
DHG 1-UP (Machine)
DHX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Troubleshooting Section

Electronic Troubleshooting

i02436970

System Overview

SMCS Code: 1900

System Operation

This engine is electronically controlled. Each cylinder has an electronic unit injector. The Electronic Control Module (ECM) sends a signal to each injector solenoid in order to control the operation of the fuel injection system.

Electronic Controls

The electronic system consists of the following components: the ECM, the Electronic Unit Injectors (EUI), the wiring harness, the switches and the sensors. The ECM is a computer that is used to control the engine. The software for the computer is loaded via the flash file. The flash file contains the operating maps and the performance maps for the engine. These maps define the following characteristics of the engine:

- Horsepower
- Torque curves

The ECM calculates the timing and the amount of fuel that is delivered to the cylinders. These calculations are based on the actual conditions and/or on the desired conditions at any given time.

The ECM compares the desired engine speed to the actual engine speed. The ECM calculates actual engine speed from signals that are produced by the engine speed/timing sensor. The desired engine speed is calculated by the ECM with the following variables:

- Throttle signal
- Input signals from engine sensors
- Certain diagnostic codes

If the desired engine speed is greater than the actual engine speed, the ECM increases the duration of the fuel injection. This injects more fuel into the cylinders in order to increase the actual engine speed.

Cold Mode

The ECM limits engine power during cold mode operation. Injection timing is also modified during cold mode operation. Cold mode operation provides the following benefits:

- Increased cold weather starting capability
- Reduced warm-up time
- Reduced white smoke

Cold mode is activated whenever the engine temperature falls below a predetermined value. Cold mode remains active until the engine temperature rises above a predetermined value or until a time limit is exceeded.

Fuel Injection

The ECM controls the amount of fuel that is injected by varying the duration of the signals to the injectors. The injector will pump fuel only while the injector solenoid is energized. The ECM sends a high voltage signal to the solenoid. This high voltage signal energizes the solenoid. By controlling the timing and the duration of the high voltage signal, the ECM can control injection timing and the engine RPM.

The flash file that is programmed into the ECM sets certain limits on the amount of fuel that can be injected. The “FRC Fuel Limit” is used to control the air/fuel ratio in order to control emissions. The “FRC Fuel Limit” is a limit that is based on the boost pressure of the engine. A higher boost pressure indicates that there is more air in the cylinder. As the boost pressure increases, the ECM calculates an increased “FRC Fuel Limit” . When the “FRC Fuel Limit” is increased, the ECM injects more fuel into the cylinder. The “FRC Fuel Limit” is programmed into the ECM at the factory. This fuel setting cannot be changed by the customer.

The “Rated Fuel Limit” is a limit that is based on the power rating of the engine and on engine rpm. The “Rated Fuel Limit” is a fuel map that provides the power curves and the torque curves for a specific engine family and for a specific engine rating. The “Rated Fuel Limit” is programmed into the ECM at the factory. This fuel setting cannot be changed by the customer.

Once the ECM calculates the amount of fuel that is required for the engine, the timing of the fuel injection cycle must be calculated. The ECM receives information about the top center position of each cylinder from the engine speed/timing sensor's signal. The ECM calculates the initiation of the fuel injection cycle relative to the top center position of the piston. The injection signal is then provided to the injector at the desired time. The ECM adjusts timing for optimum engine performance, for optimum fuel economy, and for optimum control of emissions.

Programmable Parameters

Certain parameters that affect the engine operation may be changed using Caterpillar Electronic Technician (ET). These parameters are stored in the ECM memory. Some parameters are protected from unauthorized changes by passwords. These passwords are called factory passwords.

Passwords

Several system configuration parameters and most logged events are protected by factory passwords. Factory passwords are available only to Caterpillar dealers. Refer to Troubleshooting, “Factory Passwords” for additional information.

i06844639

Electronic Service Tools

SMCS Code: 0785

Service Tools

Most of the tools that are listed in Table 1 are required to enable a service technician to perform the test procedures in this manual. Some of the devices may be specific to the type of Electronic Control Module (ECM) that is being used.

Table 1

Service Tools	
Part Number	**Description**
349-4200	Thermometer
360-0774	Refractometer
431-7087	Tool Gp (REFRACTOMETER (DEF))
N/A	4 mm Allen Wrench
1U-5805	Wire Removal Tool (14-GA, GREEN)
6V-2197	Magnetic Transducer As (TIMING CALIBRATION)
121-9588	Wire Removal Tool (16-GA, BLUE)
147-6456	Wedge Removal Tool
151-6320	Wire Removal Tool (14-GA TO 18-GA, RED)
1U-5804	Crimp Tool (12−AWG TO 18−AWG)
6V-2197	Transducer
7X-1171	Transducer Adapter
7X-1695	Cable As
146-4080	Digital Multimeter Gp (RS232)
7X-1710	Multimeter Probes

(continued)

(Table 1, contd)

Service Tools	
Part Number	**Description**
326-4904	Adapter Cable As (3-PIN BREAKOUT)
7X-1715 134-5195	Adapter Cable As (40-PIN BREAKOUT) Harness (40-PIN) (For ADEM 2 ECM (two 40-pin connectors))
208-0059	Adapter Cable As (70-PIN BREAKOUT) (For ADEM 3 ECM (two 70-pin connectors) and for ADEM 4 ECM (one 70-pin connector and one 120-pin connector))
257-8718	**The 257-8718 Adapter Cable As is not applicable with Tier IV Engines.** Adapter Cable As (120-PIN BREAKOUT) (For ADEM 4 ECM (one 70-pin connector and one 120-pin connector))
N/A	Torque Wrench (capable of applying 1.5 N·m (13.3 lb in))
Repair Kits for Connectors	
362-3555	Connector Repair Kit (AMPSEAL)
175-3700	Connector Repair Kit (Deutsch connector)
Bypass Harnesses for the ECM	
129-2018	Power Cable (Stand alone cable for ADEM 2 ECM)
217-0113	Wiring Harness (ECM BYPASS) (The bypass harness connects to the battery. The bypass harness is used with the following harnesses for different types of electronic control modules.)
328-2292	Harness (ENGINE ECM BYPASS) (For ADEM 3 ECM and ADEM 4 ECM)
277-4734	Harness (ENGINE ECM BYPASS) (For A4:E2 ECM (Two 64-pin connectors))
276-7273	Sensor Test Box (1)

(1) Instrument used to test Cylinder Position sensors.

Two short jumper wires may be needed to check the continuity of some wiring harness circuits by shorting two adjacent terminals together in a connector. A long extension wire may also be needed to check the continuity of some wiring harness circuits.

Except for harness tests, the use of certain test equipment is not recommended for use on modern Caterpillar electrical circuits. Such testers include the following examples: the 8T-0500 Continuity Tester and 5P-7277 Voltage Tester.

Note: A procedure has been developed to test "In Cylinder" Position Sensors. Reference Special Instruction REHS7338, “Procedure to Test the Position Sensor of a Hydraulic Cylinder”.

Optional Service Tools

Table 2 lists the optional service tools that may be needed during testing or repair.

Table 2

Optional Service Tools	
Part Number	**Description**
198-4240 or 1U-5470	Digital Pressure Indicator or Engine Pressure Group
4C-4075	Crimp Tool (4−AWG TO 10−AWG)
4C-4911(1)	Battery Load Tester
5P-7277	Voltage Tester
6V-9130(2)	Temperature Adapter (MULTIMETER)
8T-5319	Connector Tool Group
349-4199	AC/DC Current Probe
348-5430	Multi-Tool Gp
8T-8726	Adapter Cable As
163-5443	Adapter Cable As (3-PIN BREAKOUT)
177-2330	Battery Analyzer (DIGITAL)
190-8900	Connector Repair Kit
225-5985	Parallel Port Cable (COMMUNICATION ADAPTER)
391-8170	EMISSIONS ANALYZER TOOL GP (Bluetooth Module)
393-0673	EMISSIONS ANALYZER TOOL GP

(1) Refer to Special Instructions, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8, and 12 v Lead Acid Batteries” and Special Instructions, SEHS7633, “Battery Test Procedure”.
(2) Refer to Special Instructions, SEHS8382, “Use of the 6V-9130 Temperature Adapter Group”.

Cat ® Electronic Technician (ET)

Cat ET can be used by the technician to help perform the following procedures:

- Diagnostic testing
- Calibrations
- Flash programming
- Configuration of the ECM
- Print various reports

Cat ET can display the following information:

- Status parameters
- Event codes
- Diagnostic codes
- ECM settings
- Engine configuration

Always use the latest revision of Cat ET. The media is available on CD and the media can also be downloaded from various Caterpillar web sites.

Table 3

Software, JEBD3003, “CATERPILLAR ELECTRONIC TECHNICIAN”

Once you have downloaded Cat ET onto your PC, you will need a license from your Caterpillar dealer to use the software. Various licenses are available for different users with different requirements. Consult your Caterpillar dealer.

Note: For more information regarding the use of Cat ET and PC requirements, refer to the documentation that accompanies your Cat ET program software.

Connecting Cat ET

Connecting the Communication Adapter

Note: The 466-6258 is the latest version of the Communication Adapter Group. Older service tool versions can still be used.

Table 4 lists the standard hardware that is required to connect Cat ET.

Table 4

Standard Hardware for Connecting with Cat ET	
Part Number	**Description**
N/A	Personal Computer (PC)
466-6258	Communication Adapter Gp
317-7492	Radio Kit (NACD only)
349-1206	Radio Kit (EAME only)
Components of the 466-6258 Communication Adapter Gp	
317-7485	Communication Adapter (3)
370-4617	Cable As (USB)
457-6114	Cable As (DATA LINK)
Components of the 317-7492 Radio Kit	
317-7493	Wireless Communication Radio
317-7496	Computer Cable As
317-7510	Radio Cable Assembly
326-9606	Antenna (2)
Components of the 349-1206 Radio Kit	
348-9250	Communication Radio Gp

(continued)

(Table 4, contd)

Standard Hardware for Connecting with Cat ET	
Part Number	**Description**
317-7496	Computer Cable As
317-7510	Radio Cable Assembly
326-9606	Antenna (2)
Tool Operating Manual & Software CD ROM, NETG5057, “Communication Adapter 3”	

Follow the instructions for the communication adapter. Use the following procedure to connect Cat ET and the communication adapter to a PC.

1. Remove the electrical power from the ECM.

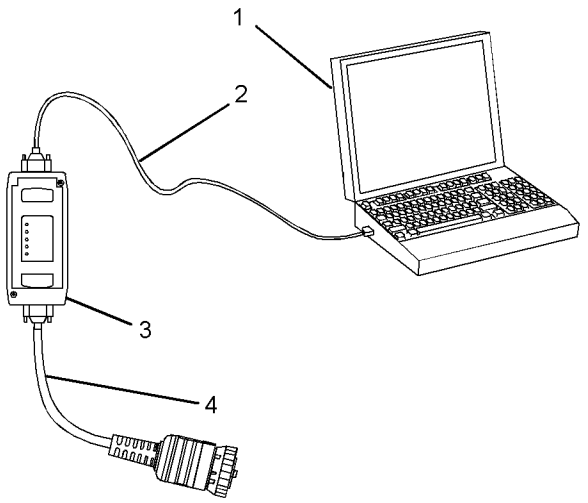


Illustration 1 g02051513

(1) PC
(2) 353-5083 Cable As (USB)
(3) 317-7485 Communication Adapter (3)
(4) 327-8981 Cable As (DATA LINK)

2. Connect cables (2) and (4) to communication adapter (3).

Note: The communication adapter will power up when the adapter is connected to a PC or to an ECM that is powered up.

3. Connect cable (2) to the USB port of the PC.

4. Connect cable (4) to a service tool connector.

5. Restore electrical power to the ECM. Verify that the “POWER” indicator on the communication adapter is illuminated. Make sure that the PC is powered up.

6. Establish communication between Cat ET and the ECM. If Cat ET indicates that there is more than one ECM, select the engine ECM.

7. If Cat ET and the communication adapter do not communicate with the ECM, refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

Refer to Troubleshooting, “Electronic Service Tool Does Not Communicate” if any of the following conditions exist:

- Cat ET displays a message that refers to a communication problem.
- Cat ET displays “Error #142 The interface hardware is not responding” .
- Cat ET displays a message that indicates that the firmware in the communications adapter is old.

Dual Data Link Communications (If so equipped)

When the connection of the communication adapter is complete, observe the communication adapter and Cat ET. Certain applications require that dual data link communications be established to perform various test procedures. These tests will be listed in the “Diagnostic Tests” menu, some tests may not be available (grayed out). If there are diagnostic tests that are unavailable in Cat ET, ensure that your service tool is communicating in dual data link mode.

Use the following indicators to confirm that Cat ET is communicating on dual data links:

- “J1939” indicator is flashing
- “Cat Data Link” indicator is flashing
- Cat ET is not displaying “Service tool support is limited”

Refer to Troubleshooting, “Electronic Service Tool Does Not Communicate” if the “J1939” indicator and the “Cat Data Link” indicator are not flashing. Both indicators will be flashing during dual data link communications with the ECM.

Communicating with the Wireless Communication Adapter (If so equipped)

Table 6 lists the optional hardware that is needed to connect Cat ET by using a wireless connection.

Note: Some applications cannot use a wireless connection. Also, a dual data link cannot be used with a wireless connection.

Table 5

Optional Hardware for the Use of Cat ET	
Part Number	**Description**
N/A	Personal Computer (PC)

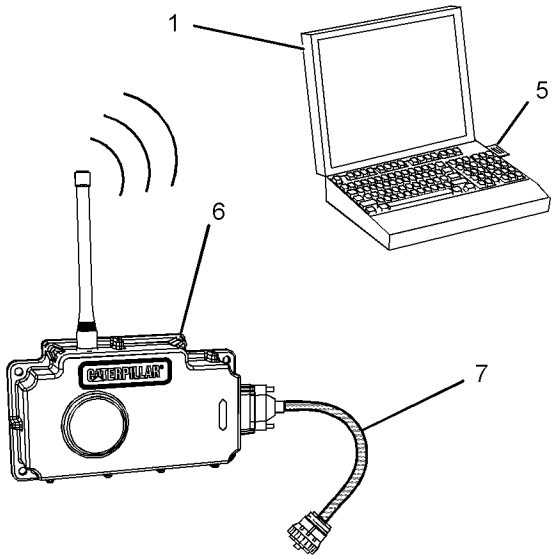


Illustration 2 g02342942

(1) Personal computer (PC)
(5) 261-4867 Card (PCMCIA)
(6) 239-9955 Communication Radio Gp
(7) 259-3183 Data Link Cable As

Note: Items (5),(6), and (7) are part of the 261 - 3363 Wireless Communication Adapter Gp.

Note: The 261 - 3363 Wireless Communication Adapter Gp was canceled and replaced by the 349 - 1206 Radio Kit. However, the 261 - 3363 Wireless Communication Adapter Gp can still be used.

Use the following procedure to connect the wireless communication adapter for use with Cat ET.

1. Remove the electrical power from the ECM.

2. Ensure that the computer has been correctly configured for the 261 - 4867 Card. Verify that the PC card is installed in the computer PCMCIA expansion slot.

3. Connect cable (9) between communication radio (8) and the service tool connector.

4. Restore the electrical power to the ECM. If Cat ET and the communication radio do not communicate with the ECM, refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

Communicating with the Wireless Communication Adapter (If so equipped)

Table 6 lists the optional hardware that is needed to connect Cat ET by using a wireless connection.

Note: Some applications cannot use a wireless connection. Also, a dual data link cannot be used with a wireless connection.

Although changes can be made to the internal settings of the W-CA3 wirelessly. Caterpillar recommends that the radio is connected to a PC via 317 - 7496 Computer Cable As (USB)Cable Assembly (8) and 317 - 7510 Radio Cable Assembly (9).

Table 6

Optional Hardware for the Use of Cat ET	
Part Number	**Description**
N/A	Personal Computer (PC)

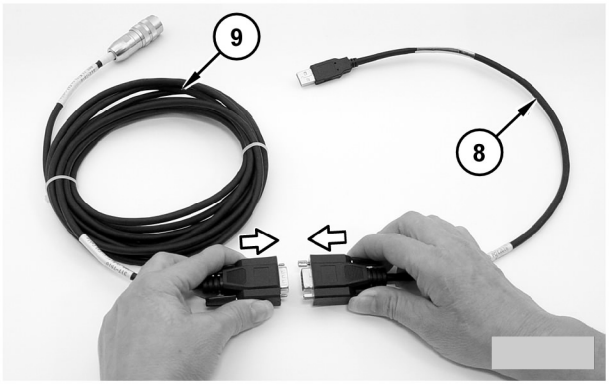


Illustration 3 g02151132

(8) 317-7496 Computer Cable As (USB)
(9) 317-7510 Radio Cable AssemblyC

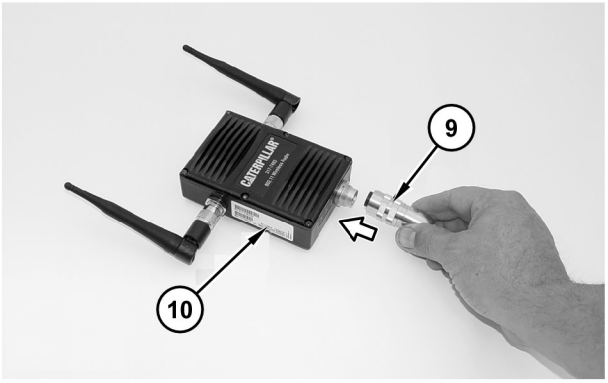


Illustration 4 g02596964

(9) 317-7510 Radio Cable Assembly
(10) W-CA3

Note: Items (8),(9), and (10) are part of the 349-1206 Radio Kit.

Use the following procedure to connect the wireless communication adapter for use with Cat ET.

1. Remove the electrical power from the ECM.

2. Ensure that the computer has been correctly configured for the 802.11a or 802.11b/g enabled wireless card. Verify that the PC wireless is installed and working correctly.

3. Connect cable (9) between communication radio (8) and the service tool connector.

4. Restore the electrical power to the ECM. If Cat ET and the communication radio do not communicate with the ECM, refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

PL1000E Communication ECM (If so equipped)

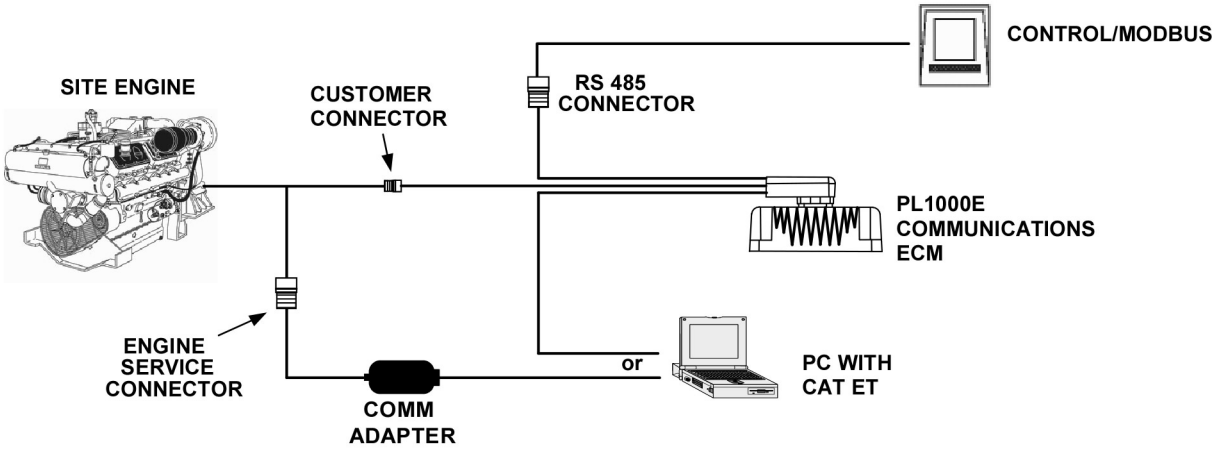


Illustration 5 g03669868

The PL1000E is an ECM that provides the customer with the ability to integrate Caterpillar engines into specific applications. The PL1000E enables communication from a J1939 data link to a device that utilizes a MODBUS communication protocol. A PC with the latest version of Cat ET installed can be connected to the PL1000E through the RS232 serial port of the PC. The PL1000E contains an embedded communications adapter that will allow Cat ET to communicate with the engine over the J1939 data link.

Refer to System Operation/Troubleshooting/Test and Adjust, RENR8091, “PL1000E Communication ECM” for additional information.

i02881454

Replacing the ECM

SMCS Code: 1901-510

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

The Electronic Control Module (ECM) contains no moving parts. Replacement of the ECM can be costly. Replacement can also be a time consuming task. Use these procedures to ensure that the ECM is the cause of the problem.

Note: Ensure that the ECM is receiving power and that the ECM is properly wired to the negative battery circuit before you attempt to replace the ECM. Refer to the diagnostic functional test Troubleshooting, “Electrical Power Supply Circuit - Test”.

Some application software supports the use of a new ECM as a test ECM. A new ECM can be temporarily placed into a “Test ECM Mode” . This ECM can then be used to replace a suspect ECM in order to determine if the suspect ECM is faulty. Refer to programming parameters Troubleshooting, “Test ECM Mode”.

NOTICE

If the flash file and engine application are not matched, engine damage may result.

Perform the following procedure in order to replace the ECM:

1. Print the parameters from the “Configuration” screen on Caterpillar Electronic Technician (ET). If a printer is unavailable, record all of the parameters. Record any logged diagnostic codes and logged event codes for your records. Record the injector serial numbers from the “Calibrations” screen under the “Service” menu on Cat ET.

Note: The injector serial numbers are necessary for obtaining the correct injector trim files. The ECM uses the injector trim files in order to compensate for manufacturing variations between individual injectors. If you replace any of the unit injectors, you must reprogram the injector trim files for the new injectors. Also, if you replace the ECM, the injector trim files must be installed into the new ECM. A successful “Copy Configuration” process will accomplish this task. For more instruction, refer to programming parameters Troubleshooting, “Injector Trim File”.

2. Use the “Copy Configuration/ECM Replacement” feature that is found under the “Service” menu on Cat ET. Select “Load from ECM” in order to copy the configuration from the suspect ECM.

Note: If the “Copy Configuration” process fails and the parameters were not obtained in Step 1, the parameters must be obtained elsewhere. Some parameters are stamped on the engine information plate, but most parameters must be obtained from the factory.

3. Remove the ECM from the engine.

a. Remove the electrical power from the ECM.

b. Disconnect the J1/P1 and J2/P2 ECM connectors.

NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

c. Remove the fuel lines (if equipped) from the ECM.

d. Remove the mounting bolts from the ECM.

e. Disconnect the ECM ground strap from the engine.

4. Install the replacement ECM.

a. If the old mounting hardware is in good repair, you can use the old mounting hardware to install the replacement ECM.

b. Reconnect the fuel lines (if equipped).

c. Ensure that the ECM mounting hardware is installed correctly. The fuel lines must not put tension on the ECM. The rubber grommets are used to protect the ECM from excessive vibration. The ECM must be able to drift in the rubber grommets. If the ECM cannot be moved slightly in the grommets, check that the fuel lines (if equipped) are not pulling the ECM against one side of the grommets.

d. Connect the ECM ground strap.

e. Connect the J1/P1 and J2/P2 ECM connectors. Tighten the allen head screw on each of the ECM connectors to the proper torque. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

5. Program the flash file into the ECM. Refer to programming parameters Troubleshooting, “Flash Programming”.

6. If the replacement ECM was used previously for a different application, use Cat ET to match the engine application and the flash file.

7. Configure the ECM.

a. If the “Load from ECM” process from Step 2 was successful, return to the “Copy Configuration/ECM Replacement” screen on Cat ET and select “Program ECM” .

After using the “Program ECM” feature, be sure to cycle the power to the ECM. Wait at least 15 seconds after turning the keyswitch to the OFF position.

Note: Some control modules have a power off delay. The 15 seconds will be sufficient to cover this delay.

b. If the “Program ECM” process was successful, proceed to Step 9.

c. If the “Program ECM” process was unsuccessful, manually program the ECM parameters into the replacement ECM. The parameters must match the parameters from Step 1.

Note: If the “Copy Configuration” process fails and the parameters were not obtained in Step 1, the parameters must be obtained elsewhere. Some parameters are stamped on the engine information plate, but most parameters must be obtained from the factory.

d. If necessary, program the engine monitoring system.

8. Program the injector trim files. Refer to programming parameters Troubleshooting, “Injector Trim File”.

9. Check for an active diagnostic code for timing calibration.

If the diagnostic code is active, calibrate the injection timing. Refer to calibration procedures Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

10. Check for diagnostic codes and for event codes.

i02378227

Self-Diagnostics

SMCS Code: 1901

The Electronic Control Module (ECM) has the ability to detect problems with the electronic system and with engine operation. When a problem is detected, a code is generated. An alarm may also be generated. There are two types of codes:

- Diagnostic
- Event

Diagnostic Code – When a problem with the electronic system is detected, the ECM generates a diagnostic code. This indicates the specific problem with the circuitry.

Diagnostic codes can have two different states:

- Active
- Logged

Active Code

An active diagnostic code indicates that an active problem has been detected. Active codes require immediate attention. Always service active codes prior to servicing logged codes.

Logged Code

Every generated code is stored in the permanent memory of the ECM. The codes are logged.

Logged codes may not indicate that a repair is needed. The problem may have been temporary. The problem may have been resolved since the logging of the code. If the system is powered, it is possible to generate an active diagnostic code whenever a component is disconnected. When the component is reconnected, the code is no longer active. Logged codes may be useful to help troubleshoot intermittent problems. Logged codes can also be used to review the performance of the engine and of the electronic system.

Event Code

An event code is generated by the detection of an abnormal engine operating condition. For example, an event code will be generated if the oil pressure is too low. In this case, the event code indicates the symptom of a problem.

i02941044

Sensors and Electrical Connectors

SMCS Code: 1439; 7553-WW

C27 and C32 Engines

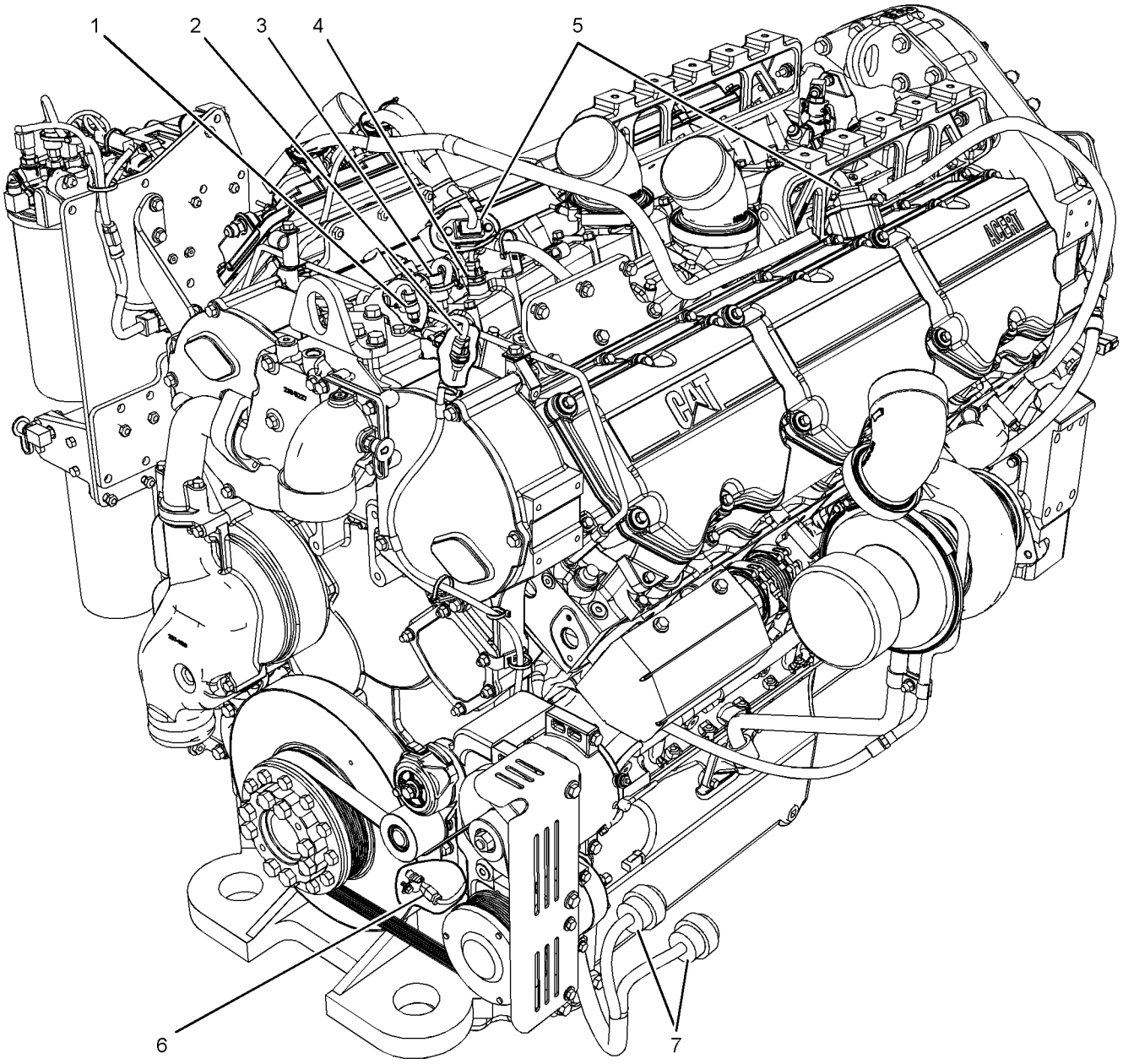


Illustration 6 g01457828

Left side engine view (typical example)

(1) Atmospheric pressure sensor
(2) Engine coolant temperature sensor
(3) Intake manifold pressure sensor
(4) Intake manifold air temperature sensor
(5) Injector valve cover entry connectors
(6) Primary engine speed/timing sensor
(7) Engine interface connectors

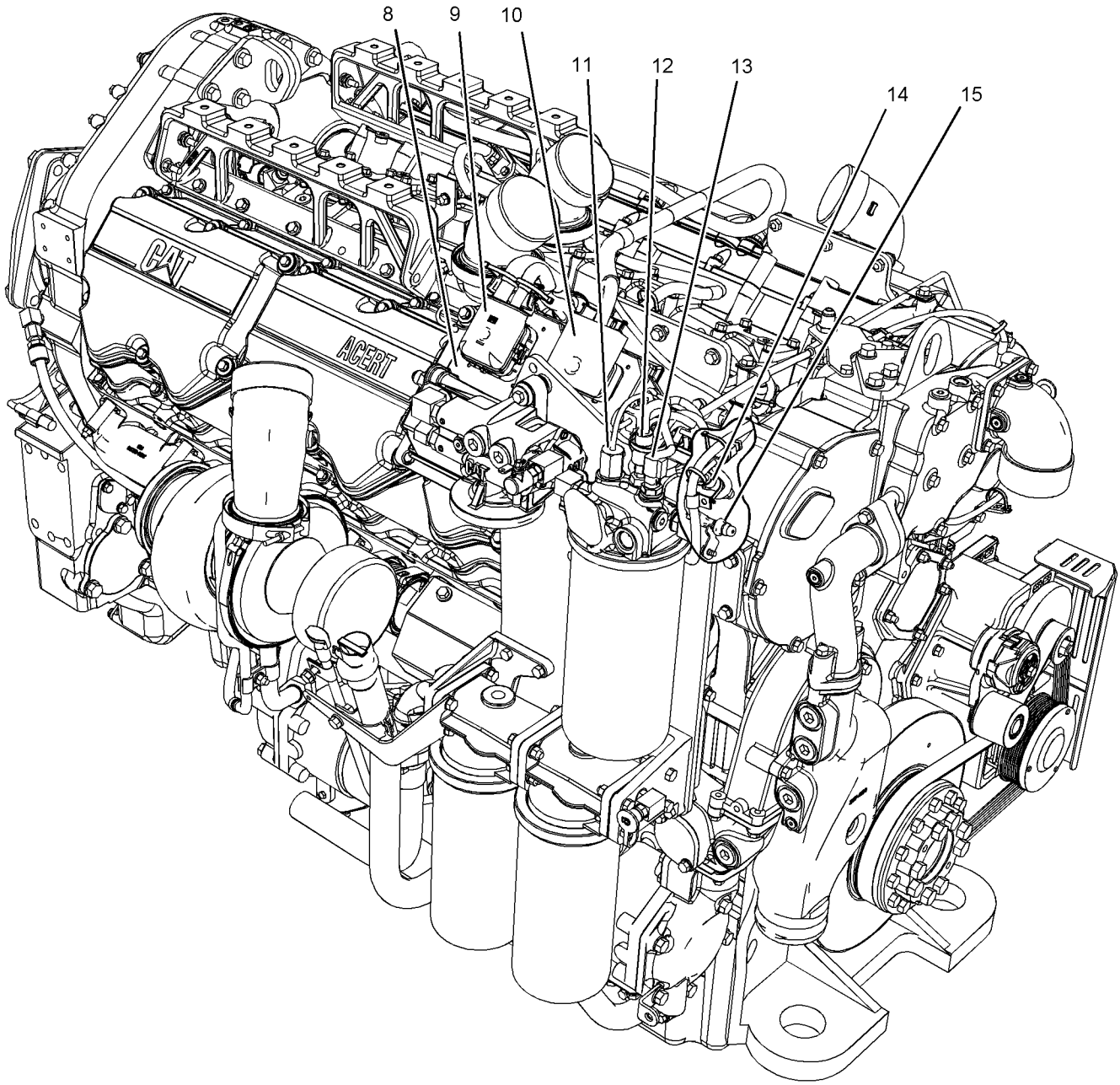


Illustration 7 g01457832

Right side engine view (typical example)

(8) ECM
(9) J2/P2 ECM connectors
(10) J1/P1 ECM connectors
(11) Fuel filter differential pressure switch
(12) Fuel pressure sensor
(13) Fuel temperature sensor
(14) Engine oil pressure sensor
(15) Secondary engine speed/timing sensor

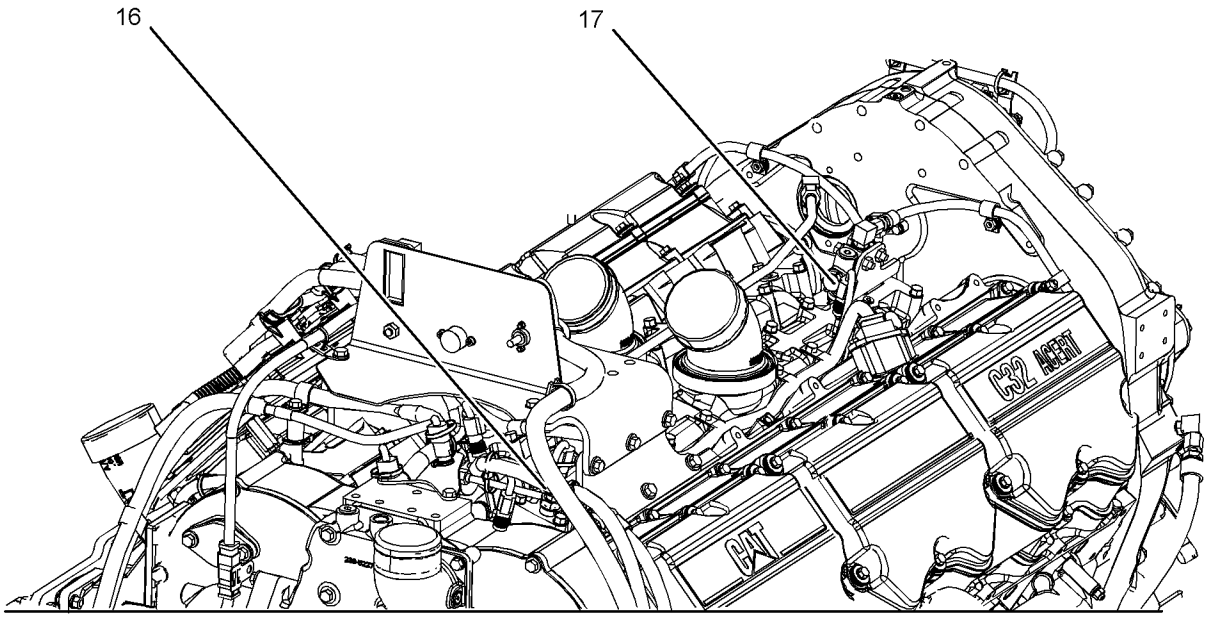


Illustration 8 g01457835

C32 engine only

(16) Turbocharger #2 outlet pressure sensor

(17) Intake manifold #2 air temperature sensor

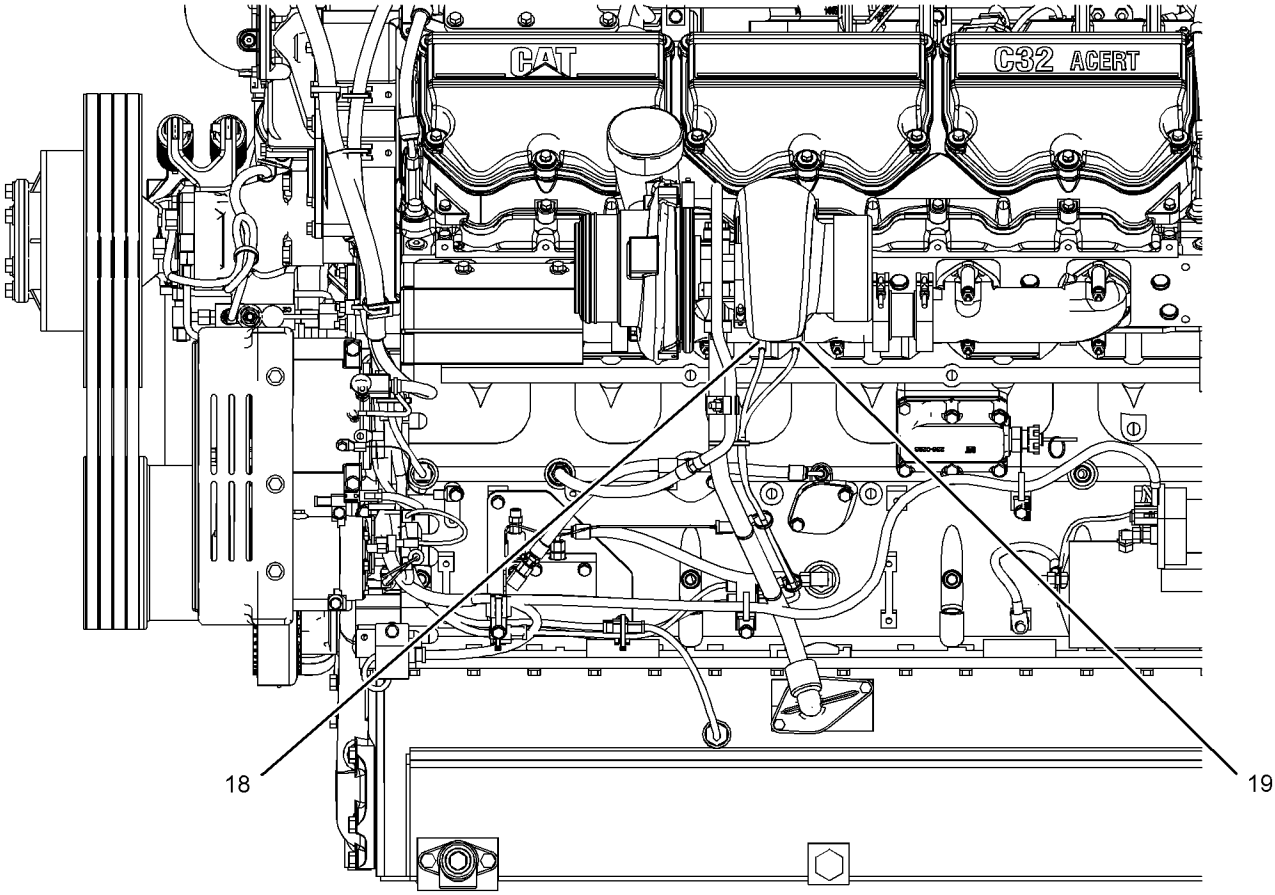


Illustration 9 g01457837

C32 engine only

(18) “FRONT LEFT EXHAUST TC” (19) “REAR LEFT EXHAUT TC”

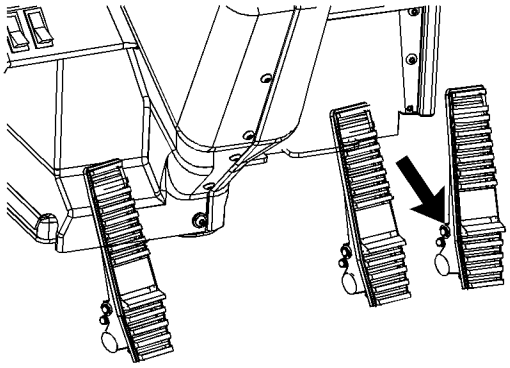


Illustration 10 g01193730

Location of the throttle position sensor (typical example)

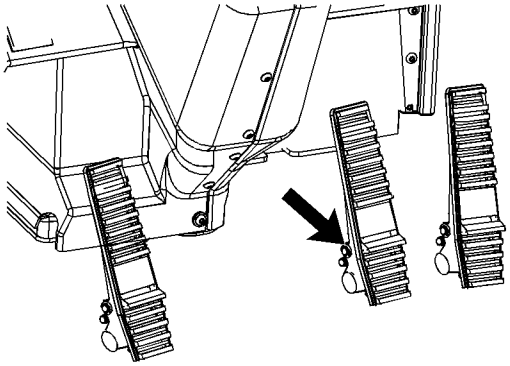


Illustration 11 g01213888

Location of the right brake pedal switch (typical example)

i02469003

Engine Wiring Information

SMCS Code: 1408

The wiring schematics are revised periodically. The wiring schematics will change as updates are made to the machine harness. For the most current information, always check the revision number of the schematic. Use the schematic with the latest revision number.

Harness Wire Identification

Caterpillar identifies all wires with eleven solid colors. The circuit number is stamped on the wire at a 25 mm (1 inch) spacing. Table 7 lists the wire colors and the color codes.

Table 7

Color Codes for the Harness Wire			
Color Code	**Color**	**Color Code**	**Color**
BK	Black	GN	Green
BR	Brown	BU	Blue
RD	Red	PU	Purple
OR	Orange	GY	Gray
YL	Yellow	WH	White
		PK	Pink

For example, a wire identification of A701-GY(Grey) on the schematic would signify a gray wire with the circuit number A701. A701-GY(Grey) identifies the power circuit for the No. 1 Injector solenoid.

Another wire identification on the schematic is the size of the wire. The size of the wire will follow the wire color. Wire size or gauge is referred to as AWG (Americal Wire Gauge). AWG is a description of the diameter of the wire.

For example, a code of 150-OR-14(Orange) on the schematic would indicate that the orange wire in circuit 150 is a 14 AWG wire.

If the gauge of the wire is not listed, the wire is 16 AWG.

Conversion of AWG Numbers to Metric Measurements

Table 8 shows the various AWG numbers that are used for the wires. The metric equivalent for the diameter of each AWG number are also shown.

Table 8

Metric Equivalents for AWG Numbers			
AWG Number	**Diameter (mm)**	**AWG Number**	**Diameter (mm)**
20	0.8	14	1.6
18	1.0	12	2.0
16	1.3	4	3.2

Welding on a Machine that is Equipped with an Electronic Control Module

Proper welding procedures are necessary in order to avoid damage to the engine's electronic control module, sensors, and associated components. The component that requires welding should be removed. When welding on a machine that is equipped with an ECM and removal of the component is not possible, the following procedure must be followed. This procedure provides the minimum amount of risk to the electronic components.

NOTICE

Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

1. Stop the engine. Turn the keyswitch to the OFF position.
2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.

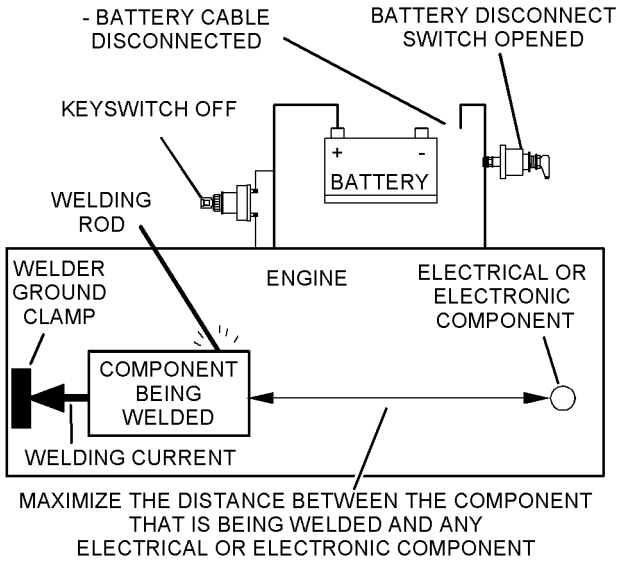


Illustration 12 g01143634

Service welding guide (typical diagram)

3. Connect the welding ground cable as close as possible to the area that will be welded. Components which may be damaged by welding include bearings, hydraulic components, and electrical/electronic components.

4. Protect the wiring harness from welding debris and from spatter.

5. Weld the materials by using standard welding methods.

Programming Parameters

i03312021

Programming Parameters

SMCS Code: 1901

The electronic service tool can be used to view certain parameters that can affect the operation of the engine. The electronic service tool can also be used to change certain parameters. The parameters are stored in the Electronic Control Module (ECM). Some of the parameters are protected from unauthorized changes by passwords. Parameters that can be changed have a tattletale number. The tattletale number shows if a parameter has been changed.

i06061809

Test ECM Mode

SMCS Code: 1901

“Test ECM Mode” is a feature on Cat ® Electronic Technician (ET) that is used to troubleshoot an engine that may have a problem with the Electronic Control Module (ECM).

If an application supports this feature, Cat ET will allow a new ECM to be used temporarily as a test ECM. If an application does not support this feature, refer to Troubleshooting, “ECM - Replace”.

When the “Test ECM Mode” is activated, an internal timer sets a 24 hour clock. This clock will count down only while the ECM is powered. If the new ECM fixes the problem, the engine can be released while the “Test ECM Mode” is still active. After the ECM has counted down the 24 hour period, the ECM will exit the “Test ECM Mode” . The parameters, the accumulated hours, and the engine serial number will be permanently programmed into the new ECM. The new ECM can no longer be used for another engine or for a test ECM.

Note: When the “Test ECM Mode” is activated, the “Personality Module Code” is 0. After the ECM has counted down the 24 hour period, the “Personality Module Code” will be dependent on the application.

If the new ECM does not resolve the problem, and 24 hours has not expired, the ECM can be used as a new ECM. Anytime prior to the 24 hour limit of the “Test ECM Mode” , a new engine serial number and new parameters can be reprogrammed.

1. Search for the latest flash file for the engine.

Note: If a newer software version is available for the engine, install the newest software on the suspect ECM. If the new software does not fix the problem, continue with this procedure.

2. Use the “Copy Configuration/ECM Replacement” feature on Cat ET to copy the configuration parameters from the suspect ECM to your personal computer (PC). If the “Copy Configuration/ECM Replacement” feature cannot be used, record the programmed values into the “Parameters Worksheet” in system configuration parameters Troubleshooting, “System Configuration Parameters”. Record the injector serial numbers from the “Calibrations” screen under the “Service” menu on Cat ET.

Note: Some applications use injectors that have trim codes or injector trim files that are associated with the injectors. If injector trim codes are necessary, the injector trim codes are printed on the injector. If injector trim files are necessary, the injector serial numbers are necessary for obtaining the correct injector trim files from Cat ET. The injector trim file is a number that is specific to each unit injector. The ECM uses this number to compensate for manufacturing variations between individual injectors. If you replace any of the unit injectors, you must program the injector trim files for the new injectors. Also, if you replace the ECM, you must program all of the injector trim files into the new ECM.

3. Disconnect the suspect ECM. Temporarily connect the new ECM to the engine. Do not mount the new ECM on the engine.

4. Program the correct flash file into the new ECM.

Note: The “Test ECM Mode” must be activated before the engine serial number is programmed into the new ECM. “Test ECM Mode” can only be activated if the engine serial number has not already been programmed during normal operation of the ECM. A new ECM can never be used as a test ECM after the engine serial number is programmed.

5. Start the “Test ECM Mode” on Cat ET. Access the feature through the “Service” menu. Cat ET will display the status of the “Test ECM Mode” and the hours that are remaining for the “Test ECM Mode” .

Note: If the “Copy Configuration/ECM Replacement” feature cannot be used, program the values from the “Parameters Worksheet” .

6. Use the “Copy Configuration/ECM Replacement” feature on Cat ET to program the correct parameters into the new ECM.

7. Program the engine serial number into the new ECM.

If the problem is resolved with the new ECM, remove the original ECM and permanently install the new ECM.

If the new ECM does not fix the problem, the original ECM is not the problem. Remove the new ECM before the 24 hour timer expires. Reconnect the original ECM.

i02433393

Factory Passwords

SMCS Code: 0785

NOTICE

Operating the engine with a flash file not designed for that engine will damage the engine. Be sure the flash file is correct for your engine.

Note: Factory passwords are provided only to Caterpillar dealers.

Factory passwords are required to perform each of the following functions:

- Program a new Electronic Control Module (ECM). When an ECM is replaced, the system configuration parameters must be programmed into the new ECM. A new ECM will allow these parameters to be programmed once without factory passwords. After the initial programming, some parameters are protected by factory passwords.
- Clear event codes. Most event codes require the use of factory passwords to clear the code once the code has been logged. Clear these codes only when you are certain that the problem has been corrected.
- Unlock parameters. Factory passwords are required in order to unlock certain system configuration parameters. Refer to Troubleshooting, “System Configuration Parameters”.

Since factory passwords contain alphabetic characters, the Caterpillar Electronic Technician (ET) must be used to perform these functions. In order to obtain factory passwords, proceed as if you already have the password. If factory passwords are needed, Cat ET will request the factory passwords and Cat ET will display the information that is required to obtain the passwords. For the worksheet that is used for acquiring factory passwords, refer to programming parameters Troubleshooting, “Factory Passwords Worksheet”.

i02419726

Flash Programming

SMCS Code: 1901-591

Flash Programming – This is a method of programming or updating the flash file in an engine's Electronic Control Module (ECM).

Caterpillar Electronic Technician (ET) is used to flash program a file into the memory of the engine's ECM.

If you do not have the flash file, use the “Flash File Search” tool on the Service Technician Workbench (STW) to obtain the flash file for your engine. Alternatively, use the “Service Software Files” feature on SIS Web to obtain the flash file for your engine. You must have the engine serial number in order to search for the flash file. After locating the correct flash file, download the flash file to your PC. Write down the name of the flash file for future reference.

Programming a Flash File

1. Establish communication between Cat ET and the engine's ECM.

2. Select “WinFlash” from the “Utilities” menu on Cat ET.

Note: If “WinFlash” will not communicate with the ECM, refer to troubleshooting without a diagnostic code Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

3. Program the flash file into the ECM.

a. Select the engine ECM under the “Detected ECMs” .

b. Press the “Browse” button in order to select the name of the flash file that will be programmed into the ECM.

c. When the correct flash file is selected, press the “Open” button.

d. Verify that the “File Values” match the application. If the “File Values” do not match the application, obtain the correct flash file.

e. When the correct flash file is selected, press the “Begin Flash” button.

f. Cat ET will indicate when flash programming has been successfully completed.

4. Start the engine and check for proper operation. Repair any active diagnostic or event codes.

“WinFlash” Error Messages

If you receive any error messages during flash programming, click on the “Cancel” button in order to stop the process. Access the information about the “ECM Summary” under the “Information” menu. Make sure that you are flashing the correct file for your engine.

i02490769

Injector Trim File

SMCS Code: 1290

The Caterpillar Electronic Technician (ET) is used to load the injector trim files into the Electronic Control Module (ECM).

The injector trim files must be loaded into the ECM if any of the following conditions occur:

- An injector is replaced.
- The ECM is replaced.
- “Injector Trim” is displayed below a 268-02 diagnostic code on Cat ET.
- Injectors are exchanged between cylinders.

Exchanging Injectors

Exchanging injectors can help determine if a combustion problem is in the injector or in the cylinder. If two injectors that are currently installed in the engine are exchanged between cylinders, the injector trim files can also be exchanged. Press the “Exchange” button at the bottom of the “Injector Trim Calibration” screen on Cat ET. Select the two injectors that will be exchanged and press the “OK” button. The tattletale for the injectors that were exchanged will increase by one.

Note: The injector serial number and the injector confirmation code are located on the injector. Cat ET may require the entry of injector confirmation code during this process. Cat ET will prompt you for the code, if necessary.

1. Record the injector serial number and the injector confirmation code for each injector.

2. Click on “Service Software Files” in SIS Web.

3. Enter the serial number for the injector in the search field.

4. Download the injector trim file to the PC. Repeat this procedure for each injector, as required.

5. Connect Cat ET to the service tool connector. Refer to electronic troubleshooting Troubleshooting, “Electronic Service Tools”.

6. Select the following menu options on Cat ET:

- Service
- Calibrations
- Injector Trim Calibration

7. Select the appropriate cylinder.

8. Click on the “Change” button.

9. Select the appropriate injector trim file from the PC.

10. Click on the “Open” button.

11. If you are prompted by Cat ET enter the injector confirmation code into the field.

12. Click on the “OK” button.

The injector trim file is loaded into the ECM.

13. Repeat the procedure for each cylinder, as required.

System Configuration Parameters

i02939596

System Configuration Parameters

SMCS Code: 1901

System configuration parameters are parameters that are configured to specify the engine's emissions levels, the power rating, and the specific application. Default values for the parameters are programmed at the factory. Some parameters may be changed in order to equip the engine for a specific application. The system configuration parameters must be reprogrammed if the Electronic Control Module (ECM) is replaced. It is not necessary to reprogram the system configuration parameters if you update the ECM flash file. Certain configuration parameters are stamped into the engine information plate.

Note: If the parameters that are protected with the factory passwords are changed, the Caterpillar warranty may be voided.

Parameter Descriptions

Equipment ID

The “Equipment ID” parameter allows the customer to enter a description into the ECM in order to identify the engine's application. A maximum of 17 characters can be entered in the field.

Engine Serial Number

Program the “Engine Serial Number” to match the engine serial number that is stamped on the engine information plate. The engine serial number is not preprogrammed on a replacement ECM.

ECM Part Number

This parameter identifies the part number for the ECM.

ECM Serial Number

This parameter identifies the serial number for the ECM.

Software Group Part Number

This parameter identifies the part number of the flash file that is currently installed in the ECM.

Software Group Release Date

This parameter identifies the release date of the flash file that is currently installed in the ECM.

Software Group Description

This parameter identifies the description of the application for the flash file that is currently installed in the ECM.

Full Load Setting (FLS)

FLS is a parameter that represents the adjustment to the fuel system that was made at the factory in order to fine tune the fuel system. The correct value for this parameter is stamped on the engine information plate. Only change this value if the engine is rerated or if a new ECM has been installed. Factory passwords are required to change this parameter.

Full Torque Setting (FTS)

FTS is similar to FLS. Only change this value if the engine is rerated or if a new ECM has been installed. Factory passwords are required to change this parameter.

Rated Power

This parameter specifies the rated power of the engine.

Rated Peak Torque

This parameter specifies the rated peak torque of the engine.

Top Engine Speed Range

This parameter specifies the maximum speed setting for the engine.

Test Spec

This is the engine's “Test Specifiction Number” . Use this number to retrieve data that is related to the engine's specifications from the Technical Marketing Information System (TMI). The following information can be retrieved from TMI:

- “As shipped consists”
- “Engine test specifications”
- “Systems data”
- “Physical data”
- “Gasket kit data”
- “Reman parts”

- “Performance data”

A link to TMI Web can be found on the web site for the Service Information System (SIS).

Total Tattletale

The total tattletale counts the number of changes to system parameters.

Low System Battery Voltage Elevated Idle

This parameter enables operation of the elevated idle function if a low battery condition is detected by the ECM.

Ether Solenoid Configuration

This parameter is enabled in order to define the installation status of an ether starting aid for the engine.

Engine Fan Reversing Feature

The “Engine Fan Reversing Feature” aids in clearing debris from the radiator.

Engine Cooling Fan Map

This parameter identifies the current map that is used by the ECM to drive the engine cooling fan.

Security System Immobilizer Installation Status

This feature enables the ECM to provide the functionality for the installation of a Machine Security System (MSS).

Engine Retarder Enable Command (Option)

This parameter is enabled in order to define the installation status of compression brakes for the engine.

Engine Warmup Elevated Idle Feature Enable Status

This feature allows a strategy for elevated idle to be enabled during cold engine operation.

Parameter Table

Table 9

System Configuration Parameters			
Parameter	**Available Range or Options**	**Default**	**Required Password**
Configuration Group 1			
Equipment ID	17 alphanumeric characters	Blank	None
ECM Identification Parameters			
Engine Serial Number	0XX00000 or XXX00000	Blank	Factory
ECM Serial Number	Hardware Dependent	Blank	Read Only(1)
ECM Part Number	Hardware Dependent	Blank	Read Only(1)
Software Group Part Number	Software Dependent		Read Only(1)
Software Group Release Date	Software Dependent		Read Only(1)
Software Group Description	Software Dependent		Read Only(1)
System Parameters			
FLS	Programmed at the Factory		Factory
FTS	Programmed at the Factory		Factory
Rated Power	Software Dependent		Read Only(1)
Rated Peak Torque	Software Dependent		Read Only(1)
Top Engine Speed Range	Software Dependent		Read Only(1)
Test Spec	Software Dependent		Read Only(1)
Total Tattletale	0 to 65535	0	Read Only(1)
Engine Configuration Parameters			
Low System Battery Voltage Elevated Idle	Enabled Disabled	Enabled	None
Ether Solenoid Configuration	Not Installed Continuous Flow Solenoid	Continuous Flow Solenoid	Customer
Engine Cooling Fan Map	Standard High Ambient	Standard	Factory
Security System Immobilizer Installation Status	Installed or Not Installed	Not Installed	Factory
Engine Retarder Enable Command (Option)	Enabled Disabled	Disabled	None
Engine Warmup Elevated Idle Feature Enable Status	Enabled Disabled	Disabled	None

(1) This parameter can be viewed only. No changes are allowed.

Parameter Worksheet

Record the following information before you change any programmable parameter.

Table 10

Engine Parameters	
Equipment ID	
Engine Serial Number	
ECM Serial Number	
ECM Part Number	
Software Group Part Number	
Software Group Release Date	
Total Tattletale	
FLS	
FTS	
Low System Battery Voltage Elevated Idle	
Ether Solenoid Configuration	
Engine Fan Reversing Feature	
Engine Cooling Fan Map	
Security System Immobilizer Installation Status	
Engine Retarder Enable Command	
Engine Warmup Elevated Idle Feature Enable Status	

Table 11

Information From Engine Information Plate	
Engine Serial Number	
FLS	
FTS	

Note: Compare the FLS and the FTS from the ECM with the values that are listed on the engine information plate. Use of incorrect parameters could cause damage to the engine. Use of the incorrect parameters may also void the Caterpillar warranty or the emission certification for the engine.

Troubleshooting without a Diagnostic Code

i02398533

Alternator
(Noisy Operation)

SMCS Code: 1405-035

Probable Causes

- Alternator drive belts
- Alternator drive pulley
- Alternator bearings

Recommended Actions

Alternator Drive Belts

1. Inspect the condition of the alternator drive belts. If the belts are worn or damaged, replace the belts.

2. Check the tension on the belts. Adjust the tension, if necessary.

3. Ensure that the belts are in proper alignment. Inspect the alternator mounting bracket for cracks and wear. Repair the mounting bracket or replace the mounting bracket in order to ensure that the belts and the alternator drive pulley are aligned.

Alternator Drive Pulley

Check the condition of the alternator drive pulley. Look for deep grooves that have been worn into the pulley by the belt. If there is excessive wear, replace the pulley. Check that the nut for the pulley has not become loose. If necessary, tighten the nut.

Alternator Bearings

Check the alternator bearings for signs of wear. Repair the alternator or replace the alternator, as needed.

i05450990

Battery

SMCS Code: 1401-035

Refer to Special Instruction, SEHS7633, “Battery Test Procedure” for the proper testing procedures.

Probable Causes

- Worn battery
- Switched battery circuit

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Table 12

Troubleshooting Test Steps	Values	Results
1. Verify that the battery is no longer able to hold a charge.	Battery	**Result:** The battery is able to hold a charge. Proceed to Test Step 2. **Result:** The battery is unable to hold a charge. Replace the battery
2. Verify that a switched battery circuit drained the battery by being left in the ON position.	Switch	**Result:** The switch has not been left in the ON position. **STOP** **Result:** The switch has been left in the ON position. Charge the battery.

i02433834

Can Not Reach Top Engine RPM

SMCS Code: 1915-035

Note: If this problem occurs only under load, refer to Troubleshooting, “Low Power/Poor or No Response to Throttle”.

Probable Causes

- Diagnostic codes and event codes
- Cold mode operation
- Throttle signal
- Intake manifold pressure sensor and atmospheric pressure sensor
- Fuel supply
- Air inlet and exhaust system
- Accessory equipment

Recommended Actions

Diagnostic Codes and Event Codes

Use Caterpillar Electronic Technician (ET) to check for logged derates. The engine speed or the engine power may be limited due to one of the following conditions: high altitude, high intake manifold air temperature, low oil pressure, air filter restriction and other factors. Refer to Troubleshooting, “Troubleshooting with an Event Code” for the specific events that are applicable to this application.

Cold Mode Operation

Use Cat ET to verify that the engine has exited cold mode. Cold mode operation may cause a slow throttle response. Engine speed may also be limited during cold mode operation.

Throttle Signal

Use Cat ET in order to monitor the throttle position while you operate the throttle pedal. Ensure that the throttle position sensor is operating correctly. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test”.

Intake Manifold Pressure Sensor and Atmospheric Pressure Sensor

1. Monitor the status of “Fuel Position” , of “Rated Fuel Limit” , and of “FRC Fuel Limit” on Cat ET while the engine is operating under full load. These parameters must reflect the information below.

Table 13

“Fuel Position” = “Rated Fuel Limit” and “Fuel Position” < “FRC Fuel Limit”

If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit” , the electronics are operating correctly. Otherwise, proceed with the next Step.

2. Use Cat ET in order to monitor the status of the “Boost Pressure” . With the engine stopped, the correct “Boost Pressure” is 0 kPa (0 psi).

3. Start the engine and monitor the status of “Boost Pressure” while you vary the engine speed. Ensure that the pressure reading is fluctuating with the engine speed.

4. Use Cat ET in order to check the status of the “Atmospheric Pressure” . Verify that the pressure reading is reasonable for the current conditions.

Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

2. Check the fuel tank for foreign objects or debris which may block the fuel supply.

3. Prime the fuel system if any of the following items have been serviced recently:

- Fuel filters
- Low pressure fuel supply circuit
- Unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Testing and Adjusting, “Air in Fuel - Test” for more information.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

5. Check the fuel pressure during engine cranking. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for the correct procedure. If the fuel pressure is below specifications, replace the fuel filters. If this does not correct the problem, check for the proper operation of the following items: fuel transfer pump, fuel pressure relief valve and fuel pressure regulator valve.

Air Inlet and Exhaust System

1. Check for an air filter restriction indicator. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.

2. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

Accessory Equipment

Check all accessory equipment for problems that may create excessive load on the engine. Make the necessary repairs to damaged components. Replace parts, if necessary.

i05988360

Coolant in Engine Oil

SMCS Code: 1348-035; 1395-035

Probable Causes

- Water pump
- Engine oil cooler core
- Water-cooled turbocharger
- Cylinder head gasket
- Cylinder head
- Cylinder liner
- Cylinder block

Recommended Actions

Table 14

Troubleshooting Test Steps	Values	Results
1. Water pump **A.** Check the weep hole in the water pump for blockage. **B.** Check the water pump seals.	Water pump	**Result :** The water pump is leaking. **Repair:** Replace the water pump. Refer to the Disassembly and Assembly manual for more information. **Result :** The water pump is not leaking. Proceed to Test Step 2.
2. Check for leaks in the oil cooler core.	Oil cooler core	**Result:** No leak is found in the oil cooler core. Proceed to Test Step 3. **Result:** There is a leak found in the oil cooler core. **Repair:** Replace the oil cooler core.
3. If the engine is equipped with a water-cooled turbocharger, inspect the turbocharger for cracks.	Turbocharger	**Result:** The turbocharger is not cracked. Proceed to Test Step 4. **Result:** The turbocharger is cracked. **Repair:** Replace the turbocharger. Refer to the Disassembly and Assembly Manual for more information.
4. Check the cylinder liner projection.	Liner projection	**Result:** Cylinder liner projection is OK. Proceed to Test Step 5. **Result:** Cylinder liner projection is NOT OK. **Repair:** Install a new cylinder head gasket and new water seals in the spacer plate. Refer to the Disassembly and Assembly manual.
5. Check for cracks in the cylinder head.	Cracks in cylinder head	**Result:** There are no cracks in the cylinder head. Proceed to Test Step 6. **Result:** There are cracks in the cylinder head. **Repair:** Repair the cylinder head and/or replace the cylinder head. Refer to the Disassembly and Assembly manual.

(continued)

(Table 14, contd)

6. Check for cracked cylinder liners.	Cracks in cylinder liners	**Result:** There are no cracks in the cylinder liners. Proceed to Test Step 7. **Result:** There are cracks in the cylinder liners. **Repair:** Replace any cracked cylinder liners. Refer to the Disassembly and Assembly manual.
7. Inspect the cylinder block for cracks.	Cracks in cylinder block.	**Result:** The cylinder block is not cracked. STOP **Result:** The cylinder block is cracked. **Repair:** Repair the cylinder block or replace the cylinder block. STOP

i05451344

Coolant Temperature Is Too High

SMCS Code: 1395-035

Probable Causes

- Low coolant level
- Air in coolant
- Water pump
- Environmental conditions
- Shunt line restriction
- Radiator or heat exchanger
- Water temperature regulator
- Coolant temperature sensor
- Engine coolant flow
- Exhaust restriction
- Excessive load
- Combustion gas in the coolant

Recommended Repairs

Low Coolant Level

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

Table 15

Troubleshooting Test Steps	Values	Results
1. Check for leaks in the cooling system. **Note:** Low coolant level can be the result of overheating rather than the cause. A. Run the engine to operating temperature. B. Inspect the cooling system for leaks. **Note:** Check for the presence of coolant in the engine oil. This would indicate an internal coolant leak.	Coolant level	**Result:** There are no leaks in the cooling system. Proceed to Test Step 2. **Result:** A leak in the cooling system was found. Add coolant, if necessary. If leaking is found, make the necessary repairs.
2. Air can enter the cooling system if the pressure cap is not operating properly. Check the operation of the pressure cap. **Note:** If the coolant has been changed recently, ensure that the air has been purged from the cooling system. Refer to Systems Operation/Testing and Adjusting. **Note:** The supply pressure to the water pump must be sufficient in order to prevent cavitation. Measure the supply pressure at the inlet to the water pump.	Pressure cap	**Result:** The operation of the pressure cap is OK. Proceed to Test Step 3. **Result:** The operation of the pressure cap is NOT OK. Replace the pressure cap, if necessary.
3. The engine will overheat if the water pump is not operating properly. Measure the coolant pressure at the outlet of the water pump.	Water pump	**Result:** The water pump is operating properly. Proceed to Test Step 4. **Result:** The water pump is not operating properly. Replace the water pump. Refer to the Disassembly and Assembly manual.
4. Check the shunt line for a restriction in the line.	Shunt line	**Result:** The shunt line does not have a restriction in the line. Proceed to Test Step 5. **Result:** The shunt line has a restriction in the line. Remove the restriction or replace the shunt line.

(continued)

(Table 15, contd)

5. If the engine is equipped with a radiator, check the fins of the radiator for obstructions.	Radiator	**Result:** The fins of the radiator does not have any obstructions. Proceed to Test Step 6 **Result:** The fins of the radiator are obstructed. If the radiator fins are obstructed, clean the fins.
6. Check the water temperature regulator for proper operation.	Water temperature regulator	**Result:** The water temperature regular is operating correctly. Proceed to Test Step 7. **Result:** The water temperature regulator is not operating correctly. Replace the water temperature regulator. Refer to the Disassembly and Assembly Manual.
7. Compare the reading for the coolant temperature from the Caterpillar Electronic Technician (ET) to the reading for the coolant temperature from a mechanical gauge. The temperature should rise steadily as the engine is warmed. Ensure that the temperature is reasonable. Refer to Systems Operation/Testing and Adjusting.	Coolant temperature sensor	**Result:** The temperature is reasonable. Proceed to Test Step 8. **Result:** The temperature is not reasonable. If the reading on Cat ET for the coolant temperature is not reasonable, troubleshoot the circuit and the coolant temperature sensor. Refer to the diagnostic functional test Troubleshooting, “Engine Temperature Sensor Open or Short Circuit - Test”.
8. Check the back pressure of the exhaust system. Refer to the engine's Technical Marketing Information.	Back pressure	**Result:** The back pressure does not exceed the specifications of the engine. STOP **Result:** the back pressure exceeds the specifications for the engine. Determine the cause of the excessive back pressure. Make the necessary repairs. STOP

i06910188

ECM Will Not Accept Factory Passwords

SMCS Code: 1901-035

Probable Causes

One of the following items may not be recorded correctly on the Cat ® Electronic Technician (ET):

- Passwords
- Serial numbers
- Total tattletale
- Reason code

Recommended Actions

Table 16

Troubleshooting Test Steps	Values	Steps
1. Check the Factory Passwords **A.** Verify that the correct passwords were entered. **B.** Verify that Cat ® Electronic Technician (ET) is displaying the “Enter Factory Passwords” dialog box.	Factory Passwords	**Result:** The factory passwords were not accepted in Cat ET. **Repair:** Check every character in each password and remove the electrical power from the engine for 30 seconds and then retry. Use Cat ET to verify that the following information has been entered correctly: Engine Serial Number, Serial Number for the Electrical Control Module, Serial Number for Cat ET, Total Tattletale, and Reason Code.

For additional information, refer to Troubleshooting, “Factory Passwords”.

If the procedure did not correct the issues, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i05852479

ECM Will Not Communicate with Other Systems or Display Modules

SMCS Code: 1901-035

Probable Causes

- Wiring and/or electrical connectors
- Cat Data Link
- CAN data link (if equipped)
- Electronic Control Module (ECM)

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in the order of the listed test steps.

Table 17

Troubleshooting Test Steps	Values	Results
1. Check for correct installation of the connectors for the ECM J1/P1, J2/P2, and J3/P3. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”	ECM	**Result:** Connectors are installed incorrectly. **Repair:** Correct the installation issue. Return to service. **Result:** Connectors are installed correctly. Proceed to Test Step 2
2. Connect Cat ® Electronic Technician (Cat ET) to the service tool connector.	Cat ET	**Result:** Cat ET will not communicate with the ECM. Proceed to troubleshooting without a diagnostic code Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM.” **Result:** Cat ET communicates with the ECM. Proceed to Test Step 3.
3. Troubleshoot the Cat Data Link for possible problems.	Cat Data Link	**Result:** Cat Data Link does not connect. Refer to the diagnostic functional test Troubleshooting, “Cat Data Link Circuit - Test”. **Result:** Cat Data Link connects. Proceed to Test Step 4.
4. Troubleshoot the CAN Data Link (if equipped) for possible problems.	CAN Data Link	**Result:** CAN Data Link does not connect. Refer to the diagnostic functional test Troubleshooting, “CAN Data Link Circuit - Test”. **Result:** CAN Data Link connects. Return to service.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i05856448

Electronic Service Tool Will Not Communicate with ECM

SMCS Code: 0785-035; 1901-035

Probable Causes

- Configuration for the communications adapter
- Electrical connectors
- Communication adapter and/or cables
- Electrical power supply to the service tool connector
- Caterpillar Electronic Technician (ET) and related hardware
- Electrical power supply to the Electronic Control Module (ECM)
- Flash file
- Cat Data Link

Recommended Actions

Table 18

Troubleshooting Test Steps	Values	Results
1. Engine Start Up	Communication problem	**Result:** Engine starts, but the ECM will not communicate with Cat ET. Proceed to Test Step 2. **Result:**Engine will not start Refer to Troubleshootings, “Engine Cranks but Will Not Start”. **Result:** Engine will not crank. Refer to Troubleshooting, “Engine Will Not Crank”.
2. Configuration for the communications adapter A. Access "Preferences" under the "Utilities" menu on Cat ET. B. Verify that the correct "Communications Interface Device" is selected. C. Verify that the correct port is selected for use by the communication adapter. **Note:** The most commonly used port is "COM 1". D. Check for any hardware that is utilizing the same port as the communications adapter.	Cat ET	**Result:** The incorrect "Communications Interface Device" is not selected. **Repair:** Select the correct "Communications Interface Device". **Result:** The correct "Communication Interface Device" is selected. **Result:** The incorrect port was selected. **Repair:** Select the correct port for the communication adapter. The correct port was selected. Proceed to Test Step 3. **Note:** The most commonly used port is "COM 1". **Result:** If any devices are configured to use the same port, exit or close the software programs for that device.
3. Check for correct installation of the J1/P1, and J2/P2 ECM connectors and of the service tool connector.	ECM	**Result:** Connectors are installed incorrectly. A. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” **Repair:** Correct the installation issue. Return to service. **Result:** Connectors are installed correctly. Proceed to Test Step 4.

(continued)

(Table 18, contd)

4. Check that the Version of the Firmware and driver files for the Communication Adapter has the Most Current Files that are Available. A. Verify that the correct cable is being used between the communication adapter and the service tool connector.	Firmware	**Result:** If the firmware and driver files do not match, the communication adapter will not communicate with Cat ET. **Repair:** Disconnect the communication adapter and the cable from the service tool connector. Reconnector the communication adapter to the service tool connector. **Result:** Refer to electronic troubleshooting Troubleshooting, “Electronic Service Tools”.
5. Check the Electrical Power to the Communication Adapter A. Check for battery voltage at the service tool connector between terminals A and B.	Electrical power	**Result:** Communication Adapter is not receiving power, and the display on the Communication Adapter is blank. **Repair:** Inspect the wiring and fuses. Determine the cause of the missing voltage and Make the necessary repairs. **Repair:** Battery voltage is present at terminals A and B. Proceed to Test Step 6.
6. Connect Cat ET to a different engine in order to eliminate Cat ET and the related hardware as the problem.	Cat ET	**Result:** Connected Cat ET and other hardware to another engine and still have problem. **Repair:** Inspect Cat ET and related hardware to determine the cause of the problem. **Result:** Connected Cat ET and other hardware to another engine and is working. Proceed To Test Step 7.
7. Check power to the ECM.	ECM	**Result:**Battery voltage is not present at ECM. **Note:** If the ECM is not receiving battery voltage, the ECM will not Communicate. **Repair:** Inspect the wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs. Refer to the diagnostic functional test Troubleshooting, “Electrical Power Supply Circuit - Test. ” **Result:** ECM is receiving battery voltage. Proceed to Test Step 8.

(continued)

(Table 18, contd)

8. Ensure that the correct flash file is properly installed in the ECM	Flash File	**Result:** Flash file is not installed properly in the ECM. **Note:** A new ECM is not programmed to any specific engine until a flash file has been installed. The engine will not start and the engine will not communicate with Cat ET until the flash file has been downloaded. Refer to programming parameters Troubleshooting, “Flash Programming”. **Repair:** Download the correct flash file and install properly to the ECM. **Result:** The flash file is correct and properly installed in the ECM. Proceed to Test Step 9.
9. Troubleshoot the Cat Data Link for possible problems.	Cat Data Link	**Result:** Refer to the diagnostic functional test Troubleshooting, “Cat Data Link Circuit - Test”.

i02400445

Elevated Idle

SMCS Code: 1915-035

Probable Causes

This condition does not indicate an electronic system problem. The low idle speed may be elevated due to the “Low Battery Voltage Elevated Idle” feature.

Note: Caterpillar Electronic Technician (ET) will display the status of “Elevated Idle” if this feature is active.

Conditions

Low Battery Voltage Elevated Idle

The engine idle speed will be elevated to 1000 rpm when all of the following conditions occur:

- The parameter is set to “Enabled” .
- System battery voltage is less than 24.5 VDC for five minutes.
- The throttle pedal position is below 25 percent for five minutes.
- The machine is not in gear.
- The parking brake is set.

i02475556

Engine Cranks but Will Not Start

SMCS Code: 1000-035

Probable Causes

- Diagnostic codes and event codes
- Electronic Control Module (ECM)
- Starting aids (if applicable)
- Engine shutdown switches
- Starting motor, solenoid, or starting circuit
- Engine speed/timing
- Unit injector
- Fuel supply
- Combustion

Recommended Actions

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may prevent the engine from starting. Connect the Caterpillar Electronic Technician (ET) and check for active codes and/or for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Electronic Control Module (ECM)

If the ECM is not receiving battery voltage, the ECM will not operate. Refer to Troubleshooting, “Electrical Power Supply Circuit - Test”.

Starting Aids (If Applicable)

If cold ambient conditions exist, check operation of starting aids. Verify that the ether system is operating correctly. Refer to the appropriate diagnostic functional test for troubleshooting information.

Engine Shutdown Switches

The engine shutdown switches must be in the RUN position in order to start the engine. Use Cat ET to verify the status of the shutdown switches. When an engine shutdown switch is used to shut down the engine, electrical power must be removed from the ECM for at least 15 seconds before restarting the engine.

Starting Motor, Solenoid, or Starting Circuit

Remove the starter and visually inspect the pinion of the starter and the flywheel ring gear for damage.

Test the operation of the starting motor solenoid. Check the condition of the engine wiring for the starting motor solenoid. Test the operation of the starting motor.

If necessary, repair the starter or the starter circuit.

Engine Speed/Timing

1. Crank the engine and observe the engine speed on the Cat ET status screen. If Cat ET indicates zero rpm, refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

Note: Upon initial cranking, the status for engine speed may indicate that the engine speed signal is abnormal. This message will be replaced with an engine speed once the ECM is able to calculate a speed from the signal.

2. If an engine speed is present, check the sensor installation. If the sensor is not properly installed, the ECM may read engine speed, but the ECM cannot determine the tooth pattern. The ability for the ECM to read the tooth pattern is necessary to determine the cylinder position. Engine speed is present when engine speed is greater than 50 rpm. Refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

Unit Injector

1. Ensure that the valve cover connector for the injectors is fully connected and free of corrosion.
2. Perform the “Injector Solenoid Test” on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for additional information.

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.
2. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
3. Check the fuel tank for foreign objects which may block the fuel supply.
4. Prime the fuel system if any of the following procedures have been performed:
   - Replacement of the fuel filters
   - Service on the low pressure fuel supply circuit
   - Replacement of unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Testing and Adjusting for more information.

5. Check the fuel filters.
6. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

7. Check the fuel pressure during engine cranking. Check the fuel pressure after the fuel filter. Refer to Systems Operation/Testing and Adjusting, “Fuel System Pressure - Test” for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling and fuel pressure regulating valve.

Combustion

Check the engine for combustion problems.

i05451574

Engine Has Early Wear

SMCS Code: 1000-035

Probable Causes

- Incorrect maintenance intervals and/or incorrect oil
- Contaminated engine oil
- Low oil pressure
- Leaks in the air system
- Inspect the fuel filters for contamination.

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Table 19

Troubleshooting Test Steps	Values	Results
1. Incorrect Maintenance Intervals and/or Incorrect Oil A. Use engine oil that is recommended and change the engine oil at the interval that is recommended by the engines Operation and Maintenance Manual.	Maintenance intervals	**Result:** The engine oil was changed at the interval that is recommended by the engines Operation and Maintenance Manual. Proceed to Test Step 2. **Result:** The engine oil was not changed at the interval that is recommended by the engines Operation and Maintenance Manual. Use at least the minimum grade of Cat oil. Change the engine oil at the interval that is recommended. Repair or replace any damaged parts.
2. Contaminated Engine Oil A. Obtain an S-O-S oil analysis. The analysis will contribute to a better understanding of oil contamination. B. Check the oil filter bypass valve. If the oil filter bypass valve is open, the oil will not be filtered. Check the oil filter bypass valve for a weak spring or for a broken spring. If the spring is broken, replace the spring. Verify that the oil bypass valve is operating correctly. Refer to the Disassembly and Assembly manual. Refer to the Caterpillar guidelines for “Reusability and Salvage/ Repair” for determining if the replacement of parts is necessary in order to perform a quality repair.	Contamination	**Result:** The oil is contaminated. Determine the reason for any contamination of the engine oil and make the necessary repairs. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the engines Operation and Maintenance Manual. **Result:** The oil is not contaminated. Proceed to Test Step 3.
3. Low Oil Pressure A. Engine oil that is contaminated with another liquid can cause low engine oil pressure. High engine oil level can be an indication of contamination. Obtain an analysis of the engine oil. B. The inlet screen of the suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure. Check the inlet screen on the suction tube and remove any material that may be restricting engine oil flow. When some components of the engine show wear in a short time, the cause can be a restriction in a passage for engine oil. An indicator for the engine oil pressure may indicate sufficient pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the engine oil supply to the component. Refer to Systems Operation/Testing and Adjusting, “Lubrication System” for additional information.	Restriction	**Result:** The inlet tube has a restriction. Clear the obstruction. Verify the repair. **Result:** The inlet tube does not have a restriction. Proceed to Test Step 4.

(continued)

(Table 19, contd)

Troubleshooting Test Steps	Values	Results
4. Leaks in Air System A. A leak in the air intake system may allow unfiltered air into the engine. Inspect the air intake system for streaks which may indicate a leakage of unfiltered air. Inspect all of the gaskets and the connections.	Air leak	**Result:** There are no air leaks. Proceed to Test Step 5. **Result:** There are air leaks. Repair any leaks.
5. Inspect the Fuel Filters for Contamination A. Remove the fuel filters. Inspect the fuel filters for contamination. Contaminants in the fuel such as hydrogen sulfide and sulfur can lead to the formation of acids in the crankcase. Obtain a fuel analysis.	Fuel filters	**Result:** The fuel has contamination. Determine the cause of any contamination and make the necessary repairs. Install new fuel filters. Refer to the Operation and Maintenance Manual.

Complete the procedure in the order in which the steps are listed.

The procedure corrected the issue. Return the engine to service.

The procedure did not correct the issue.

Contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i05451591

Engine Misfires, Runs Rough or Is Unstable

SMCS Code: 1000-035

Note: Refer to Troubleshooting, “Cat ET Service Features” for information about service features.

Probable Causes

- Active codes and logged codes
- Low quality fuel
- Fuel injectors
- Lack of lubrication
- Valve train components
- Gear train and components of the lower end

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Table 20

Troubleshooting Test Steps	Values	Results
1. Active Codes and Logged Codes A. Establish communication between Caterpillar Electronic Technician (ET) and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary. B. Download the “Warranty Report” from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes. Troubleshoot any active codes before continuing with this procedure.	Codes	**Result:** There are active codes. Troubleshoot any active codes before continuing with this procedure. **Result:** There are no active codes. Proceed to Test Step 2.
2. Fuel Quality A. Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine. If necessary, obtain a fuel analysis in order to confirm that the correct fuel is being used for the engine. Refer to Systems Operation/Testing and Adjusting, “Fuel Quality - Test” for the proper procedure.	Fuel	**Result:** The fuel quality is OK. Proceed to Test Step 3. **Result:** The fuel quality is not OK. Replace the fuel. Verify that the repair eliminated the problem.
3. Fuel Injectors **C13, C15, and C18 Applications** If service has been performed on the engine fuel system recently, verify that the injector trim files are correct. Use Cat ET to check that the injector trim files are correct for the injectors that are installed on the engine. A. Perform the “Injector Solenoid Test” on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. B. Access the “Cylinder Cutout Test” in the “Diagnostic Tests” under the “Diagnostics” menu. C. Perform the “Automatic Cylinder Cutout Test” on Cat ET. **C9.3 Applications** A. Use Cat ET to ensure that there are not any active diagnostic codes for the injector solenoids. Perform the “Cylinder Cutout Test” in order to check for a misfiring cylinder. Refer to Troubleshooting, “Injector Solenoid - Test” for information that is related to the test. Use Cat ET to perform the “Fuel System Verification Test” in order to check the mechanical condition of the fuel injectors. Refer to Troubleshooting, “Injector Solenoid - Test” for information that is related to the test.	Injector Solenoid Test or Fuel System Verification Test	**Result:** The test was successful. Proceed to Test Step 4. **Result:** The test was not successful. Diagnose the problem and then repair the problem. Reset all active codes and clear all logged codes. Verify that the repair eliminated the problem.

(continued)

(Table 20, contd)

Troubleshooting Test Steps	Values	Results
4. Proper Lubrication A. Check for proper lubrication of the valve components. Check for sufficient lubrication between the injector tappets and the rocker arms. B. Check for blocked oil passages. Oil passages must be clean. Clean any oil passages that are questionable. Refer to the Disassembly and Assembly for additional information. C. Inspect the engine oil filters for ferrous material. D. Obtain an S-O-S oil analysis. The analysis will contribute to a better understanding of oil contamination and the origin of the contamination.	Lubrication	**Result:** The oil passages are not blocked and the engine has proper lubrication. Proceed to Test Step 5. **Result:** The oil passages are blocked or the engine does not have proper lubrication. Make the necessary repairs, Verify that the repair eliminated the problem.
5. Valve Train Components A. Check the valve lash. Refer to Troubleshooting, “Valve Lash Is Excessive”. B. Check for damage to valve train components. Remove the valve cover from the suspect cylinders. Check the following items for damage: 1. Camshaft 2. Valve rotocoil 3.Valve springs 4. Camshaft followers 5. Rocker shaft 4. Bridges 5. Pushrods 6. Injectors Refer to the Disassembly and Assembly for additional information. C. Check for valves that do not move freely. Remove the cylinder head and inspect the valves. Refer to the Disassembly and Assembly for additional information.	Valve train	**Result:** The valve train components are not damaged. Proceed to Test Step 6. **Result:** The valve train components are damaged. Make the necessary repairs, Verify that the repair eliminated the problem.
6. Gear Train and Components of the Lower End A. Inspect the gear train and lower end components.	Gear train	**Result:** The gear train or lower end components are damaged. Replace any damaged parts.

Complete the procedure in the order in which the steps are listed.

The procedure corrected the issue. Return the engine to service.

The procedure did not correct the issue.

Contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i05870429

Engine Oil in Cooling System

SMCS Code: 1348-035; 1350-035

Probable Causes

- Engine oil cooler core
- Cylinder head gasket
- Water pump

Recommended Actions

Table 21

Troubleshooting Test Steps	Values	Results
1. Engine Oil Cooler Core A. Inspect the engine oil cooler core for any leaks.	Oil Cooler Core	**Result:** The oil cooler core is leaking. **Repair:** Replace the oil cooler core. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to Disassembly and Assembly and Operation and Maintenance Manual.
2. Cylinder Head Gasket A. Remove the cylinder head. Refer to the Disassembly and Assembly B. Check the cylinder liner projection. Refer to the Systems Operation and Testing and Adjusting manual. C. Install a new cylinder head gasket and new water seals in the spacer plate. Refer to the Disassembly and Assembly manual.	Cylinder Head Gasket	**Result:** New cylinder head gasket and water seals were installed. Proceed to Test Step 3.
3. Water Pump A. Check the weep hole in the water pump for blockage. B. Check the water pump seals.	Water Pump	**Result:** The water pump is leaking. **Repair:** Replace the water pump. Refer to the Disassembly and Assembly manual for more information. **Result:** The water pump is not leaking. Verify that the repair eliminated the problem.

i06570240

Engine Oil Temperature Is Too High

SMCS Code: 1348-035-TA

Probable Causes

- Engine oil level
- Engine oil cooler bypass valve
- Engine oil cooler core
- Engine coolant temperature

Recommended Actions

Table 22

Troubleshooting Test Steps	Values	Results
1. Check the Engine Oil Level **A.** Use the engine oil dipstick to check for the correct oil level.	Engine Oil Level	**Result:** The engine oil level is OK. Proceed to Test Step 2. **Result:** The engine oil level is NOT OK. **Repair:** Add oil to the crankcase.
2. Check the Engine Oil Cooler Bypass Valve **A.** Inspect the components of the engine oil cooler bypass valve for damage. Clean the engine oil cooler bypass valve and clean the bore for the valve. Ensure that the bypass valve is not stuck in the open position.	Engine Oil Cooler Bypass Valve	**Result:** The engine oil cooler bypass valve is OK. Proceed to Test Step 3. **Result:** The engine oil cooler bypass valve is NOT OK. **Repair:** Repair or replace the engine oil cooler bypass valve.
3. Check the Engine Oil Cooler Core **A.** Check the engine oil cooler core for damage and for plugging.	Engine Oil Cooler Core	**Result:** The engine oil cooler core is not damaged or plugged. Proceed to Test Step 4. **Result:** The engine oil cooler core is damaged and/or plugged. **Repair:** Clean the engine oil cooler core or replace the engine oil cooler core.
4. Check the Engine Coolant Temperature	Engine Coolant Temperature	**Result:** The engine coolant temperature is normal. Return the engine to service. **Result:** The engine coolant temperature is not normal. **Repair:** Refer to troubleshooting without a diagnostic code Troubleshooting, “Coolant Temperature Is Too High”.

i03891494

Engine Shutdown While Idling

SMCS Code: 1900-035

Use this procedure if one of the following event codes is active. Refer to Troubleshooting, “Event Codes” for information about event codes.

Table 23

Event Code		
CDL Code	**Description**	**System Response**
E1171(1)	Engine Idle Shutdown Occurred	The engine has been idling for an extended amount of time. This is a notification for the operator. This is not a suspected engine problem. The code is logged.
E1172(2)	Engine Idle Shutdown Pending	The engine is preparing to shutdown due to extended idle time. The code is logged.
E1172(3)	Engine Idle Shutdown Pending	The engine is shutting down. An alarm will sound. The code is logged.

Probable Causes

Normal Operation

- Extended idle time

Recommended Actions

Engine at idle speed

This condition is normal operation. The engine has been idling for an extended amount of time and the Electronic Control Module (ECM) will shut down the engine.

The “Extended Engine Idle Shutdown” parameter in Caterpillar Electronic Technician (ET) can be disabled and the amount of time before engine shutdown can then be configured.

i05451609

Engine Stalls at Low RPM

SMCS Code: 1915-035

Note: Refer to Troubleshooting, “Cat ET Service Features” for information about service features.

Probable Causes

- Unit injectors
- Fuel supply
- Air supply
- Engine idle
- Accessory equipment

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Table 24

Troubleshooting Test Steps	Values	Results
1. Unit Injectors A. Check for correct installation of the J1/P1 and J2/P2 connectors for the Electronic Control Module (ECM). B. Check for correct installation of the J300/P300 connectors for the unit injectors. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” .	Unit Injectors	**Result:** The J1/P1 and J2/P2 connectors have been installed correctly. **Result:** The J300/P300 connectors have been installed correctly. Proceed to Test Step 2. **Result:** The connectors have not been installed properly. Repair the connectors.
2. Fuel Supply A. Check the fuel pressure. Refer to Systems Operation/Testing and Adjusting. B. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. C. Check the fuel tank for foreign objects which may block the fuel supply. Note: A sight glass in the low-pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting. D. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual. E. Check the fuel pressure after the fuel filter while the engine is being cranked. For the correct pressure values, refer to the Systems Operation/Testing and Adjusting manual.	Fuel Supply	**Result:** The fuel lines are OK. **Result:** The fuel lines are NOT OK. Replace or repair the fuel lines. **Result:** The fuel tank does not have a blockage of the fuel supply. **Result:** The fuel tank has a blockage of the fuel tank. Repair the blockage in the fuel tank. **Result:** The fuel pressure is OK. Proceed to Test Step 3. **Result:** The fuel pressure is NOT OK. Make the necessary repairs.
3. Air Supply A. Check for restrictions in the air inlet system. Refer to Systems Operation/Testing and Adjusting.	Air inlet system	**Result:** The are no restrictions in the air inlet system. Proceed to Test Step 4. **Result:** There are restrictions in the air inlet system. Repair the restrictions in the air inlet system.
4. Engine Idle A. Check the parameter for the low engine idle (if applicable). Refer to Troubleshooting, “System Configuration Parameters” .	Parameters	**Result:** The low engine idle parameters are OK. Proceed to Test Step 5. **Result:** The low engine idle parameters are NOT OK. Repair the low engine idle parameters.
5. Engine Accessories A. Inspect any engine accessories and the transmission (if applicable).	Engine accessories	**Result:** An engine accessory is creating an excessive load. Repair the engine accessory.

Complete the procedure in the order in which the steps are listed.

The procedure corrected the issue. Return the engine to service.

The procedure did not correct the issue.

Contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i05451717

Engine Vibration

SMCS Code: 1000-035

Probable Causes

- Vibration damper
- Engine supports
- Driven equipment
- Engine misfiring or running rough

Recommended Actions

Table 25

1. Vibration Damper A. Check the vibration damper for damage. B. Inspect the mounting bolts for damage and/or for wear.	Damage to vibration damper	**Result:** The vibration damper has not been damaged. Proceed to Test Step 2. **Result:** The vibration damper has been damaged. Replace the vibration damper. Replace any damaged bolts. Refer to the Disassembly and Assembly manual.
2. Engine Supports A. Inspect the mounts and the brackets while you run the engine through the speed range. Look for mounts and brackets that are loose and/or broken.	Loose or broken mounts	**Results:** Mounts and brackets are not damaged. Proceed to Test Step 3. **Results:** Mounts and brackets are damaged. Tighten all of the mounting bolts. Install new components, if necessary.
3. Driven Equipment Check the alignment and the balance of the driven equipment.	Alignment and balance of driven equipment	**Result:** Driven equipment is OK. STOP **Result:** Driven equipment is NOT OK. Repair or replace the faulty driven equipment.

i02349504

Engine Will Not Crank

SMCS Code: 1000-035

Probable Causes

- Engine shutdown switch
- Battery cables
- Batteries
- Starting circuit
- Starting motor solenoid
- Starting motor
- Flywheel ring gear
- Driven equipment
- Engine accessories
- Hydraulic cylinder lock
- Internal engine problem

Recommended Actions

Engine Shutdown Switch

Verify that the engine shutdown switch is in the RUN position. If the switch is in the OFF position, fuel injection is disabled. Some engine shutdown devices will prevent the engine from being cranked. If the condition of the engine shutdown switch is suspect, refer to Troubleshooting, “Switch Circuits - Test” for troubleshooting information.

Ensure that other engine shutdown devices are not preventing the engine from being cranked. Check the application for a starter relay that is actuated by another controller. Check for a security system that may be preventing the engine from being started.

Battery Cables and/or Batteries

1. Inspect the battery disconnect switch, bus bars, battery posts, and battery cables for loose connections and corrosion. If the battery cables are corroded, remove the battery cables and clean the battery cables. Tighten any loose connections.
2. Inspect the batteries.
   a. Charge the batteries. Refer to Special Instruction, SEHS7633, “Battery Test Procedure”.
   b. Load test the batteries. Refer to Special Instruction, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries”.

Starting Motor Solenoid and/or Starting Circuit

1. Test the operation of the starting motor solenoid.
2. Check the wiring to the starting motor solenoid.

Starting Motor and/or Flywheel Ring Gear

1. Test the operation of the starting motor.
2. Inspect the starter pinion and the flywheel ring gear for damage. Ensure that the pinion gear does not bind with the flywheel ring gear during starting.

Driven Equipment and/or Engine Accessories

1. Ensure free movement of the driveline.
2. Ensure that the timing pin was not left in the flywheel housing.
3. Remove any engine accessories that may lock up the engine. Inspect the condition of the accessories.

   The following list illustrates examples of engine accessories that may lock up the engine:

   - Fuel transfer pump
   - Air compressor
   - Engine oil pump

Hydraulic Cylinder Lock

Check for fluid in the cylinders (hydraulic cylinder lock) by removing the individual unit injectors.

Note: Be sure to drain the fuel from the cylinder head prior to removing the injectors. Fuel will flow from the cylinder head into the cylinders when the unit injector is removed.

Internal Engine Problem

1. Disassemble the engine. Refer to Disassembly and Assembly.
2. Inspect the internal components for the following conditions:

   - Seizure
   - Broken components
   - Bent components

i05901433

Excessive Black Smoke

SMCS Code: 1088-035

Probable Causes

- Air inlet or exhaust system
- Engine speed/timing sensor
- Atmospheric pressure sensor
- Boost pressure sensor
- “Fuel Position” and/or “FRC Fuel Limit”
- Flash file
- Fuel quality
- Valve adjustment

Recommended Actions

Table 26

Troubleshooting Test Steps	Values	Results
1. Air Inlet and Exhaust System A. Check the air inlet system, air filter, air inlet piping, and exhaust system for restrictions and/or leaks. B. Ensure that the turbocharger is in working order. C. Repair any leaks that were found. Remove any restrictions that were found and replace any damaged components that were found.	Restrictions	**Result:** There are no restrictions or leaks in the air inlet or exhaust system. Proceed to Test Step 2. **Result:** There are restrictions and leaks in the air inlet or exhaust system. **Repair:** Make the necessary repairs, and refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust” for the correct procedure.
2. Engine Speed/Timing A. Check the calibration of the engine speed/timing sensor. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”. B. Verify that the crankshaft and the camshaft drive gears are set with the proper orientation. Refer to the Disassembly and Assembly manual.	Timing Signal	**Result:** The timing sensor is operating properly and the crankshaft and camshaft drive gears are aligned. Proceed to Test Step 3. **Result:** The timing sensor is not operating properly and the crankshaft and camshaft drive gears are not aligned. **Repair:** Repair the timing sensor and properly align the crankshaft and camshaft drive gears. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate” for troubleshooting information. Verify that the repair eliminated the problem.
3. Atmospheric Pressure Sensor A. Remove the atmospheric pressure sensor and inspect the sensor. B. Check the Caterpillar Electronic Technician (ET) for active diagnostic codes on the sensor. If no active diagnostic code exists, the sensor may be used. The correct reading for the atmospheric pressure is between 50 kPa (7.25 psi) and 100 kPa (14.5 psi).	Pressure Sensor	**Result:** The atmospheric pressure sensor is properly working and shows no signs of debris, moisture, and ice. Proceed to Test Step 4. **Result:** The atmospheric pressure sensor is not properly work and has either debris, moisture, and/or ice on the sensor. **Repair:** Remove the debris, moisture, or ice from the sensor and reuse. If sensor is not working properly replace the sensor.

(continued)

(Table 26, contd)

4. Boost Pressure Sensor, "Fuel Position", and/or "FRC Fuel Limit" A. Monitor the status of "Fuel Position" and "Rated Fuel Limit" while the engine is operating under full load. If "Fuel Position" equals "Rated Fuel Limit", and "Fuel Position" is less than "FRC Fuel Limit" the Electronic Control Module (ECM) is providing the correct control. B. Monitor the status of "Boost Pressure" and "Atmospheric Pressure" on Cat ET and verify that there are no active codes for the boost pressure sensor. When the engine is not running, "Boost Pressure" should be 0 kPa (0 psi). **Note:** A problem with the "FRC Fuel Limit" will only cause black smoke during acceleration. A problem with the "FRC Fuel Limit" will not cause black smoke during steady state operation.	Pressure Sensor	**Result:** The boost pressure sensor, "Fuel Position" and "FRC Fuel Limit" are OK. Proceed to Test Step 5. **Result:** The boost pressure sensor, "Fuel Position" and "FRC Fuel Limit" are not correct and properly working. **Repair:** Perform the necessary repairs and return to service.
5. Flash File A. Verify that the correct flash file is installed.	Flash File	**Result:** The correct flash file is installed. Proceed to Test Step 6. **Result:** The correct flash file is not installed. **Repair:** Install the correct flash file and refer to Troubleshooting, “Flash Programming” for information.
6. Fuel Quality A. Verify that the fuel quality is correct. **Note:** Cold weather adversely affects the characteristics of the fuel.	Fuel Quality	**Result:** The fuel quality is correct. Proceed to Test Step 7. **Result:** The fuel quality is not correct. **Repair:** Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.
7. Valve Adjustment A. Check the valve lash.	Valve Lash	**Result:** The valve lash is set correctly. STOP **Result:** The valve lash is not set correctly. **Repair:** Set the valve lash correctly and refer to Systems Operation and Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust” for the correct procedure.

i05902673

Excessive Engine Oil Consumption

SMCS Code: 1348-035

Probable Causes

- Oil leaks
- Oil level
- Turbocharger seal
- Internal engine wear

Recommended Actions

Table 27

Troubleshooting Test Steps	Values	Results
1. Oil Leaks A. Check the engine compartment for any oil leaks.	Oil Leaks	**Result:** There are no oil leaks in the engine compartment. Proceed to Test Step 2. **Result:** There are oil leaks in the engine compartment. **Repair:** Find the source of the oil leaks and perform the necessary repairs. Verify that the repair eliminated the problem.
2. Oil Level A. Check the engine oil level. Too much oil in the engine crankcase can cause the engine to consume oil. B. Ensure that the dipstick is properly calibrated correctly for the installation.	Oil Level	**Result:** The oil level is correct and the dipstick is correctly calibrated. Proceed to Test Step 3. **Result:** The oil level is high or the dipstick is incorrectly calibrated. **Repair:** Remove excessive engine oil from the crankcase.
3. Turbocharger A. Check the turbocharger shaft seal for leakage. B. Remove the air inlet piping and the exhaust outlet piping from the turbocharger. C. Check the compressor wheel and the turbine for evidence of an oil leak.	Turbocharger	**Result:** The turbocharger shows no sign of any leaks. Proceed to Test Step 4. **Result:** The turbocharger shows signs of an oil leak. **Repair:** Repair the turbocharger or replace the turbocharger. Refer to Systems Operation and Testing and Adjusting.
4. Internal Engine Wear A. Check for excessive crankcase blowby at the engine crankcase breather. Internal engine wear can cause excessive oil leakage into the combustion area of the cylinders. Excessive wear on the following components may cause oil consumption: - Piston Rings - Valve Guides	Engine Wear	**Result:** There is not excessive blowby at the crankcase breather. STOP **Result:** There is excessive blowby at the crankcase breather. **Repair:** Repair or replace the worn or damaged parts. Verify that the repair eliminated the problem.

i05902924

Excessive Fuel Consumption

SMCS Code: 1250-035

Probable Causes

- Engine operation
- Fuel leaks
- Fuel quality
- Engine speed/timing
- Unit injectors
- Air inlet and exhaust system
- Accessory equipment

Recommended Actions

Table 28

Troubleshooting Test Steps	Values	Results
1. Engine Operation A. Use Caterpillar Electronic Technician (ET) to check the "Current Totals" for excessive idle time and/or for a high load factor which would be indicative of poor operating habits.	Engine Operation	**Result:** Cat ET shows no sign of excessive idle time and/or high load factor. Proceed to Test Step 2. **Result:** Cat ET shows signs of excessive idle time and/or high load factor. **Repair:** Make the necessary repairs and return to service.
2. Fuel Leaks A. Check the fuel pressure during engine cranking. B. Check the fuel pressure after the fuel filter. Refer to the Systems Operation and Testing and Adjusting for the correct pressure values.	Fuel Leaks	**Result:** The fuel pressure during engine cranking and after the fuel filter is within specifications. Proceed to Test Step 3. **Result:** The fuel pressure during engine cranking and after the fuel filter is not within specifications. **Repair:** If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: - Fuel Transfer Pump - Fuel Transfer Pump Coupling - Fuel Pressure Regulating Valve
3. Fuel Quality A. Verify that the fuel quality is correct. **Note:** Cold weather adversely affects the characteristics of the fuel.	Fuel Quality	**Result:** The fuel quality is correct. Proceed to Test Step 4. **Result:** The fuel quality is not correct. **Repair:** Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.
4. Engine Speed/Timing A. Perform a speed/timing sensor calibration. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate” for troubleshooting information.	Timing Signal	**Result:** The speed/timing sensor is operating properly. Proceed to Test Step 5. **Result:** The speed/timing sensor is not operating properly. **Repair:** Repair the speed/timing sensor. Verify that the repair eliminated the problem.

(continued)

(Table 28, contd)

5. Unit Injectors A. Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors and the unit injector connectors. B. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. C. Perform the "Cylinder Cutout Test" in order to identify any injectors that might be misfiring. Refer to Troubleshooting, “Injector Solenoid - Test”.	Fuel Injectors	**Result:** The connectors were correctly installed and the test were successful. Proceed to Test Step 6. **Result:** The connectors were not installed correctly and the test were not successful. **Repair:** Reinstall the connectors correctly and remove the suspect injector, and install a new electronic unit injector. Refer to Disassembly and Assembly. Ensure that the repairs have determined the problem.
6. Air Inlet and Exhaust System A. Check the air filter restriction indicator, if equipped. Clean plugged air filter or replace plugged air filters. Refer to the Operation and Maintenance Manual. B. Check the air inlet and exhaust system for restrictions and/or leaks.	Restrictions	**Result:** There are restrictions in the air inlet or exhaust system. **Repair:** Make the necessary repairs. Verify that the repair eliminated the problem. **Result:** There are no restrictions in the air inlet or exhaust system. Proceed to Test Step 7.
7. Accessory Equipment A. Check all accessory equipment for problems that may create excessive load on the engine.	Engine Accessories	**Result:** There is no engine accessories creating an excessive load on the engine. STOP **Result:** An engine accessory is creating an excessive load. **Repair:** Repair the engine accessory. Verify that the repair eliminated the problem.

i02285926

Excessive Valve Lash

SMCS Code: 1105-035

Probable Causes

- Lubrication
- Valve lash
- Valve train components

Recommended Actions

Lubrication

1. Remove the valve mechanism covers. Refer to the engine's Disassembly and Assembly manual for the correct procedure.
2. Check the lubrication in the valve compartment. Ensure that there is adequate engine oil flow in the valve compartment. The passages for the engine oil must be clean.

Valve Lash

Adjust the engine valve lash. Refer to the engine's Systems Operation/Testing and Adjusting manual for the correct procedure.

Valve Train Components

1. Inspect the following components of the valve train:

- Rocker arms
- Roller followers (rocker arm)
- Camshaft
- Valve stems
- Valve guides
- Rocker shafts

2. Check the components for the following conditions: abnormal wear, excessive wear, straightness and cleanliness. Replace parts, if necessary.

Note: If you replace the camshaft, you must also replace the roller followers (rocker arm).

3. Adjust the engine valve lash. Refer to the engine's Systems Operation/Testing and Adjusting manual for the correct procedure.

i06570296

Excessive White Smoke

SMCS Code: 1088-035

Note: Some white smoke may be present during cold start-up conditions when the engine is operating normally. If the white smoke persists, there may be a problem.

Probable Causes

- Starting aids (if applicable)
- Coolant temperature sensor
- Engine speed/timing
- Unit injectors
- Flash file
- Fuel supply
- Component wear
- Cooling system

Recommended Actions

Table 29

Troubleshooting Test Steps	Values	Results
1. Check the Starting Aids **A.** Check for proper operation of the jacket water heater. Repair the jacket water heater or replace the jacket water heater. **B.** Ensure that the ether canister is not empty or low. Replace the ether canister if the ether canister is empty or low. Refer to Troubleshooting, “Ether Injection System - Test”.	Starting Aids	**Result:** The starting aids are OK. Proceed to Test Step 2. **Result:** The starting aids are NOT OK. **Repair:** Repair or replace any damaged or worn components.
2. Check the Coolant Temperature Sensor **A.** Use Cat ® Electronic Technician (ET) to verify that the engine has exited cold mode. **B.** Compare the coolant temperature from Cat ET to the coolant temperature that is obtained from the 6V-9130 Temperature Adapter (MULTIMETER). Ensure that the temperature readings are reasonable for the conditions that are present.	Coolant Temperature Sensor	**Result:** The coolant temperature sensor is OK. Proceed to Test Step 3. **Result:** The coolant temperature sensor is NOT OK. **Repair:** Replace the coolant temperature sensor.
3. Check the Engine Speed/Timing **A.** Check the calibration of the engine speed/timing sensor. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”. **B.** Verify that the timing of the crankshaft and camshaft drive gears are set with the proper orientation. Refer to Disassembly and Assembly for information that is related to the correct gear installation.	Engine Speed/Timing	**Result:** The engine speed/timing is OK. Proceed to Test Step 4. **Result:** The engine speed/timing is NOT OK. **Repair:** Repair or replace any damaged or worn components.
4. Check the Unit Injectors **A.** Perform the “Cylinder Cutout Test” on Cat ET to try to isolate any cylinders that may be misfiring. A misfiring cylinder could be related to an injector that is worn or in poor repair. Refer to Troubleshooting, “Injector Solenoid Circuit - Test”. **B.** Cut out each individual cylinder for 30 to 60 seconds. Verify that the smoke decreases.	Unit Injectors	**Result:** The unit injectors are OK. Proceed to Test Step 5. **Result:** The unit injectors are NOT OK. **Repair:** Replace the unit injectors.

(continued)

(Table 29, contd)

5. Check for the Correct Flash File **A.** Verify that the correct flash file is installed.	Flash File	**Result:** The correct flash file is installed. Proceed to Test Step 6. **Result:** The correct flash file is NOT installed. **Repair:** Download and install the correct flash file.
6. Check the Fuel Supply **A.** Inspect the fuel system components. **B.** Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/Testing and Adjusting for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve. **C.** Check the fuel quality. Low cetane fuel can create white smoke. If necessary, replace the fuel with a higher cetane fuel. **Note:** Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.	Fuel Supply	**Result:** The fuel supply is OK. Proceed to Test Step 7. **Result:** The fuel supply is NOT OK. **Repair:** Repair or replace any damaged or worn components.
7. Check for Component Wear **A.** Check the engine for the following problems: Excessive valve wear, piston wear, ring wear, liner wear, and reduced compression pressure.	Wear	**Result:** The components are OK. Proceed to Test Step 8. **Result:** The components are NOT OK. **Repair:** Repair or replace any damaged or worn components.
8. Check the Cooling System **A.** Check for an internal coolant leak into the cylinder and/or the exhaust. Refer to Systems Operation/Testing and Adjusting for information on inspecting the cooling system.	Cooling System	**Result:** The cooling system is OK. Return the engine to service. **Result:** The cooling system is NOT OK. **Repair:** Repair or replace any damaged or worn components.

i05915209

Exhaust Temperature Is Too High

SMCS Code: 1088-035-TA

Probable Causes

- Diagnostic codes
- Electrical connectors
- Air inlet and exhaust system

Recommended Actions

Table 30

Troubleshooting Test Steps	Values	Results
1. Diagnostic codes A. Connect the Cat ® Electronic Technician (Cat ET) and check for active codes and/or logged codes.	Diagnostic Codes	**Result:** Active codes were found when connected to Cat ET. **Repair:** Troubleshoot any codes that present before continuing with this procedure. **Result:** No Active codes were found when connected to Cat ET. Proceed to Test Step 2.
2. Check the condition of the connectors at the ECM. A. Check for the correct installations of the J2/P2 ECM connectors. B. Check the J300/P300 injector solenoid harness connector.	Electrical Connectors	**Result:** There is no problem in the connectors and/or wiring. Proceed to Test Step 3. **Result:** There is a problem in the connectors and/or wiring. **Repair:** Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.
3. Air Inlet and Exhaust System A. Check the air inlet system, air filter, air inlet piping, and exhaust system for restrictions and/or leaks. B. Repair any leaks that were found. Remove any restrictions that were found and replace any damaged components that were found. C. Check the air inlet manifold pressure.	Restrictions	**Result:** There are no restrictions or leaks in the air inlet or exhaust system. STOP **Result:** There are restrictions and leaks in the air inlet and/or exhaust system. **Repair:** Make the necessary repairs, and refer to System Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

i05915860

Fuel in Cooling System

SMCS Code: 1350-035

Probable Causes

Injector Sleeve or Injector Sleeve Seal

- Leaking injector sleeve and/or damaged seal

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

Recommended Actions

Table 31

Troubleshooting Test Steps	Values	Results
1. Check for a Leaking Injector Sleeve and/or Damaged Seal **A.** Remove the valve mechanism covers. **B.** Remove the fuel injectors from the cylinder head. **Note:** Do not allow the pressure on the cooling system to exceed 103 kPa (15 psi) during the test. Damage to the cooling system may result from applying excessive pressure. **C.** Pressurize the cooling system in order to identify the leaking injector sleeve. Closely inspect the sealing joint around the top of each injector sleeve. Small amounts of coolant will be dripping from the injector sleeve that is leaking. **Note:** Coolant may also be contaminating the fuel system. Pressure in the cooling system after the engine is shut down may cause the transfer of coolant into the fuel system. Inspect the fuel tank for coolant. If necessary, obtain a fuel analysis in order to determine if the fuel is contaminated. The contamination of coolant in the fuel system may damage injectors and other fuel system components. Ensure that all of the fuel system components are in good repair prior to returning the engine to service.	Damaged Sleeve or Seal	**Result:** The injector sleeve and/or seal is leaking. **Repair:** Remove the injector sleeve that is leaking. Carefully inspect the sleeve for damage. If there are visible signs of damage to the injector sleeve, replace the sleeve. Replace the O-ring seals for the injector sleeve and reinstall the sleeve. Replace any damaged components. Verify that the repair eliminated the problem. **Note:** Coolant may also be contaminating the fuel system. Pressure in the cooling system after the engine is shut down may cause the transfer of coolant into the fuel system. Inspect the fuel tank for coolant. If necessary, obtain a fuel analysis in order to determine if the fuel is contaminated. The contamination of coolant in the fuel system may damage injectors and other fuel system components. Ensure that all of the fuel system components are in good repair prior to returning the engine to service. **Note: Do not crank the engine if a cylinder is full of fluid. Damage can occur to the engine.** Evacuate all cylinders of fluid before attempting to start the engine.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i02360438

Fuel Dilution of Engine Oil

SMCS Code: 1348-035

Probable Causes

- Leaking seals on the body or the sleeve of the unit injector
- Excessive leakage from the unit injector tip or a broken unit injector tip
- Cracked cylinder head or leaking cylinder head gasket
- Leakage of the drive shaft seal on the fuel transfer pump

Recommended Actions

Leaking Seals on the Body or the Sleeve of the Unit Injector

Check the torque for the unit injector clamp retaining bolts. Ensure that the unit injectors are properly installed into the cylinder head.

If damage to the unit injector sleeves or to the O-ring seals is suspected, remove the unit injectors and/or the unit injector sleeves. Inspect the O-ring seals and the unit injector sleeves for damage. Replace any seals or sleeves that show evidence of leakage.

Excessive Leakage from the Unit Injector Tip or a Broken Unit Injector Tip

Look for signs of damage to the unit injectors. If necessary, replace the unit injectors that have damaged tips.

Cracked Cylinder Head or Leaking Cylinder Head Gasket

Check for symptoms of a damaged cylinder head or cylinder head gasket.

Inspect the cooling system for contamination of fuel. Inspect the crankcase for dilution of the engine oil. This may be a sign of a cracked cylinder head or of a leaking cylinder head gasket.

Leakage of the Drive Shaft Seal on the Fuel Transfer Pump

Ensure that the weep hole for the fuel transfer pump is not plugged. Inspect the front of the pump for signs of leakage. If necessary, repair the fuel transfer pump or replace the fuel transfer pump.

i05915838

Intermittent Engine Shutdown

SMCS Code: 1000-035

Note: Use this procedure only if the engine shuts down completely during operation.

Probable Causes

- Diagnostic codes
- Event codes
- Electrical connectors
- Air inlet and exhaust restrictions
- Circuit protection
- Unstable fuel supply

Recommended Actions

Table 32

Troubleshooting Test Steps	Values	Results
1. Check for Diagnostic Codes **A.** Establish communication between Cat ® Electronic Technician (Cat ET) and the Electronic Control Module (ECM). **B.** Certain event codes may derate engine power. Monitor the diagnostic codes on Cat ET. Check for active diagnostic codes and logged codes (intermittent problems). **Note:** Wait at least 30 seconds in order for diagnostic codes to become active.	Codes	**Result:** A code is active or logged. **Repair:** Troubleshoot any codes before continuing with this procedure. Verify that the repair eliminated the problem. **Result:** A code is not active or logged. Proceed to Test Step 2.
2. Inspect Electrical Connectors and Wiring **A.** Remove the electrical power from the ECM. **B.** Thoroughly inspect the ECM connectors J1/P1 and J2/P2. Inspect all of the other connectors for the circuit. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit. **D.** Check the ECM connector (allen head screw) for the proper torque. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”. **E.** Check the harness and the wiring for abrasion and for pinch points.	Connectors and Wiring	**Result:** The harness and wiring are OK. Proceed to Test Step 3. **Result:** There is a problem in the connectors and/or wiring. Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are coupled.
3. Check for a Restriction in the Inlet Air and Exhaust System **A.** Check the air filter restriction indicator, if equipped. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual. **B.** Check the air inlet and exhaust system for restrictions and/or leaks.	Restrictions	**Result:** There are no restrictions in the inlet air or exhaust system. Proceed to Test Step 4. **Result:** There are restrictions in the inlet air or exhaust system. **Repair:** Repair or replace damaged inlet air or exhaust system components. If the problem is not resolved, proceed to Test Step 4.

(continued)

(Table 32, contd)

4. Circuit Protection **A.** Inspect the wires and connectors to all circuit protection for the engine. **B.** Check the device for circuit protection.	Circuit Protection	**Result** The circuit protection device is tripped. Reset the circuit breakers if the circuit breakers are tripped. If necessary, replace fuses (if equipped). Prior to returning the engine to service, determine the condition that caused the circuit breaker to trip. Make the necessary repairs. **Result** The circuit protection device is not tripped. Proceed to Test Step 5.
5. Unstable Fuel Supply If there is an immediate engine shutdown, troubleshoot the electrical connectors before proceeding with this procedure. **A.** Inspect the fuel system. Refer to Systems Operation/ Testing and Adjusting, “Fuel System - Inspect” for additional information. Cold weather adversely affects the characteristics of the fuel. Refer to the engine Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation. **B.** Check fuel quality. Check the fuel tank for debris or foreign objects which may block the fuel supply. **C.** Check the filtered fuel pressure while the engine is being cranked.	Fuel	**Result:** The fuel quality is not OK. Replace the fuel. Verify that the repair eliminated the problem.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i02433904

Intermittent Low Power or Power Cutout

SMCS Code: 1000-035

Note: Use this procedure only if the engine does not shut down completely.

Probable Causes

- Diagnostic codes
- Event codes
- Throttle signal
- Power supply for the Electronic Control Module (ECM)
- Fuel supply

Recommended Actions

Note: If the problem only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high engine speed, full load and engine operating temperature. Troubleshooting the symptoms under other conditions can give misleading results.

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may cause poor performance. Connect the Caterpillar Electronic Technician (ET) and check for active codes and/or for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Throttle Signal

Monitor the status for “Throttle Position” on Cat ET. Verify that the status for “Throttle Position” is stable and that the engine is able to reach high idle engine speed. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test” for information that is related to troubleshooting the circuit for the throttle signal.

ECM Power Supply

1. Inspect the circuit between the ECM and the batteries. Refer to the Electrical System Schematic. Inspect the wires, the connectors, and the components in the circuit. Refer to Troubleshooting, “Electrical Power Supply Circuit - Test” for more information.

2. Inspect the circuit between the ECM and the keyswitch. Refer to the Electrical System Schematic. Inspect the wires, the connectors, and the components in the circuit. Refer to Troubleshooting, “Electrical Power Supply Circuit - Test” for more information.

Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

2. Check the fuel tank for foreign objects and debris which may block the fuel supply.

3. Prime the fuel system if any of the following components have been serviced recently:

- Fuel filters
- Low pressure fuel supply circuit
- Unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. For more information, refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test”.

4. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

5. Check the fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for the correct test procedure. If the fuel pressure is below the specification, replace the fuel filters. If the fuel pressure remains below the specification, check the following items: fuel transfer pump, fuel pressure relief valve and fuel pressure regulator valve. Refer to Systems Operation/Testing and Adjusting for more information.

i07583193

Low Engine Oil Pressure

SMCS Code: 1348-035-LP

NOTICE

Do not operate engine with low oil pressure. Engine damage will result. If measured engine oil pressure is low, discontinue engine operation until the problem is corrected.

Probable Causes

- Engine oil level
- Engine oil filters and oil filter bypass valve
- Engine oil pump
- Engine oil cooler
- Fuel dilution
- Engine wear

Recommended Actions

Table 33

Troubleshooting Test Steps	Values	Results
1. Engine Oil Level **A.** Inspect the engine oil level.	Level	**Result:** The oil level is correct. Proceed to Test Step 2. **Result:** The oil level is not correct. **Repair:** If engine oil is low, add engine oil. Refer to the Operation and Maintenance Manual.
2. Engine Oil filters and Oil Filter Bypass Valve **A.** Check the service records of the engine for information that is related to the last oil change. **B.** Check the operation of the oil filter bypass valve.	Oil Filter	**Result:** The engine is up to date with service and the operation of the oil filter bypass valve is working correctly. Proceed to Test Step 3. **Result:** The engine is not up to date with service and the oil filter bypass valve is not properly operating. **Result:** Perform an oil change on the engine with new filters and clean the bypass valve and the housing. If necessary, install new parts.
3. Engine Oil Pump **A.** Check for blockage of the inlet screen for the engine oil pump. **B.** Check the components of the engine oil pump for excessive wear.	Oil Pump	**Result:** There is no blockage of the inlet screen and the engine oil pump components do not have excessive wear. Proceed to Test Step 4. **Result:** There is blockage of the inlet screen and/or the engine oil pump components have excessive wear. **Repair:** Remove blockage from the inlet screen and repair the oil pump or replace the oil pump.
4. Oil Cooler **A.** Check the inlet side of the oil cooler for debris or blockage.	Restriction	**Result:** There is no debris or restrictions in the oil cooler. Proceed to Test Step 5. **Result:** There is debris or restrictions in the oil cooler. **Repair:** Clean or replace the oil cooler. If the problem is not resolved, proceed to Test Step 5.

(continued)

(Table 33, contd)

5. Fuel Dilution **A.** Check for presence of fuel in the lubricating oil. Refer to Special Instruction, REHS3007, “Determining the Cause of Fuel Dilution of Engine Oil”.	Fuel Dilution	**Result:** There is no presence of fuel in the oil. Proceed to Test Step 6. **Result:** There is presence of fuel in the oil. **Repair:** Make the necessary repairs and return to service.
6. Engine Wear **A.** Inspect the camshaft and/or camshaft bearings for excessive wear. **B.** Inspect the crankshaft and/or crankshaft bearings. Excessive wear to discrete components may be an indication of a blocked oil passage. Use an oil pressure gauge to check the oil pressure at the main oil gallery. This will help determine if the excessive wear is from low system pressure or from passages that are blocked.	Engine Wear	**Result:** There is excessive wear on the camshaft, camshaft bearings, and/or crankshaft, crankshaft bearings. **Repair:** Repair or replace the damaged components and return to service.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i02437042

Low Power/Poor or No Response to Throttle

SMCS Code: 1000-035

Probable Causes

- Engine derate or active codes
- Cold mode
- Throttle signal
- Electrical connectors
- Unit injectors
- Intake manifold pressure sensor
- Air inlet and exhaust system
- Parameters
- Fuel supply

Recommended Actions

Note: If the problem only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high engine speed, full load, and engine operating temperature. Troubleshooting the symptoms under other conditions can give misleading results.

Engine Derate or Active Codes

Some engine monitoring parameters that are capable of triggering an engine derate do not produce an event code. Connect Caterpillar Electronic Technician (ET) in order to check for a derate of the engine.

Certain diagnostic codes and/or event codes may cause poor performance. Use Cat ET to check for active codes and for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Note: Although a sensor's signal may be in the operational range of the sensor, the signal may not represent the actual reading. Use Cat ET to check that the pressures and the temperatures are fluctuating. Also check that the values are reasonable for the conditions that are present.

Cold Mode

1. Use Cat ET to verify that the engine has exited cold mode. Cold mode operation may cause the engine to run rough and engine power may be limited.

2. Observe the coolant temperature on the Cat ET status screen. Verify that the reading is valid.

Throttle Signal

Monitor the status for “Throttle Position” on Cat ET. Verify that the status for “Throttle Position” is stable and that the engine is able to reach high idle speed. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test” for the correct procedure.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors and the J300/P300 connectors for the unit injectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

Unit Injectors

1. Perform the “Injector Solenoid Test” on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.

2. Perform the “Cylinder Cutout Test” on Cat ET in order to identify any misfiring cylinder(s). Refer to Troubleshooting, “Injector Solenoids Circuit - Test” for more information.

Intake Manifold Pressure Sensor

1. Monitor the status of “Fuel Position” , “Rated Fuel Limit” , and “FRC Fuel Limit” on Cat ET while the engine is operating under full load. These parameters should reflect the information below.

Table 34

“Fuel Position” = “Rated Fuel Limit”
and
“Fuel Position” < “FRC Fuel Limit”

If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit” , the electronics are operating correctly. Otherwise, proceed with the next Step.

2. Monitor the status of “Boost Pressure” and “Atmospheric Pressure” for normal operation on Cat ET. When the engine is not running, the correct value for “Boost Pressure” is 0 kPa (0 psi) while the engine is off.

Air Inlet and Exhaust System

1. Check for an air filter restriction. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual for additional information.

2. Check the air inlet and exhaust system for restrictions and/or for leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

Parameters

If the ECM has been replaced, compare the values that are on the engine information plate to following parameters from Cat ET:

- FRC offset
- Full Load Setting (FLS)
- Full Torque Setting (FTS)

Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. If necessary, add fuel to the fuel tank. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

2. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

3. Check the fuel tank for debris or foreign objects which may block the fuel supply.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Prime the fuel system if any of the following procedures have been performed:

- Replacement of the fuel filters
- Service on the low pressure fuel supply circuit
- Replacement of unit injectors

Note: Check the fuel system for air. Refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test” for information that is related to checking the fuel system for air.

5. Check fuel quality. Cold weather adversely affects the characteristics of the fuel. Refer to the engine's Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

6. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/ Testing and Adjusting for the test procedure and for the correct pressure values.

If the fuel pressure is low, replace the fuel filters. Clean the primary filter/water separator of debris. Refer to the Operation and Maintenance Manual for details.

If the fuel pressure is still low, check the operation of the fuel pressure regulating valve. Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting for test information.

i02286073

Mechanical Noise (Knock) in Engine

SMCS Code: 1000-035

The probable root causes are listed below:

- Faulty accessory
- Damage to valve train components
- Failure of connecting rod bearing
- Crankshaft bearings

Perform the following checks:

1. Isolate the source of the noise. Remove the suspect engine accessories. Inspect the suspect engine accessories. Repair the engine accessories and/or replace the engine accessories.

2. Remove the valve cover from the suspect cylinder (s). Check the following items for damage: camshaft, valve rotocoil, valve springs, roller followers (rocker arm), rocker shaft, bridges and injectors. Check for valves that do not move freely. Remove the cylinder head and inspect the valves. Replace any damaged parts. If damage has occurred, ensure that the following components are free of contamination: cylinder liner, piston and exhaust system. Replace any damaged parts.

3. Inspect the connecting rod bearings and the bearing surfaces (journals) on the crankshaft. Check the piston pin for excessive wear. Replace any damaged parts.

4. Check main journals of the crankshaft and the main journal bearings for excessive wear. Replace any damaged parts.

i05921864

Noise Coming from Cylinder

SMCS Code: 1000-035

Probable Causes

- Diagnostic codes
- Fuel quality
- Unit injectors
- Valve lash
- Cylinder head and related components

Recommended Actions

Table 35

Troubleshooting Test Step	Values	Results
1. Check for Active Codes and Logged Codes **A.** Establish communication between Cat Electronic Technician (ET) and the Electronic Control Module (ECM). **B.** Certain event codes may derate engine power. Monitor the diagnostic codes on Cat ET. Check for active diagnostic codes and logged codes (intermittent problems). **Note:** Wait at least 30 seconds in order for diagnostic codes to become active.	Codes	**Result:** A code is active or logged. **Repair:** Troubleshoot any codes before continuing with this procedure. Verify that the repair eliminated the problem. **Result:** A code is not active or logged. Proceed to Test Step 2.
2. Fuel Supply Refer to System Operation/Testing and Adjusting “Fuel System - Inspect” for additional information. **A.** Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. **B.** Ensure that the vent in the fuel cap is not filled with debris. **C.** Ensure that the fuel supply valve (if equipped) is in the full OPEN position. Cold weather adversely affects the characteristics of the fuel. Refer to the engines Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation. **D.** Check the fuel quality. Refer to Systems Operation/Testing and Adjusting, “Fuel Quality - Test” for the proper procedure. Check the fuel tank for debris or foreign objects which may block the fuel supply. **E.** Check the filtered fuel pressure while the engine is being cranked. Refer to Troubleshooting, “Fuel Pressure Is Low” for the proper testing procedure.	Fuel System	**Result:** The fuel system is NOT OK. Proceed to Test Step 3. **Repair:** Repair or replace damaged fuel system components. Verify that the repair eliminated the problem.
3. Unit Injectors **A.** Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. **B.** Perform the "Cylinder Cutout Test" in order to identify any injectors that might be misfiring. **Note:** Refer to the procedure in Special Instruction, “Procedure for Troubleshooting and Cleaning the Oil Rail System for the Hydraulic Electronic Unit Injector”.	Fuel Injectors	**Result:** The tests were successful. Proceed Test Step 4. **Result:** The tests were NOT successful. **Repair:** Remove the suspect injector, and install a new electronic unit injector. Refer to Disassembly and Assembly. Ensure that the repairs have determined the problem. Refer to Troubleshooting “Injector Solenoid - Test” and Troubleshooting, “Injection Actuation Pressure - Test”.

(continued)

(Table 35, contd)

4. Check the Valve Lash **A.** Inspect the valve train for sufficient lubrication. **B.** Check for damage to valve train components which may cause excessive valve lash.	Valve Lash	**Result:** The valve lash and components are OK. Proceed to Test Step 5. **Result:** The valve lash and components are NOT OK. **Repair:** Reset the valve lash. Refer to Systems Operation/ Testing and Adjusting, “Valve Lash - Adjust”- for additional information.
5. Cylinder and Related Components **A.** Check for signs of damage and/or wear to the valves, cylinder head gaskets, and other head components. **B.** Inspect the condition of the camshaft.	Engine Components	**Result:** The engine components and/or camshaft has damage and/or wear. **Repair:** Repair or replace damaged components.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i02407700

Poor Acceleration or Response

SMCS Code: 1000-035

Probable Causes

- Engine derate or active codes
- Cold mode
- Flash file
- Throttle signal
- Electrical connectors
- Unit injectors
- Intake manifold pressure sensor
- Air inlet and exhaust system
- Fuel supply

Recommended Actions

Note: If the problem only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high engine speed, full load and engine operating temperature. Troubleshooting the symptoms under other conditions can give misleading results.

Engine Derate or Active Codes

Some engine monitoring parameters that are capable of triggering an engine derate do not produce an event code. Connect Caterpillar Electronic Technician (ET) in order to check for a derate of the engine.

Certain diagnostic codes and/or event codes may cause poor performance. Use Cat ET to check for active codes and for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Note: Although a sensor's signal may be in the operational range of the sensor, the signal may not represent the actual reading. Use Cat ET to check that the pressures and the temperatures are fluctuating. Also check that the values are reasonable for the conditions that are present.

Cold Mode

Use Cat ET to verify that the engine has exited cold mode. Cold mode operation may slow throttle response.

Flash File

Verify that the latest flash file is installed in the Electronic Control Module (ECM).

Throttle Signal

Monitor the status for “Throttle Position” on Cat ET. Verify that the status for “Throttle Position” is stable and that the engine is able to reach high idle speed. If a problem is suspected with the throttle, refer to the appropriate troubleshooting procedure for troubleshooting the throttle signal.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors and the J300/P300 connectors for the unit injectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

Unit Injectors

1. Perform the “Injector Solenoid Test” on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.

2. Perform the “Cylinder Cutout Test” on Cat ET in order to determine the performance of each cylinder. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

Intake Manifold Pressure Sensor

1. Monitor the status of “Fuel Position” , “Rated Fuel Limit” , and “FRC Fuel Limit” on Cat ET while the engine is operating under full load. These parameters should reflect the information below.

Table 36

“Fuel Position” = “Rated Fuel Limit”
and
“Fuel Position” < “FRC Fuel Limit”

If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit” , the electronics are operating correctly. Otherwise, proceed with the next Step.

2. Monitor the status of “Intake Manifold Pressure” and of “Atmospheric Pressure” for normal operation on Cat ET. When the engine is not running, the correct value for “Intake Manifold Pressure” is 0 kPa (0 psi).

Air Inlet and Exhaust System

1. Observe the check engine lamp. Check for an air filter restriction indicator. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.

2. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to Systems Operation/Testing and Adjusting for information on inspecting the air inlet and exhaust system.

Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. If necessary, add fuel to the fuel tank. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual for the correct procedure.

2. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

3. Check the fuel tank for debris or foreign objects which may block the fuel supply.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Prime the fuel system if any of the following procedures have been performed:

- Replacement of the fuel filters
- Service on the low pressure fuel supply circuit
- Replacement of unit injectors

Note: Check the fuel system for air. Refer to Systems Operation/Testing and Adjusting for information that is related to checking the fuel system for air.

5. Check fuel quality. Cold weather adversely affects the characteristics of the fuel. Refer to the engine's Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

6. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/ Testing and Adjusting for the test procedure and for the correct pressure values.

If the fuel pressure is low, replace the fuel filters. Clean the primary filter/water separator of debris. Refer to the Operation and Maintenance Manual for details.

If the fuel pressure is still low, check the operation of the fuel pressure regulating valve. Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting for test information.

i04563324

Valve Rotator or Spring Lock Is Free

SMCS Code: 1109-035

Use this procedure in order to troubleshoot a problem with the valve rotators or spring locks.

Probable Cause

- Valve Components

Recommended Actions

Table 37

Troubleshooting Test Steps	Values	Results
1. Valve Components A. Inspect the following components for damage: 1. Valve rotators 2. Spring locks 3. Valve springs 4. Valves B. Ensure that the valve has not contacted the piston. If the valve has contacted the piston, check the exhaust system for debris.	Damaged components	**Result:** The valve components are damaged. Replace the damaged components. **A valve rotator that is cracked or a valve rotator that is broken is an indication of an engine overspeed. Determine the cause of the engine overspeed. Repair the condition.**

Complete the procedure in the order in which the steps are listed.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

Troubleshooting with a Diagnostic Code

i02769238

Diagnostic Codes

SMCS Code: 1900

Diagnostic Codes

Diagnostic codes alert the operator that a problem in the electronic system has been detected. Diagnostic codes are also used by the service technician to identify the nature of the problem. Caterpillar Electronic Technician (ET) is a software program that is designed to run on a personal computer. The software can be used by the service technician in order to view the diagnostic code information for an ECM. Diagnostic codes may consist of the component identifier (CID), and the failure mode identifier (FMI).

Component Identifier (CID) – The CID indicates the component that generated the code. For example, the CID number 1 identifies the fuel injector for the number one cylinder.

Failure Mode Identifier (FMI) – The FMI indicates the type of failure.

Suspect Parameter Number (SPN) – The SPN is a three digit code which is assigned to each component in order to identify data via the data link to the ECM. This is used on the diagnostics for the CAN data link.

Refer to Troubleshooting, “Diagnostic Code Cross Reference” for the complete list of the diagnostic codes and a description of each code. There is a troubleshooting procedure for every diagnostic code. Refer to Troubleshooting, “Troubleshooting With A Diagnostic Code”.

When a diagnostic code is activated, the Electronic Control Module (ECM) transmits information about the code over the J1939 data link. Some J1939 devices may display the code. However, the code will be displayed with a SPN-FMI code. Refer to Troubleshooting, “Diagnostic Code Cross Reference” for a cross-reference between SPN-FMI codes and diagnostic codes.

Do not confuse diagnostic codes with event codes. Event codes alert the operator that an abnormal operating condition such as low oil pressure or high coolant temperature has been detected. Refer to Troubleshooting, “Troubleshooting with an Event Code” for additional information on event codes.

Illustration 13 is an example of the operating range of a sensor.

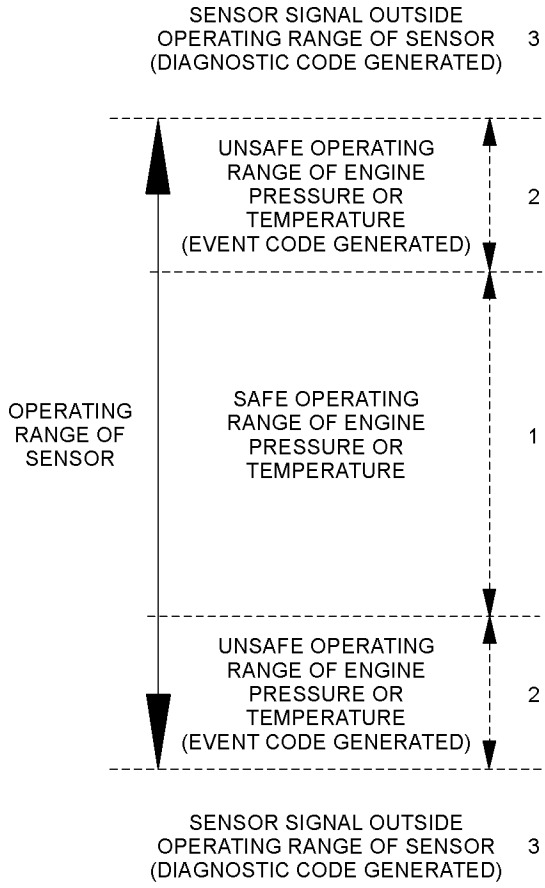


Illustration 13 g01365757

Example of the typical operating range of a sensor

(1) This area represents the normal operating range of the engine parameter.
(2) In these areas, the engine is operating in an unsafe operating range of the monitored parameter. An event code will be generated for the monitored parameter. The sensor circuit does not have an electronic problem. Refer to Troubleshooting, “Troubleshooting with an Event Code” for additional information on event codes.
(3) In these areas, the signal from the sensor is outside of the operating range of the sensor. The sensor circuit has an electronic problem. A diagnostic code will be generated for the sensor circuit.

Active Diagnostic Codes

An active diagnostic code represents a problem with the electronic control system. **Correct the problem as soon as possible.**

When the ECM generates an active diagnostic code, the “Active Alarm” indicator (“Engine Control Alarm Status” on Cat ET) is activated in order to alert the operator. If the condition that generated the code is momentary, the message disappears from the list of active diagnostic codes. The diagnostic code becomes logged.

Logged Diagnostic Codes

When the ECM generates a diagnostic code, the ECM logs the code in permanent memory. The ECM has an internal diagnostic clock. Each ECM will record the following information when a code is generated:

- The hour of the first occurrence of the code
- The hour of the last occurrence of the code
- The number of occurrences of the code

This information is a valuable indicator for troubleshooting intermittent problems.

A code is cleared from memory when one of the following conditions occur:

- The service technician manually clears the code.
- The code does not recur for 100 hours.
- A new code is logged and there are already ten codes in memory. In this case, the oldest code is cleared.

Some diagnostic codes may be easily triggered. Some diagnostic codes may log occurrences that did not result in complaints. The most likely cause of an intermittent problem is a faulty connection or damaged wiring. The next likely cause is a component failure. The least likely cause is the failure of an electronic module. Diagnostic codes that are logged repeatedly may indicate a problem that needs special investigation.

Note: Always clear logged diagnostic codes after investigating and correcting the problem which generated the code.

i06714734

CID 0001 FMI 05 Cylinder #1 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714767

CID 0001 FMI 06 Cylinder #1 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06709659

CID 0002 FMI 05 Cylinder #2 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02430363

CID 0002 FMI 06 Cylinder #2 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714774

CID 0003 FMI 05 Cylinder #3 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714074

CID 0003 FMI 06 Cylinder #3 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714781

CID 0004 FMI 05 Cylinder #4 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714232

CID 0004 FMI 06 Cylinder #4 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714234

CID 0005 FMI 05 Cylinder #5 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714236

CID 0005 FMI 06 Cylinder #5 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714245

CID 0006 FMI 05 Cylinder #6 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714255

CID 0006 FMI 06 Cylinder #6 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714812

CID 0007 FMI 05 Cylinder #7 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714304

CID 0007 FMI 06 Cylinder #7 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714307

CID 0008 FMI 05 Cylinder #8 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714309

CID 0008 FMI 06 Cylinder #8 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714310

CID 0009 FMI 05 Cylinder #9 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714817

CID 0009 FMI 06 Cylinder #9 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714818

CID 0010 FMI 05 Cylinder #10 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714819

CID 0010 FMI 06 Cylinder #10 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714822

CID 0011 FMI 05 Cylinder #11 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714826

CID 0011 FMI 06 Cylinder #11 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714829

CID 0012 FMI 05 Cylinder #12 Injector open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i06714831

CID 0012 FMI 06 Cylinder #12 Injector short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02419277

CID 0041 FMI 03 8 Volt DC Supply short to +batt

SMCS Code: 1439-038

Conditions Which Generate This Code:

The voltage level of the 8 volt supply is above normal.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags all digital sensors as invalid data and all digital sensors are set to the respective default values.

Possible Performance Effect:

- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Digital Sensor Supply Circuit - Test”

Results:

- OK – STOP. STOP

i02419278

CID 0041 FMI 04 8 Volt DC Supply short to ground

SMCS Code: 1439-038

Conditions Which Generate This Code:

The voltage level of the 8 volt supply is below normal.

System Response:

The Electronic Control Module (ECM) logs the diagnostic code. The ECM flags all digital sensors as invalid data and all digital sensors are set to the respective default values.

Possible Performance Effect:

- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Digital Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i06714835

CID 0091 FMI 08 Throttle Position signal abnormal

SMCS Code: 1439-038; 1913-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an incorrect frequency on the throttle signal.

System Response:

The code is logged. The ECM flags the throttle position as invalid data and a default value of zero percent is used.

Possible Performance Effect:

- The engine speed is limited to low idle.

Troubleshooting:

Perform the following diagnostic procedure: “Throttle Position Sensor Circuit - Test”

Results:

- OK – STOP.

i06714839

CID 0094 FMI 03 Fuel Pressure open/short to +batt

SMCS Code: 1439-038; 1718-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage from the sensor that is above normal.

System Response:

The code is logged. The ECM flags fuel pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714844

CID 0094 FMI 04 Fuel Pressure short to ground

SMCS Code: 1439-038; 1718-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM flags fuel pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714848

CID 0100 FMI 03 Engine Oil Pressure open/short to +batt

SMCS Code: 1439-038-OC; 1924-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM flags oil pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714852

CID 0100 FMI 04 Engine Oil Pressure short to ground

SMCS Code: 1439-038-OC; 1924-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM flags oil pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02437115

CID 0100 FMI 10 Engine Oil Pressure Sensor abnormal rate of change

SMCS Code: 1439-038-OC; 1924-038

Conditions Which Generate This Code:

This code indicates that the 5 volt supply is missing from the sensor connector.

During normal engine operation, the oil pressure fluctuates slightly. When the 5 volt supply is missing from the oil pressure sensor, the signal from the oil pressure sensor goes to a midrange value. The signal does not fluctuate. If the signal from the oil pressure sensor remains abnormally steady for more than 30 seconds, the Engine Control Module (ECM) activates this code.

System Response:

The ECM uses a default value for the oil pressure.

Possible Performance Effect:

- None

Troubleshooting:

Repair the Open Circuit

A. Repair the open circuit on the supply wire between the ECM and the sensor.

Expected Result:

The problem is resolved.

Results:

- OK – The problem is resolved.

  STOP. SOP

- Not OK – The problem is not resolved.

  Repair: Replace the sensor.

  STOP.

i02427669

CID 0110 FMI 03 Engine Coolant Temperature open/ short to +batt

SMCS Code: 1439-038-CLT; 1906-038

Conditions Which Generate This Code:

The signal voltage from the engine coolant temperature sensor is above normal.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags coolant temperature as invalid data and a default value is used. The engine will not go into cold mode.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience reduced speed (rpm) and/or low power.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02427678

CID 0110 FMI 04 Engine Coolant Temperature short to ground

SMCS Code: 1439-038-CLT; 1906-038

Conditions Which Generate This Code:

The signal voltage from the engine coolant temperature sensor is below normal.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags coolant temperature as invalid data and a default value is used. The engine will not go into cold mode.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience reduced speed (rpm) and/or low power.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714858

CID 0168 FMI 00 System Voltage High

SMCS Code: 1401-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- For 12 volt systems, the ECM reads battery voltage that is above 16 VDC.
- For 24 Volt systems, the ECM reads battery voltage that is above 32 VDC.

Note: Excessive voltage to the ECM may damage the ECM.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure:
“Electrical Power Supply Circuit - Test”

Results:

- OK – STOP.

i06714860

CID 0168 FMI 01 System Voltage Low

SMCS Code: 1401-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) has been powered for at least three seconds. The ECM detects the following condition:

- For 12 volt systems, the ECM reads battery voltage that is below 9 VDC.
- For 24 volt systems, the ECM reads battery voltage that is below 18 VDC.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- The engine may shut down.
- The engine may have hard starting and/or misfire.
- The contacts for the starting motor solenoid may be chatter during cranking. This can damage the contacts.

Troubleshooting:

Perform the following diagnostic procedure:
“Electrical Power Supply Circuit - Test”

Results:

- OK – STOP.

i06714861

CID 0168 FMI 02 System Voltage intermittent/erratic

SMCS Code: 1401-038

Conditions Which Generate This Code:

While the engine is running the Electronic Control Module (ECM) detects battery voltage that drops below 6 VDC and returns above 9 VDC.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- An engine misfire may occur.
- An engine shutdown condition may occur.

Troubleshooting:

Perform the following diagnostic procedure:
“Electrical Power Supply Circuit - Test”

Results:

- OK – STOP.

i06714862

CID 0172 FMI 03 Intake Manifold Air Temp open/short to +batt

SMCS Code: 1439-038-AI; 1921-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal or the intake manifold air temperature is below −35 °C (−31 °F) .

System Response:

The code is logged. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06656180

CID 0172 FMI 04 Intake Manifold Air Temp short to ground

SMCS Code: 1439-038-AI; 1921-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value.

Possible Performance Effect:

- The engine may experience hard starting and/or rough running.
- The engine may smoke.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714863

CID 0174 FMI 03 Fuel Temperature open/short to +batt

SMCS Code: 1439-038; 1922-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage from the sensor that is above normal.

System Response:

The ECM will log the diagnostic code. The ECM flags fuel temperature as invalid data and fuel temperature is set to a default value.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714866

CID 0174 FMI 04 Fuel Temperature short to ground

SMCS Code: 1439-038; 1922-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects signal voltage that is below normal.

System Response:

The ECM will log the diagnostic code. The ECM flags fuel temperature as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06724590

CID 0190 FMI 08 Engine Speed signal abnormal

SMCS Code: 1439-038-VF; 1907-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) receives erratic data from the engine speed/timing sensor.

System Response:

The code is logged.

Possible Performance Effect:

- The engine may not start.
- The engine will run rough.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Speed/Timing Sensor Circuit - Test”

Results:

- OK – STOP.

i02428636

CID 0253 FMI 02 Personality Module mismatch

SMCS Code: 1902-038

Conditions Which Generate This Code:

The flash file that is used for replacement is for a different engine family or for a different engine application.

System Response:

Caterpillar Electronic Technician (ET) will not be able to clear the code.

Possible Performance Effect:

- The fuel injection system is disabled and the engine will not start.

Troubleshooting:

Check the Part Number of the Flash File

A. Restore the electrical power to the Electronic Control Module (ECM).

B. Verify that the part number for the flash file agrees with the latest update that is available on Service Technician Workbench (STW), or on SIS Web.

Expected Result:

The correct flash file is installed in the ECM.

Results:

- OK – The correct flash file is installed in the ECM.

  Repair: The engine will not start until the 253-02 diagnostic code is cleared. Clearing this code requires factory passwords.

  Acquire factory passwords. Clear the 253-02 diagnostic code. Return the engine to service.

  STOP.

- Not OK – The correct flash file is not installed in the ECM.

  Repair: Flash program the ECM with the correct flash file. Refer to programming parameters Troubleshooting, “Flash Programming”. Verify that the problem is resolved.

  STOP.

i05951872

CID 0261 FMI 11 Engine Timing Offset fault

SMCS Code: 1439-038; 1912-038

Conditions Which Generate This Code:

The signals from the engine speed/timing sensors indicate that the expected position of the camshaft is incorrect with respect to the crankshaft. Or the polarity of the wiring to one of the speed/timing sensors is reversed.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code.

The ECM sets engine timing calibration to zero degrees.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power and/or reduced speed.
- The engine may experience increased exhaust emissions and/or white exhaust smoke.

Troubleshooting:

Test Step 1. Check the Installation of the Speed/Timing Sensors

A. Visually inspect the sensors for correct installation:

a. Ensure that the sensor mounting flanges are seated onto the surface of the engine.

b. Ensure that the locating notch on the flange of each sensor is oriented correctly.

c. Ensure that the sensor brackets are not bent or broken. Ensure that the brackets are securely holding the sensor in place.

d. Ensure that the sensors are tight in the housing bore. If a sensor is loose in the bore, check the condition of the sensor O-ring seals. Ensure that the seals are not missing. Also, inspect the seals for damage.

B. Check for the correct installation of the sensor connectors. Ensure that the electrical connector is securely latched. Check for the correct polarity in the wiring at each sensor connector and at the ECM connector.

C. Ensure that the harness is properly secured, and ensure that each tie-wrap is placed in the correct location.

Expected Result:

The sensors, the connectors, and the wiring are correctly installed.

Results:

- OK – The sensors and the harness are OK.The problem is not with the sensor or the harness. There may be a mechanical problem with the engine front gear train. Proceed to Test Step 2.
- Not OK – A problem has been identified with the installation of the sensors and/or the harness.

  Repair: Correct the problem that has been identified. Replace parts, if necessary. Ensure that the diagnostic code is no longer active.

  A timing calibration is necessary after this diagnostic code has become active. Refer to the diagnostic functional test Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

  STOP. STOP.

Test Step 2. Check the Condition of the Engine Gear Trains

The problem may be due to the incorrect orientation of the camshaft gear with respect to the orientation of the crankshaft gear during engine operation. Check the gear trains for damage and excessive wear:

Refer to the Disassembly and Assembly manual for more information.

A. Remove the covers from the front and rear gear housing.

B. Check for correct timing between the crankshaft gear and the camshaft gear.

C. Check the gear trains for gear tooth failure.

D. Check the gear trains for excessive gear tooth wear and gear tooth failure. Perform a timing gear backlash check.

E. Check each idler gear assembly for excessive wear to the bearing and/or the idler stub shaft. Check for correct bearing clearance.

Expected Result:

The mechanical condition of the gear train is within specifications.

Results:

- OK – The condition of the gear train is OK.

  Repair: The problem is not in the gear train. Clear the diagnostic code. There may be a problem with the circuit for the speed/timing sensors. Refer to the diagnostic functional test Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

  STOP. STOP.

- Not OK – The mechanical condition of the gear train is not within specifications.

  Repair: A problem with the gear train has been identified. Make the necessary repairs to the gear train. Clear the diagnostic code. A timing calibration is necessary after this diagnostic code has become active. Refer to the calibration procedure Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

  Verify that the original problem has been resolved.

  STOP. STOP.

i06714872

CID 0261 FMI 13 Engine Timing Calibration required

SMCS Code: 1439-038; 1912-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an incorrect engine timing.

Note: A timing calibration is required for a new engine, replacing an ECM that fails to communicate or following work on the front gear train, the camshaft, or the crankshaft.

System Response:

The check engine lamp will illuminate while this diagnostic code is active. The ECM uses default timing. Timing may be off as much as three degrees.

Possible Performance Effect:

- The engine may run rough and/or the engine may emit white smoke in the exhaust.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Speed/Timing Sensor - Calibrate”

Results:

- OK – STOP.

i06714875

CID 0262 FMI 03 5 Volt Sensor DC Power Supply short to +batt

SMCS Code: 1439-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an above normal voltage on the 5 volt supply.

System Response:

The code is logged. The check engine lamp will illuminate while this diagnostic code is active. The ECM sets all of the pressure sensors to the default values.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

Perform the following diagnostic procedure: “5 Volt Engine Pressure Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i06714878

CID 0262 FMI 04 5 Volt Sensor DC Power Supply short to ground

SMCS Code: 1439-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a below normal voltage on the 5 volt supply.

System Response:

The code is logged. The check engine lamp will illuminate while this diagnostic code is active. The ECM sets all of the pressure sensors to the default value.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

Perform the following diagnostic procedure: “5 Volt Engine Pressure Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02939823

CID 0267 FMI 03 Remote Shutdown Input open/short to +batt

SMCS Code: 7332-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Both of the switch inputs from the service brake pedal switch are in the open state.

System Response:

The diagnostic code may be viewed on the Caterpillar Electronic Technician (ET). If both of the switch inputs from the engine shutdown switch change to the same state and the engine is running, the engine will continue to run. If both of the switch inputs from the engine shutdown switch change to the same state and the engine is not running, the engine control will allow the engine to start.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Shutdown Switch Circuit - Test”

Results:

- OK – STOP. OK

i02939860

CID 0267 FMI 04 Remote Shutdown Input short to ground

SMCS Code: 7332-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Both of the switch inputs from the service brake pedal switch are in the closed state.

System Response:

The diagnostic code may be viewed on the Caterpillar Electronic Technician (ET). If both of the switch inputs from the engine shutdown switch change to the same state and the engine is running, the engine will continue to run. If both of the switch inputs from the engine shutdown switch change to the same state and the engine is not running, the engine control will allow the engine to start.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Shutdown Switch Circuit - Test”

Results:

- OK – STOP. OK

i06714881

CID 0268 FMI 02 Check Programmable Parameters

SMCS Code: 1901-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects one of the following conditions:

- At least one system configuration parameter is not programmed.
- At least one injector trim file is not programmed.

System Response:

The diagnostic code will only be active. The check engine lamp will illuminate while this diagnostic code is active. Any unprogrammed parameters are set to the default value.

Possible Performance Effect:

- The unprogrammed parameters determine the action that is taken by the ECM.

Troubleshooting:

Program the missing parameter.

If a system configuration parameter has not been programmed, refer to Troubleshooting, “System Configuration Parameters”.

If an injector trim file has not been programmed, refer to programming parameters Troubleshooting, “Injector Trim File”.

Results:

- OK – STOP.

i06714883

CID 0274 FMI 03 Atmospheric Pressure open/short to +batt

SMCS Code: 1439-038-AI; 1923-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM will use the default value for atmospheric pressure.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i06714995

CID 0274 FMI 04 Atmospheric Pressure short to ground

SMCS Code: 1439-038-AI; 1923-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal that is below normal.

System Response:

The code is logged. The ECM will use the default value for atmospheric pressure.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02390257

CID 0291 FMI 05 Engine Cooling Fan Solenoid open circuit

SMCS Code: 5479-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an open circuit or a short to +Battery condition in the circuit for the engine cooling fan solenoid.

System Response:

The ECM logs the diagnostic code. While the condition is present, the ECM loses the ability to control the engine cooling fan.

Possible Performance Effect:

- Overheating of the engine
- Overcooling of the engine

Troubleshooting:

Perform the following diagnostic procedure: “Engine Fan Control Solenoid Circuit - Test”

Results:

- OK – STOP.

i02390261

CID 0291 FMI 06 Engine Cooling Fan Solenoid short to ground

SMCS Code: 5479-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a short to ground condition in the circuit for the engine cooling fan solenoid.

System Response:

The ECM logs the diagnostic code. While the condition is present, the ECM loses the ability to control the engine cooling fan.

Possible Performance Effect:

- Overheating of the engine
- Overcooling of the engine

Troubleshooting:

Perform the following diagnostic procedure: “Engine Fan Control Solenoid Circuit - Test”

Results:

- OK – STOP.

i02445693

CID 0296 FMI 09 Unable to communicate with Transmission ECM

SMCS Code: 4800-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects erratic communication with the transmission.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- Transmission features that rely on the data link are disabled.

Troubleshooting:

Perform the following diagnostic procedure: “Cat Data Link Circuit - Test”

Results:

- OK – STOP.

i02433154

CID 0296 FMI 12 See Service Manual

SMCS Code: 4800-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) for the engine is not receiving complete information from the transmission ECM.

System Response:

The code is logged.

Possible Performance Effect:

- All features that depend on the Cat Data Link will be disabled.

Troubleshooting:

Update the ECM Flash Files

A. Check that the most current version of the flash files have been installed in both the engine ECM and the transmission ECM.

Expected Result:

The flash files that are installed in the engine ECM and the transmission ECM are the latest version.

Results:

- OK – The flash files are the latest version.

  Repair: There may be an electrical problem with the data link circuit or in a connector.

  Refer to the diagnostic functional test Troubleshooting, “Cat Data Link Circuit - Test”.

  STOP.

- Not OK – The flash files are not the latest version.

  Repair: Perform the following procedure:

  A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

  B. Obtain the latest version of the flash files for both the engine ECM and the transmission ECM.

  Note: The “Flash File Search” tool on the Service Technician Workbench (STW) can be used to obtain flash files. SIS Web can also be used to obtain the flash files by clicking the “Service Software Files” feature that is on the SIS Web web site.

  C. Use Cat ET to install the flash files. Verify that the original problem has been resolved.

  STOP.

i02939610

CID 0298 FMI 03 Service Brake Pedal Switch : Voltage Above Normal

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Both of the switch inputs from the service brake pedal switch are in the open state.

System Response:

Operating in throttle lock mode is not allowed.

Troubleshooting:

Perform the following diagnostic procedure: “Switch Circuits - Test”

Results:

- OK – STOP.

i02939799

CID 0298 FMI 04 Service Brake Pedal Switch : Voltage Below Normal

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Both of the switch inputs from the service brake pedal switch are in the open state.

System Response:

Operating in throttle lock mode is not allowed.

Troubleshooting:

Perform the following diagnostic procedure: “Switch Circuits - Test”

Results:

- OK – STOP.

i06715008

CID 0342 FMI 08 Secondary Engine Speed signal abnormal

SMCS Code: 1439-038-VF; 1907-038

Conditions Which Generate This Code:

The signal from the secondary engine speed/timing sensor is intermittent or the signal has been lost.

System Response:

The code is logged. If a valid signal is not received from the secondary engine speed/timing sensor, the Electronic Control Module (ECM) will default to the primary engine speed/timing sensor.

Possible Performance Effect:

- None

Note: The engine will shut down only if the signals from the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Speed/Timing Sensor Circuit - Test”

Results:

- OK – STOP.

i02933831

CID 0800 FMI 09 VIMS Main Module abnormal update rate

SMCS Code: 7601-038

Conditions Which Generate This Code:

The engine Electronic Control Module (ECM) loses communication with the ECM for the Vital Information Management System (VIMS).

System Response:

The engine ECM will log the diagnostic code.

Possible Performance Effect:

- All features that depend on input from the VIMS ECM will be affected.

Troubleshooting:

Results:

- OK – STOP.

i02933781

CID 0800 FMI 14 VIMS Main Module special instruction

SMCS Code: 7601-038

Conditions Which Generate This Code:

After successful communication has been established with the Vital Information Management System (VIMS) , the engine Electronic Control Module (ECM) has not received all the information that was requested over the Cat Data Link.

System Response:

The engine ECM will log the diagnostic code.

Possible Performance Effect:

- All features that depend on the missing data will be affected.

Troubleshooting:

There is at least one parameter that is requested by the engine ECM that is not being received.

Ensure that the Flash Files for the Machine's Control Modules are Current

A. Ensure that each control module that is on the machine has been updated with the most current flash file.

Expected Result:

All of the flash files for the machine are the latest part number.

Results:

- OK – The flash files are the latest part number.

  Repair: Contact the Dealer Solution Network (DSN) for information that is related to troubleshooting the problem further.

  STOP.

i02817711

CID 0827 FMI 03 Left Exhaust Temperature open/short to +batt

SMCS Code: 1439-038-TA; 1919-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02817787

CID 0827 FMI 04 Left Exhaust Temperature short to ground

SMCS Code: 1439-038-TA; 1919-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02443808

CID 1589 FMI 03 Turbo Inlet Air Pressure Sensor open/shrt to +bat

SMCS Code: 1439-038-PX; 1917-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects signal voltage that is above normal.

System Response:

The ECM will log the diagnostic code. The ECM flags turbocharger inlet pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02445694

CID 1589 FMI 04 Turbo Inlet Air Pressure Sensor short to ground

SMCS Code: 1439-038-PX; 1917-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The ECM will log the diagnostic code. The ECM flags turbocharger inlet pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine may have low power.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02418079

CID 1639 FMI 02 Machine Security System incorrect

SMCS Code: 7631-038

Conditions Which Generate This Code:

The serial number of the Machine Security System (MSS) that is stored in the Electronic Control Module (ECM) does not match the serial number of the MSS.

System Response:

The code is logged.

Possible Performance Effect:

- The engine will not start.

Troubleshooting:

Enter the correct serial number of the MSS.

Results:

- OK – STOP.

i02418084

CID 1639 FMI 09 Machine Security System Module not communicating on link

SMCS Code: 7631-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a loss of communication with the Machine Security System (MSS).

System Response:

The code is logged.

Possible Performance Effect:

- The engine will not start.

Troubleshooting:

Perform the following diagnostic procedure: “Cat Data Link Circuit - Test”

Results:

- OK – STOP.

i02481519

CID 1785 FMI 03 Intake Manifold Pressure Sensor voltage high

SMCS Code: 1439-038-IL

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

- The signal voltage from the intake manifold (boost) pressure sensor is above normal.
- For extremely low altitude conditions the engine speed is zero or the engine load is less than 50 percent with the engine retarder (if equipped) OFF.

System Response:

The ECM will log the diagnostic code. The ECM will flag the engine intake manifold (boost) pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02445698

CID 1785 FMI 04 Intake Manifold Pressure Sensor voltage low

SMCS Code: 1439-038-IL

Conditions Which Generate This Code:

The signal voltage from the intake manifold (boost) pressure sensor is below normal.

System Response:

The ECM will log the diagnostic code. The ECM will flag the engine intake manifold (boost) pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine may experience low power.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02475274

CID 1785 FMI 10 Intake Manifold Pressure Signal abnormal rate of change

SMCS Code: 1439-038-IL

Conditions Which Generate This Code:

This diagnostic code is designed to detect the loss of the 5 volt supply at the sensor connector.

System Response:

The ECM will log the diagnostic code. The ECM will flag the engine intake manifold (boost) pressure as invalid data and a default value is used.

Possible Performance Effect:

- Engine performance is adversely affected.

Troubleshooting:

Perform the following diagnostic procedure: “5 Volt Engine Pressure Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02509423

CID 1795 FMI 03 Turbo #2 Outlet Pressure Sensor voltage above normal

SMCS Code: 1439-038-PX; 1917-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage above normal.

System Response:

The code is logged. The ECM flags intake manifold pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine power will be derated.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02509453

CID 1795 FMI 04 Turbo #2 Outlet Pressure Sensor voltage below normal

SMCS Code: 1439-038-PX; 1917-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage below the normal.

System Response:

The code is logged. The ECM flags intake manifold pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine power will be derated.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02509473

CID 1795 FMI 10 Turbo #2 Outlet Pressure Sensor abnormal rate of change

SMCS Code: 1439-038-PX; 1917-038

Conditions Which Generate This Code:

This code indicates that the 5 volt supply is missing from the sensor connector.

During normal engine operation, the intake manifold pressure fluctuates slightly. When the 5 volt supply is missing from the intake manifold pressure sensor, the signal from the pressure sensor floats to a midrange value. The signal does not fluctuate. If the signal from the intake manifold pressure sensor remains abnormally steady for more than 30 seconds, the Engine Control Module (ECM) activates this code.

System Response:

The ECM uses a default value for the intake manifold pressure.

Possible Performance Effect:

- Low power

Troubleshooting:

Repair the Sensor Supply Circuit

A. Repair the circuit for the supply wire between the ECM and the sensor.

Expected Result:

The problem is resolved.

Results:

- OK – The problem is resolved.

  STOP.

- Not OK – The problem is not resolved.

  Repair: Replace the sensor.

  STOP.

i02509512

CID 1796 FMI 03 Intake Manifold #2 Air Temperature Sensor voltage above normal

SMCS Code: 1439-038-AI; 1921-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal or the intake manifold air temperature is below −35 °C (−31 °F) .

System Response:

The code is logged. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02509521

CID 1796 FMI 04 Intake Manifold #2 Air Temperature Sensor voltage below normal

SMCS Code: 1439-038-AI; 1921-038

Conditions Which Generate This Code:

The signal voltage from the intake manifold air temperature sensor is below normal or the intake manifold air temperature is above 140 °C (284 °F).

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM will flag the intake manifold air temperature as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02527831

CID 2271 FMI 05 Engine Oil Renewal System Actuation Solenoid current below normal

SMCS Code: 5479-038-OC

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects low current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine oil renewal solenoid may not activate.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Oil Renewal Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02527841

CID 2271 FMI 06 Engine Oil Renewal System Actuation Solenoid current above normal

SMCS Code: 5479-038-OC

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects high current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine oil renewal solenoid may not activate.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Oil Renewal Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02817760

CID 2350 FMI 03 Left Exhaust #2 Temperature voltage above normal

SMCS Code: 1919-038-LT

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02817802

CID 2350 FMI 04 Left Exhaust #2 Temperature voltage below normal

SMCS Code: 1919-038-LT

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02817831

CID 2350 FMI 08 Left Exhaust #2 Temperature abnormal frequency, pulse width, or period

SMCS Code: 1919-038-LT

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an incorrect frequency for the exhaust temperature sensor or the exhaust temperature sensor is out of the acceptable range.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02817762

CID 2351 FMI 03 Right Exhaust #2 Temperature voltage above normal

SMCS Code: 1919-038-RI

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02817804

CID 2351 FMI 04 Right Exhaust #2 Temperature voltage below normal

SMCS Code: 1919-038-RI

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02817833

CID 2351 FMI 08 Right Exhaust #2 Temperature abnormal frequency, pulse width, or period

SMCS Code: 1919-038-RI

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an incorrect frequency for the exhaust temperature sensor or the exhaust temperature sensor is out of the acceptable range.

System Response:

The code is logged. The ECM will flag the exhaust temperature as invalid data.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Perform the following diagnostic procedure: “Sensor Signal (PWM) - Test”

Results:

- OK – STOP.

i02938307

CID 2354 FMI 03 Engine Compression Brake Pedal Switch voltage above normal

SMCS Code: 1129-038-ZS; 1435-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Both of the switch inputs from the compression brake switch are in the open state.

System Response:

The compression brake will default to the automatic mode.

Troubleshooting:

Perform the following diagnostic procedure: “Switch Circuits - Test”

Results:

- OK – STOP.

i02938348

CID 2354 FMI 04 Engine Compression Brake Pedal Switch voltage below normal

SMCS Code: 1129-038-ZS; 1435-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Both of the switch inputs from the compression brake switch are in the closed state.

System Response:

The compression brake will default to the automatic mode.

Troubleshooting:

Results:

- OK – STOP.

i02511159

CID 2533 FMI 05 Compression Brake Low/High Solenoid #1 current below normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects low current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02510965

CID 2533 FMI 06 Compression Brake Low/High Solenoid #1 current above normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects excessive current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02511335

CID 2534 FMI 05 Compression Brake Low/High Solenoid #2 current below normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects low current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02511529

CID 2534 FMI 06 Compression Brake Low/High Solenoid #2 current above normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects excessive current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02511361

CID 2535 FMI 05 Compression Brake Medium/High Solenoid #1 current below normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects low current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02511535

CID 2535 FMI 06 Compression Brake Medium/High Solenoid #1 current above normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects excessive current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02511372

CID 2536 FMI 05 Compression Brake Medium/High Solenoid #2 current below normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects low current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

i02511545

CID 2536 FMI 06 Compression Brake Medium/High Solenoid #2 current above normal

SMCS Code: 1129-038-OD; 5479-038-BRK

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects excessive current in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine compression brake may not activate.

Troubleshooting:

Perform the following diagnostic procedure:
“Compression Brake Solenoid Circuit - Test”

Results:

- OK – STOP. OK

Troubleshooting with an Event Code

i02919903

Event Codes

SMCS Code: 1901

Event codes alert the operator that an abnormal engine operating condition such as low oil pressure or high coolant temperature has been detected. When the event code is generated, this indicates that an event has taken place.

Active Event Codes

An event code represents a problem with the operating condition of the engine. **Correct the problem as soon as possible.**

Each event has a trip point. The trip point is a value that is out of the normal operating range for a system such as the engine cooling system or the lubrication system. Once the trip point has been exceeded, the Electronic Control Module (ECM) will count down the trip delay for the code. Once the trip delay expires, the code will be logged. The trip delay is the amount of time before the ECM will act on the code. This delay helps to ensure that the condition is valid. There is also a start delay that prevents the ECM from mistakenly generating event codes during engine start-up. The start delay is the amount of time after the engine starts before an event code can be generated. Once the system falls below the reset level and the reset delay expires, the event will become inactive.

In the format for an event code, the “E” is used to identify the code as an event code. The first three numbers “XXX” represent a numeric identifier for the event code. The fourth “(X)” identifies the event as a warning, a derate, or a shutdown. This is followed by a description of the code. Refer to the following example:

- E360(1) Low Oil Pressure Warning
- E360(2) Low Oil Pressure Derate
- E360(3) Low Oil Pressure Shutdown

The definition for a warning, a derate, and a shutdown are defined below:

Warning (1) – This condition represents a serious problem with engine operation. However, this condition does not require a derate or a shutdown.

Derate (2) – For this condition, the engine's power is reduced in order to help prevent possible engine damage. However, this condition does not require a shutdown.

Shutdown (3) – For this condition, the operator is alerted of the event. The operator must shut down the engine in order to prevent possible engine damage.

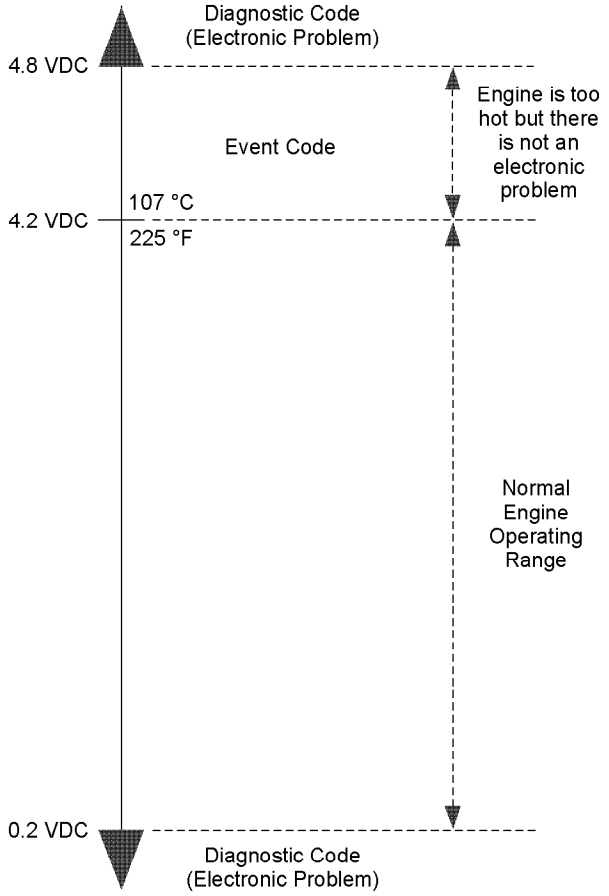


Illustration 14 g01100964

Output voltage from a typical temperature sensor

Illustration 14 shows the typical output voltage from an analog sensor. If the output signal voltage is between 4.2 VDC and 4.8 VDC, the ECM will generate an event code.

These responses to certain events may be programmed into the ECM. If the responses are programmed, Caterpillar Electronic Technician (ET) can display the event. If the responses are not programmed, the display will not appear. However, the occurrence of any event will cause the event code to be logged in the ECM.

Note: Do not confuse event codes with diagnostic codes. For information on diagnostic codes, refer to Troubleshooting, “Troubleshooting with a Diagnostic Code”.

Logged Event Codes

When the ECM generates an event code the code is logged into permanent memory. The ECM has an internal diagnostic clock that is used to time stamp the activation of the event. The ECM will record the following information when an event code is generated:

- The hour of the first occurrence of the code
- The hour of the last occurrence of the code
- The number of occurrences of the code

Logged events are listed in chronological order. The most recent event code is listed first.

This information can be helpful for troubleshooting intermittent problems. Logged codes can also be used to review any performance problems with the engine.

Clearing Event Codes

A code is cleared from memory when one of the following conditions occur:

- The code does not recur for 100 hours.
- A new code is logged and there are already ten codes in memory. In this case, the oldest code is cleared.
- The service technician manually clears the code.

Always clear logged event codes after investigating and correcting the problem which generated the code.

Troubleshooting

For basic troubleshooting of the engine, perform the following steps in order to diagnose a malfunction:

1. Obtain the following information about the complaint:

- The event and the time of the event
- Determine the conditions for the event. The conditions will include the engine rpm and the load.
- Determine if there are any systems that were installed by the dealer or by the customer that could cause the event.
- Determine whether any additional events occurred.

2. Verify that the complaint is not due to normal engine operation. Verify that the complaint is not due to error of the operator.

3. Narrow the probable cause. Consider the operator information, the conditions of operation, and the history of the engine.

4. Perform a visual inspection. Inspect the following items:

- Condition of the fuel and fuel system components
- Oil level and condition of the oil
- Engine wiring and condition of the connectors

Be sure to check the connectors. This is very important for problems that may be logged several times over a long period of time. This may indicate that an intermittent problem exists. If an intermittent condition is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

If these steps do not resolve the problem, identify the procedures in this manual that best describe the event. Check each probable cause according to the tests that are recommended.

Trip Points for the Monitoring System

The monitoring system determines the level of action that is taken by the ECM in response to a condition that can damage the engine. When any of these conditions occur, the appropriate event code will trip.

Table 38 contains the conditions that are monitored and the default trip points for each condition. Each condition has an associated parameter. The settings for each parameter can be viewed with Cat ET. The trip points for some of the parameters may be adjustable.

Table 38

Trip Points for the Monitoring System							
Parameter	**Event Code**	**Action**	**Default Value**	**Time Delay in Seconds**		**Set Points**	
				Range	**Default**	**Range**	**Default**
Low Engine Oil Level	E171	Warning	Switch Closed	None	N/A	N/A	Switch Open on Low Level
High Air Filter Restriction	E172	Warning	On	None	30	None	7.5 kPa (1.1 psi)
		Derate					9.0 kPa (1.3 psi)
High Exhaust Temperature	E194	Refer to Troubleshooting, “E194 High Exhaust Temperature” for information.					
High Right Exhaust Temperature	E321	Warning	Always On	5-60	60	None	760 °C (1400 °F)
		Derate					805 °C (1481 °F)
High Left Exhaust Temperature	E322	Warning	Always On	5-60	60	None	760 °C (1400 °F)
		Derate					805 °C (1481 °F)
Low Engine Oil Pressure	E360	Warning	Always On	None	8	Maps are not programmable. (1)	
		Shutdown			4	Maps are not programmable. (2)	
High Engine Coolant Temperature	E361	Warning	Always On	None	10	None	110 °C (230 °F)
		Derate		1 to 120			111 °C (232°F)
		Shutdown	On				116 °C (241 °F)
Engine Overspeed	E362	Warning	Always On	None	0.6	None	2600
		Derate					2800
High Fuel Temperature	E363	Warning	Always On	None	30	None	90 °C (194 °F)
		Derate	On	1 to 120	10		91 °C (196 °F)
Fuel Filter Restriction(3)	E390	Warning	Switch Closed	None	3600	None	138 ± 14 kPa (20 ± 2 psi)(4)
		Derate			14400		
High Intake Manifold Air Temperature	E539	Warning	Always On	None	8	None	82 °C (179 °F)
		Derate					86 °C (187 °F)
Low Engine Oil Refill Tank Level	E540	Warning	Switch Closed	None	N/A	N/A	Switch Open on Low Level
High Left Exhaust #2 Temperature	E775	Warning	Always On	5-60	60	None	760 °C (1400 °F)
		Derate					805 °C (1481 °F)
High Right Exhaust #2 Temperature	E776	Warning	Always On	5-60	60	None	760 °C (1400 °F)
		Derate					805 °C (1481 °F)
High Left Intake Manifold Air Temperature	E1000	Warning	Always On	None	8	None	82 °C (179 °F)
		Derate					86 °C (187 °F)

(1) Refer to Table 39 for trigger points.
(2) Refer to Table 40 for trigger points.
(3) This event is disabled for fuel temperatures that are below 60 °C (140 °F).
(4) Pressures for the 258-0883 Pressure Switch Gp

Table 39

Trip Points for Low Oil Pressure Warning (Gauge Pressures)	
0 rpm	0 kPa (0 psi)
500 rpm	0 kPa (0 psi)
1600 rpm	154 kPa (22 psi)
2400 rpm	154 kPa (22 psi)

Table 40

Trip Points for Low Oil Pressure Shutdown (Gauge Pressures)	
0 rpm	0 kPa (0 psi)
500 rpm	0 kPa (0 psi)
1600 rpm	104 kPa (15 psi)
2400 rpm	104 kPa (15 psi)

i01776428

E094 Axle Protection Derate

SMCS Code: 3282-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

- 296-09 Unable to communicate with Transmission ECM is active for 5 minutes.
- The transmission control sends negative values for the speed limit for 5 minutes.

System Response:

The ECM will derate the engine by 20 percent.

Possible Performance Effect:

- Low power

Troubleshooting:

- There may be a problem with the CAT Data Link.
- There may be a problem with the transmission control.

Test Step 1. Check for Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector.

B. Turn the keyswitch to the ON position. The engine should be OFF.

C. Check for any Active Diagnostic Codes or Logged Diagnostic Codes.

Expected Result:

There should be no diagnostic codes that are present.

Results:

- OK – There are no diagnostic codes that are present.Proceed to Test Step 2.
- Not OK – Diagnostic codes are present.

  Repair: Repair the diagnostic codes that are present. Refer to the appropriate topic in the “Troubleshooting With a Diagnostic Code” section of this manual.

  Ensure that the repair eliminates the problem.

  STOP.

Test Step 2. Perform a Check of the CAT Data Link.

A. Perform a check of the CAT Data Link. Refer to Troubleshooting, “ECM Will Not Communicate With Other Systems or Display Modules”.

Expected Result:

There are no problems with the CAT Data Link.

Results:

- OK – There may be an intermittent problem.

  Repair: If the problem is intermittent, perform the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

  STOP.

- Not OK – A problem was found with the CAT Data Link.

  Repair: Repair the problem.

  Ensure that the repair eliminates the problem.

  STOP.

i02515471

E172 High Air Filter Restriction

SMCS Code: 1054-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an abnormal difference in pressure between the atmospheric pressure and the turbocharger inlet pressure. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The ECM logs the event code.

Possible Performance Effect:

172(1)

- There are no performance effects.

172(2)

- The engine power will be derated.

Troubleshooting:

Check for Restrictions in the Air Inlet System

A. Inspect the air filter for restrictions and/or clogging. Clean the air filter or replace the air filter.

B. Check the air inlet piping for restrictions and for damage. Refer to Systems Operation/Testing and Adjusting.

Expected Result:

The air filter was cleaned or the air filter was replaced. No restrictions have been found in the air inlet system.

Results:

- OK – The air filter and the air inlet system are OK.

  Repair: If an electrical problem with the sensor is suspected, refer to the diagnostic functional test Troubleshooting, “Engine Pressure Sensor Open or Short Circuit - Test”.

  STOP.

- Not OK – There is a problem with the air filter and/or the air inlet system.

  Repair: Clean the air filter or replace the air filter, if necessary. Repair any damage that has been found with the air inlet system.

  STOP.

i03251205

E194 High Exhaust Temperature

SMCS Code: 1088-038-TA

S/N: DN21–Up

S/N: DR21–Up

S/N: DN31–Up

S/N: DR41–Up

S/N: DT41–Up

S/N: DS61–Up

S/N: DT61–Up

S/N: DS71–Up

S/N: DT71–Up

S/N: DT91–Up

S/N: 4YC1–Up

S/N: AGC1–Up

S/N: AAF1–Up

S/N: DHG1–Up

S/N: 4XJ1–Up

S/N: DHJ1–Up

S/N: DHL1–Up

S/N: 3PR1–Up

S/N: 9TR1–Up

S/N: 9XR1–Up

S/N: FKR1–Up

S/N: BTW1–Up

S/N: KNW1–Up

S/N: NNW1–Up

S/N: BWX1–Up

S/N: DHX1–Up

S/N: EHX1–Up

S/N: 7PZ1–Up

S/N: E9Z1–Up

Conditions Which Generate This Code:

The Electronic Control Module (ECM) monitors the following parameters in order to calculate the exhaust temperature:

- Intake manifold air temperature
- Barometric pressure
- Engine speed

High intake manifold air temperature, high altitude operation, and high engine loads can cause the exhaust temperature to increase to a level that may damage the components of the exhaust system. When this occurs, the ECM derates the engine in order to reduce the exhaust temperature. This protects the components of the exhaust system from damage.

System Response:

The code is logged. Passwords are not required in order to clear the logged code.

Possible Performance Effect:

Engine power is reduced.

Test Step 1. Determine the Operating Conditions

Interview the operator, when possible. Determine if the engine was under heavy load or the engine is operating at a high altitude.

Expected Result:

The event occurred because of normal engine operation.

Results:

- OK – The event occurred because of normal engine operation. Clear the logged event and return the engine to service.

  STOP.

- Not OK – The event should not have occurred. Proceed to Test Step 2.

Test Step 2. Check the Air-to-Air Aftercooler (ATAAC)

The intake manifold air temperature can increase if the ATAAC is obstructed. Check the fins of the ATAAC for obstructions.

Expected Result:

The fins of the ATAAC are obstructed.

Results:

- OK – The fins of the ATAAC are obstructed.

  Repair: Clean the fins of the ATAAC. Clear the event. Return the engine to service.

  STOP. STOP

- Not OK – The fins of the ATAAC are clear of obstructions.Proceed to Test Step 3.

Test Step 3. Check the 5 Volt Supply to the Atmospheric Pressure Sensor

If the atmospheric pressure sensor is not being powered by the 5 volt supply, the output of the sensor may float to a value that is interpreted by the ECM as a high altitude condition. The ECM receives the erroneous value of altitude and the ECM derates the engine.

A. Verify that the keyswitch is in the ON position.

B. Measure the value of the 5 volt supply at the harness connector for the atmospheric pressure sensor.

Expected Result:

The voltage is approximately five volts.

Results:

- OK – The supply voltage at the atmospheric pressure sensor is approximately five volts. There are no further troubleshooting procedures for this event. Clear the event and return the engine to service.

  STOP. STOP

- Not OK – The supply voltage at the atmospheric pressure sensor is not approximately five volts. There is a problem with the wiring for the 5 volt supply between the atmospheric pressure sensor and the ECM.

  Repair: Identify the wiring problem and make the necessary repairs.

  When the 5 volt supply is present at the atmospheric pressure sensor, clear the event and return the engine to service.

  STOP. STOP

i02441265

E265 User Defined Shutdown

SMCS Code: 1400-038

Conditions Which Generate This Code:

The engine shutdown switch has been activated.

Note: Certain conditions must be met on some applications prior to the activation of the engine shutdown switch. These conditions may include setting the parking brake and/or placing the transmission in neutral.

System Response:

The Electronic Control Module (ECM) will log the event.

Possible Performance Effect:

- The engine is shutdown.

Troubleshooting:

Talk to the Operator

Determine the reason for the activation of the engine shutdown switch.

Results:

- OK – The operator activated the engine shutdown switch.

  Repair: Cycle the electrical power to the ECM in order to reset the event code.

  STOP.

- Not OK – The operator did not activate the engine shutdown switch.

  Repair: If you suspect that there is a problem with the circuit for the engine shutdown switch, refer to the diagnostic functional test Troubleshooting, “Engine Shutdown Switch Circuit - Test”.

  STOP.

i02817265

E321 High Right Exhaust Temperature

SMCS Code: 1088-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive exhaust temperature for the engine at the “FRONT RIGHT EXHAUST TC” . This sensor is located in the exhaust manifold below the turbocharger. This sensor measures the exhaust gas temperature for cylinders 2, 4, and 6. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E321(1)

- There are no performance effects.

E321(2)

- The engine power will be derated.

Troubleshooting:

High exhaust temperature can be caused by problems with the following.

- Diagnostic codes
- Air inlet and exhaust system
- Fuel injectors
- Aftercooler (if applicable)
- Exhaust temperature sensor

Test Step 1. Check for Diagnostic Codes

Connect Cat ET and check for active and/or logged diagnostic codes. Troubleshoot any active diagnostic codes before continuing with this procedure.

Results:

- OK – There are no active diagnostic codes. Proceed to Test Step 2.
- Not OK – There are active diagnostic codes. Resolve any active diagnostic codes before proceeding to Test Step 2.

Test Step 2. Inspect the Air Inlet and Exhaust System

Check for air inlet restrictions and/or leaks. A one degree increase in the inlet manifold temperature will increase the exhaust temperature by approximately three degrees. Check for leaks between the exhaust manifold and the turbocharger. Check for exhaust restrictions. Refer to the Systems Operation/Testing and Adjusting manual for more information on inspecting the air inlet and exhaust system.

Results:

- OK – There are no problems with the air inlet and exhaust system.Proceed to Test Step 3.
- Not OK – A problem has been identified with the air inlet or the exhaust system.

  Repair: Resolve the problem and verify if the E321 code has been eliminated.

STOP.

Test Step 3. Check for Faults with the Fuel Injectors

Faulty injectors that deliver too much fuel will increase exhaust temperatures. Connect Cat ET in order to determine if any diagnostic codes for the injector solenoids are present. Perform the “Injector Solenoid Test” . Observe that the injector solenoids are being energized on Cat ET. Perform the “Cylinder Cutout Test” . Locate the misfiring cylinder. Refer to Troubleshooting, “Injector Solenoid - Test”.

Results:

- OK – There are no problems with the fuel injectors.Proceed to Test Step 4.
- Not OK – A problem has been identified with the fuel injectors.

  Repair: Resolve the problem and verify if the E321 code has been eliminated.

  STOP.

Test Step 4. Inspect the Aftercooler (if applicable)

Normal intake manifold pressure with high exhaust temperature can be caused by blockage in the aftercooler.

If the application has an aftercooler, check the aftercooler for correct operation. Check for blockage in the cores of the aftercooler.

Results:

- OK – There is no problem with the aftercooler. Proceed to Test Step 5.
- Not OK – A problem has been identified with the aftercooler.

  Repair: Resolve the problem and verify if the E321 code has been eliminated.

  STOP.

Test Step 5. Check the Exhaust Temperature Sensor

Use Cat ET to check the status of the exhaust temperature.

A. Start the engine.

B. Use Cat ET to monitor the status of the exhaust temperature while the engine is warming to operating temperature.

C. Ensure that the reading that is displayed is reasonable.

Results:

- The temperature indicated by the sensor is not within reasonable expectations.

  Repair: If an electronic problem with the sensor is suspected, refer to Troubleshooting, “Sensor Signal (PWM) - Test” for information that is related to troubleshooting the circuit that is for the exhaust temperature sensor.

  STOP.

i02817685

E322 High Left Exhaust Temperature

SMCS Code: 1088-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive exhaust temperature for the engine at the “FRONT LEFT EXHAUST TC” . This sensor is located in the exhaust manifold below the turbocharger. This sensor measures the exhaust gas temperature for cylinders 1, 3, and 5. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E322(1)

- There are no performance effects.

E322(2)

- The engine power will be derated.

Troubleshooting:

High exhaust temperature can be caused by problems with the following.

- Diagnostic codes
- Air inlet and exhaust system
- Fuel injectors
- Aftercooler (if applicable)
- Exhaust temperature sensor

Test Step 1. Check for Diagnostic Codes

Connect Cat ET and check for active and/or logged diagnostic codes. Troubleshoot any active diagnostic codes before continuing with this procedure.

Results:

- OK – There are no active diagnostic codes. Proceed to Test Step 2.
- Not OK – There are active diagnostic codes. Resolve any active diagnostic codes before proceeding to Test Step 2.

Test Step 2. Inspect the Air Inlet and Exhaust System

Check for air inlet restrictions and/or leaks. A one degree increase in the inlet manifold temperature will increase the exhaust temperature by approximately three degrees. Check for leaks between the exhaust manifold and the turbocharger. Check for exhaust restrictions. Refer to the Systems Operation/Testing and Adjusting manual for more information on inspecting the air inlet and exhaust system.

Results:

- OK – There are no problems with the air inlet and exhaust system.Proceed to Test Step 3.
- Not OK – A problem has been identified with the air inlet or the exhaust system.

  Repair: Resolve the problem and verify if the E322 code has been eliminated.

  STOP.

Test Step 3. Check for Faults with the Fuel Injectors

Faulty injectors that deliver too much fuel will increase exhaust temperatures. Connect Cat ET in order to determine if any diagnostic codes for the injector solenoids are present. Perform the “Injector Solenoid Test” . Observe that the injector solenoids are being energized on Cat ET. Perform the “Cylinder Cutout Test” . Locate the misfiring cylinder. Refer to Troubleshooting, “Injector Solenoid - Test”.

Results:

- OK – There are no problems with the fuel injectors.Proceed to Test Step 4.
- Not OK – A problem has been identified with the fuel injectors.

  Repair: Resolve the problem and verify if the E322 code has been eliminated.

  STOP.

Test Step 4. Inspect the Aftercooler (if applicable)

Normal intake manifold pressure with high exhaust temperature can be caused by blockage in the aftercooler.

If the application has an aftercooler, check the aftercooler for correct operation. Check for blockage in the cores of the aftercooler.

Results:

- OK – There is no problem with the aftercooler. Proceed to Test Step 5.
- Not OK – A problem has been identified with the aftercooler.

  Repair: Resolve the problem and verify if the E322 code has been eliminated.

  STOP.

Test Step 5. Check the Exhaust Temperature Sensor

Use Cat ET to check the status of the exhaust temperature.

A. Start the engine.

B. Use Cat ET to monitor the status of the exhaust temperature while the engine is warming to operating temperature.

C. Ensure that the reading that is displayed is reasonable.

Results:

- The temperature indicated by the sensor is not within reasonable expectations.

  Repair: If an electronic problem with the sensor is suspected, refer to Troubleshooting, “Sensor Signal (PWM) - Test” for information that is related to troubleshooting the circuit that is for the exhaust temperature sensor.

  STOP.

i02486798

E360 Low Engine Oil Pressure

SMCS Code: 1348-038-LP

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's oil pressure. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E360(1)

- There are no performance effects.

E360(3)

- The engine will be shut down.

Troubleshooting:

There may be a problem with the engine's lubrication system.

Check the Engine's Lubrication System

A. Check the engine oil level. If the oil level is below the oil pump's supply tube, the oil pump will not have the ability to supply enough lubrication to the engine components. If the engine oil level is low, add engine oil in order to obtain the correct engine oil level.

B. Check the following problems that may occur to the engine oil pump:

a. Air leakage in the supply side of the oil pump will also cause cavitation and loss of oil pressure. Check the supply side of the oil pump and make necessary repairs.

b. Oil pump gears that have too much wear will cause a reduction in oil pressure. Repair the engine oil pump.

c. If the engine is equipped with a scavenge pump, the scavenge pump may not be supplying oil to the main engine oil pump.

C. The inlet screen of the oil suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure. Check the inlet screen on the oil pickup tube and remove any material that may be restricting engine oil flow. Low engine oil pressure may also be the result of the oil pickup tube that is drawing in air. Check the joints of the oil pickup tube for cracks or a damaged O-ring seal.

D. If the engine oil bypass valves are held in the open position, a reduction in the oil pressure can be the result. This may be due to debris in the engine oil. If the engine oil bypass valves are stuck in the open position, remove each engine oil bypass valve and clean each bypass valve in order to correct this problem. You must also clean each bypass valve bore.

E. Engine oil that is contaminated with fuel or coolant will cause low engine oil pressure. High engine oil level in the crankcase can be an indication of contamination.

F. Excessive clearance at engine bearings will cause low engine oil pressure. Check the engine components for excessive bearing clearance.

G. An oil line that is open, broken, or disconnected will cause low engine oil pressure.

Expected Result:

An inspection of the engine's lubrication system indicated a problem.

Results:

- OK – There is a problem in the engine's lubrication system.

  Repair: Repair the problem. Ensure that the repair eliminates the problem.

  STOP.

i02498357

E361 High Engine Coolant Temperature

SMCS Code: 1395-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's cooling system. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E361(1)

- There are no performance effects.

E361(2)

- The engine power will be derated.

E361(3)

- The engine may be derated or shut down.

Note: For certain applications, the ECM may only derate the engine. The ECM will notify the operator that the condition exists and that the engine must be shutdown.

Troubleshooting:

There may be a problem with the engine's cooling system.

Check the Engine's Cooling System

A. Verify that the cooling system is filled to the proper level. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow.

B. Check the radiator or the heat exchanger for a restriction to coolant flow.

a. Check for debris or damage between the fins of the radiator core. Debris between the fins of the radiator core restricts air flow through the radiator core.

b. Check internally for debris, dirt, or deposits on the radiator core. Debris, dirt, or deposits will restrict the flow of coolant through the radiator.

C. Check the mixture of antifreeze and water. Make sure that the coolant mixture meets recommendations.

D. Check the water temperature regulator. A water temperature regulator that does not open, or a water temperature regulator that only opens part of the way can cause overheating.

E. Check the water pump. A water pump with a damaged impeller does not pump enough coolant. Remove the water pump and check for damage to the impeller.

F. If the cooling system for this application is equipped with a fan, check the operation of the fan. A fan that is not turning at the correct speed can cause improper air speed across the radiator core. The lack of proper air flow across the radiator core can cause the coolant not to cool to the proper temperature differential.

G. Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are the incorrect filling of the cooling system and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket.

H. Check the cooling system hoses and clamps. Damaged hoses with leaks can normally be seen. Hoses that have no visual leaks can soften during operation. The soft areas of the hose can become kinked or crushed during operation. These areas of the hose can restrict the coolant flow. Hoses become soft and/or get cracks after a period of time. The inside of a hose can deteriorate, and the loose particles of the hose can restrict the coolant flow.

I. If the cooling system for this application is equipped with an expansion tank, check the shunt line for the expansion tank. The shunt line must be submerged in the expansion tank. A restriction of the shunt line from the expansion tank to the inlet of the jacket water pump will cause a reduction in water pump efficiency. A reduction in water pump efficiency will result in low coolant flow.

J. If the cooling system for this application is equipped with an aftercooler, check the aftercooler. A restriction of air flow through the air to air aftercooler can cause overheating. Check for debris or deposits which would prevent the free flow of air through the aftercooler.

K. Check for a restriction in the air inlet system. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system.

L. Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

M. Consider high ambient temperatures. When ambient temperatures are too high for the rating of the cooling system, there is not enough of a temperature difference between the ambient air and coolant temperatures.

N. Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that is large enough to keep the coolant from boiling must be used.

O. The engine may be running in the lug condition. When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system.

Expected Result:

A thorough inspection of the cooling system revealed a problem.

Results:

- OK – There is a problem with the cooling system.

  Repair: Repair the problem. Ensure that the repair eliminates the problem.

  STOP.

i02510596

E362 Engine Overspeed

SMCS Code: 7410-038; 7427-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an engine overspeed. Information on default settings and ranges for this event code can be found in Troubleshooting, “Event Codes”.

System Response:

The event code is logged.

Possible Performance Effect:

E362-1 (Warning)

- There are no performance effects.

E362-2 (Derate)

- The ECM will stop sending signals to the injector solenoids until the engine speed is 200 rpm below the trip point.

Troubleshooting:

The operator may be operating the engine incorrectly.

The atmosphere may be combustible.

The driven equipment may have caused the overspeed.

Determine the events that caused the overspeed. Make corrections in order to prevent the overspeed from recurring.

Results:

- OK – STOP.

i02437229

E363 High Fuel Supply Temperature

SMCS Code: 1250-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive fuel temperature for the engine. Information on default settings and ranges for this event code can be found in troubleshooting with an event code Troubleshooting, “Event Codes”.

System Response:

The event code is logged.

Possible Performance Effect:

E363-1 (Warning)

- There are no performance effects.

E363-2 (Derate)

- The engine power is derated.

Troubleshooting:

Check the Fuel System

Check the fuel system for problems.

Expected Result:

A thorough inspection of the fuel system revealed a problem.

Results:

- OK – There is a problem with the fuel system.

  Repair: Make the necessary repairs. Verify that the repair eliminates the problem.

  STOP.

i02637267

E390 Fuel Filter Restriction

SMCS Code: 1261-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an abnormal fuel filter differential pressure. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The ECM will log the event.

Possible Performance Effect:

390(1)

- There are no performance effects.

The delay time for this event code is one hour.

390(2)

- The engine power is derated.

The delay time for this event code is four hours.

Troubleshooting:

The fuel filter element may need to be replaced.

Replace the Fuel Filter Element

A. Replace the fuel filter element.

Refer to the Operation and Maintenance Manual .

B. Restart the engine and check for an active event code.

Expected Result:

The event code is no longer active.

Results:

- OK – The event code is no longer active.

  STOP.

- Not OK – The event code is active.

  Repair: There may be an electrical problem with the circuit for the fuel filter differential pressure switch. Refer to Troubleshooting, “Fuel Filter Differential Pressure Switch Circuit - Test” for diagnostic information.

  STOP.

i02376958

E441 Idle Elevated to Increase Battery Voltage

SMCS Code: 1915-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a low battery voltage. The trip point for this event is a battery voltage of 12.25 V for the 12 V system and 24.5 V for the 24 V system.

System Response:

The ECM logs the event.

The ECM will set a new engine idle speed of 1000 to 1100 rpm.

The event code can be viewed on the diagnostic screen of the Caterpillar Electronic Technician (ET).

Possible Performance Effect:

The idle speed increases.

Troubleshooting:

This event indicates low battery voltage.

Refer to Troubleshooting, “Battery”.

Results:

- OK – STOP. STOP

i02498485

E539 High Intake Manifold Air Temperature

SMCS Code: 1050-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's intake manifold air temperature. Information on default settings and ranges for this event can be found in troubleshooting with an event code Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E539(1)

- There are no performance effects.

E539(2)

- The engine power will be derated.

Troubleshooting:

Intake manifold air temperature can be high for the following reasons:

- High ambient air temperature
- High inlet air restriction and/or high altitude
- Restriction in the exhaust system
- Faulty inlet air temperature sensor and/or circuit

Perform the following Inspections

A. Check for High Ambient Air Temperature

a. Determine if the ambient air temperature is within the design specifications for the inlet air system. When ambient temperatures are too high for the rating of the inlet air system, there is not enough of a temperature difference between the ambient air and inlet air temperatures.

b. Determine the cause of the high inlet air temperature. Correct the situation, when possible.

B. Check for High Inlet Air Restriction and/or High Altitude Operation

When inlet air pressure is low, the turbocharger works harder in order to achieve the desired inlet manifold pressure. This increases inlet air temperature.

a. Measure the inlet air pressure while the engine is operating under load. For specific data, refer to the Technical Marketing Information for the engine.

b. Check for plugged air filters. Check for obstructions to the air inlet. A restriction of the air that enters the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system.

c. Replace the air filters and/or remove the obstruction from the air inlet.

d. Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that has been designed for the higher altitudes must be used. Ensure that the engine is configured for high altitude operation.

C. Check for Exhaust System Restriction

Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

Expected Result:

A problem has been found in the inlet air system and/or the related engine systems.

Results:

- OK – A thorough inspection revealed a problem.

  Repair: Repair the problem.

  STOP.

- Not OK – A thorough inspection did not reveal a problem.

  Repair: Connect Caterpillar Electronic Technician (ET) to the service tool connector. Check Cat ET for active/logged diagnostic codes related for the inlet air system. If an active/logged code is found, refer to the appropriate troubleshooting procedure.

  STOP.

i02302403

E540 Low Engine Oil Refill Tank Level

SMCS Code: 1300-038

Conditions Which Generate This Code:

The Vital Information Management System (VIMS) detects a low oil level in the makeup oil tank for the oil renewal system. VIMS sends this information to the engine's Electronic Control Module (ECM). The engine's ECM generates an event code. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

Check the Oil level in the Makeup Oil Tank

A. Turn the keyswitch to the STOP position.

B. Check the oil level in the makeup oil tank.

Expected Result:

The oil level in the makeup oil tank is low.

Results:

- OK – The oil level in the makeup oil tank is low.

  Repair: Refill the makeup oil tank to the proper level.

  STOP.

- Not OK – The oil level in the makeup oil tank is not low.

  Repair: Check the oil level switch in the makeup oil tank for proper operation.

  STOP.

i02817689

E775 High Left Exhaust #2 Temperature

SMCS Code: 1088-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive exhaust temperature for the engine at the “REAR LEFT EXHAUST TC” . This sensor is located in the exhaust manifold below the turbocharger. This sensor measures the exhaust gas temperature for cylinders 7, 9, and 11. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E775(1)

- There are no performance effects.

E775(2)

- The engine power will be derated.

Troubleshooting:

High exhaust temperature can be caused by problems with the following.

- Diagnostic codes
- Air inlet and exhaust system
- Fuel injectors
- Aftercooler (if applicable)
- Exhaust temperature sensor

Test Step 1. Check for Diagnostic Codes

Connect Cat ET and check for active and/or logged diagnostic codes. Troubleshoot any active diagnostic codes before continuing with this procedure.

Results:

- OK – There are no active diagnostic codes. Proceed to Test Step 2.
- Not OK – There are active diagnostic codes. Resolve any active diagnostic codes before proceeding to Test Step 2.

Test Step 2. Inspect the Air Inlet and Exhaust System

Check for air inlet restrictions and/or leaks. A one degree increase in the inlet manifold temperature will increase the exhaust temperature by approximately three degrees. Check for leaks between the exhaust manifold and the turbocharger. Check for exhaust restrictions. Refer to the Systems Operation/Testing and Adjusting manual for more information on inspecting the air inlet and exhaust system.

Results:

- OK – There are no problems with the air inlet and exhaust system.Proceed to Test Step 3.
- Not OK – A problem has been identified with the air inlet or the exhaust system.

  Repair: Resolve the problem and verify if the E775 code has been eliminated.

  STOP.

Test Step 3. Check for Faults with the Fuel Injectors

Faulty injectors that deliver too much fuel will increase exhaust temperatures. Connect Cat ET in order to determine if any diagnostic codes for the injector solenoids are present. Perform the “Injector Solenoid Test” . Observe that the injector solenoids are being energized on Cat ET. Perform the “Cylinder Cutout Test” . Locate the misfiring cylinder. Refer to Troubleshooting, “Injector Solenoid - Test”.

Results:

- OK – There are no problems with the fuel injectors.Proceed to Test Step 4.
- Not OK – A problem has been identified with the fuel injectors.

  Repair: Resolve the problem and verify if the E775 code has been eliminated.

  STOP.

Test Step 4. Inspect the Aftercooler (if applicable)

Normal intake manifold pressure with high exhaust temperature can be caused by blockage in the aftercooler.

If the application has an aftercooler, check the aftercooler for correct operation. Check for blockage in the cores of the aftercooler.

Results:

- OK – There is no problem with the aftercooler. Proceed to Test Step 5.
- Not OK – A problem has been identified with the aftercooler.

  Repair: Resolve the problem and verify if the E775 code has been eliminated.

  STOP.

Test Step 5. Check the Exhaust Temperature Sensor

Use Cat ET to check the status of the exhaust temperature.

A. Start the engine.

B. Use Cat ET to monitor the status of the exhaust temperature while the engine is warming to operating temperature.

C. Ensure that the reading that is displayed is reasonable.

Results:

- The temperature indicated by the sensor is not within reasonable expectations.

  Repair: If an electronic problem with the sensor is suspected, refer to Troubleshooting, “Sensor Signal (PWM) - Test” for information that is related to troubleshooting the circuit that is for the exhaust temperature sensor.

  STOP.

i02817691

E776 High Right Exhaust #2 Temperature

SMCS Code: 1088-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive exhaust temperature for the engine at the “REAR RIGHT EXHAUST TC” . This sensor is located in the exhaust manifold below the turbocharger. This sensor measures the exhaust gas temperature for cylinders 8, 10, and 12. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E776(1)

- There are no performance effects.

E776(2)

- The engine power will be derated.

Troubleshooting:

High exhaust temperature can be caused by problems with the following.

- Diagnostic codes
- Air inlet and exhaust system
- Fuel injectors
- Aftercooler (if applicable)
- Exhaust temperature sensor

Test Step 1. Check for Diagnostic Codes

Connect Cat ET and check for active and/or logged diagnostic codes. Troubleshoot any active diagnostic codes before continuing with this procedure.

Results:

- OK – There are no active diagnostic codes. Proceed to Test Step 2.
- Not OK – There are active diagnostic codes. Resolve any active diagnostic codes before proceeding to Test Step 2.

Test Step 2. Inspect the Air Inlet and Exhaust System

Check for air inlet restrictions and/or leaks. A one degree increase in the inlet manifold temperature will increase the exhaust temperature by approximately three degrees. Check for leaks between the exhaust manifold and the turbocharger. Check for exhaust restrictions. Refer to the Systems Operation/Testing and Adjusting manual for more information on inspecting the air inlet and exhaust system.

Results:

- OK – There are no problems with the air inlet and exhaust system.Proceed to Test Step 3.
- Not OK – A problem has been identified with the air inlet or the exhaust system.

  Repair: Resolve the problem and verify if the E776 code has been eliminated.

  STOP.

Test Step 3. Check for Faults with the Fuel Injectors

Faulty injectors that deliver too much fuel will increase exhaust temperatures. Connect Cat ET in order to determine if any diagnostic codes for the injector solenoids are present. Perform the “Injector Solenoid Test” . Observe that the injector solenoids are being energized on Cat ET. Perform the “Cylinder Cutout Test” . Locate the misfiring cylinder. Refer to Troubleshooting, “Injector Solenoid - Test”.

Results:

- OK – There are no problems with the fuel injectors.Proceed to Test Step 4.
- Not OK – A problem has been identified with the fuel injectors.

  Repair: Resolve the problem and verify if the E776 code has been eliminated.

  STOP.

Test Step 4. Inspect the Aftercooler (if applicable)

Normal intake manifold pressure with high exhaust temperature can be caused by blockage in the aftercooler.

If the application has an aftercooler, check the aftercooler for correct operation. Check for blockage in the cores of the aftercooler.

Results:

- OK – There is no problem with the aftercooler. Proceed to Test Step 5.
- Not OK – A problem has been identified with the aftercooler.

  Repair: Resolve the problem and verify if the E776 code has been eliminated.

  STOP.

Test Step 5. Check the Exhaust Temperature Sensor

Use Cat ET to check the status of the exhaust temperature.

A. Start the engine.

B. Use Cat ET to monitor the status of the exhaust temperature while the engine is warming to operating temperature.

C. Ensure that the reading that is displayed is reasonable.

Results:

- The temperature indicated by the sensor is not within reasonable expectations.

  Repair: If an electronic problem with the sensor is suspected, refer to Troubleshooting, “Sensor Signal (PWM) - Test” for information that is related to troubleshooting the circuit that is for the exhaust temperature sensor.

  STOP.

i02513538

E1000 High Left Intake Manifold Air Temperature

SMCS Code: 1050-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive intake manifold air temperature. Information on default settings and ranges for this event can be found in troubleshooting with an event code Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E539(1)

- There are no performance effects.

E539(2)

- The engine power will be derated.

Troubleshooting:

Intake manifold air temperature can be high for the following reasons:

- High ambient air temperature
- High inlet air restriction and/or high altitude
- Restriction in the exhaust system
- Problem with the aftercooler
- Faulty inlet air temperature sensor and/or circuit

Perform the following Inspections

A. Check for High Ambient Air Temperature

a. Determine if the ambient air temperature is within the design specifications for the inlet air system. When ambient temperatures are

too high for the rating of the inlet air system, there is not enough of a temperature difference between the ambient air and inlet air temperatures.

b. Determine the cause of the high inlet air temperature. Correct the situation, when possible.

B. Check for High Inlet Air Restriction and/or High Altitude Operation

When inlet air pressure is low, the turbocharger works harder in order to achieve the desired inlet manifold pressure. This increases inlet air temperature.

a. Measure the inlet air pressure while the engine is operating under load. For specific data, refer to the Technical Marketing Information for the engine.

b. Check for plugged air filters. Check for obstructions to the air inlet. A restriction of the air that enters the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system.

c. Replace the air filters and/or remove the obstruction from the air inlet.

d. Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that has been designed for the higher altitudes must be used. Ensure that the engine is configured for high altitude operation.

C. Check for Exhaust System Restriction

Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

D. Check for Problems with the Aftercooler

If the air inlet system for this application is equipped with an aftercooler, check the aftercooler. A restriction of air flow through the air to air aftercooler can cause overheating. Check for debris or deposits which would prevent the free flow of air through the aftercooler. If the engine is equipped with a liquid cooled aftercooler verify that the coolant flow is unobstructed.

Expected Result:

A problem has been found in the inlet air system and/or the related engine systems.

Results:

- OK – A thorough inspection revealed a problem.

  Repair: Repair the problem.

  STOP.

- Not OK – A thorough inspection did not reveal a problem.

  Repair: Connect Caterpillar Electronic Technician (ET) to the service tool connector. Check Cat ET for active/logged diagnostic codes related for the inlet air system. If an active/logged code is found, refer to the appropriate troubleshooting procedure.

  STOP.

i02933373

E2089 Oil Renewal System Cannot Operate

SMCS Code: 1349-038

Conditions Which Generate This Code:

The engine's Electronic Control Module (ECM) will disable the oil renewal system if one of the following conditions is true.

Note: If the condition resets, the ECM will enable the oil renewal system.

The VIMS module detects low engine oil level.

The VIMS module detects low fuel level.

The VIMS module detects low engine oil refill tank level.

Note: E540 Low Engine Oil Refill Tank Level is detected by the VIMS module. The condition is communicated to the engine ECM. The engine ECM then sets the E540. Other related codes will be set by the VIMS module.

The engine's Electronic Control Module (ECM) will disable the oil renewal system if a diagnostic code is active for one of the following components:

Note: If the condition resets, the ECM will enable the oil renewal system.

- Engine coolant temperature sensor
- Engine oil pressure sensor
- Fuel level sensor
- Oil renewal solenoid

The engine's ECM will disable the oil renewal system if the following event code is active:

Note: Power must be cycled to the engine's ECM before the ECM can enable the oil renewal system for this code.

- E360 Low Engine Oil Pressure

Check for Diagnostic or Event Codes

A. Turn the keyswitch to the ON position.

B. Start the Caterpillar Electronic Technician (ET).

C. Check for any diagnostic codes for the following engine components:

- Engine coolant temperature sensor
- Engine oil pressure sensor
- Fuel level sensor
- Oil renewal solenoid

D. Check for any of the following event codes:

- E360 Low Engine Oil Pressure
- E540 Low Engine Oil Refill Tank Level

Expected Result:

There is a diagnostic code that is active or an event code that is active or logged.

Results:

- OK – There diagnostic code that is active or an event code that is active or logged

  Repair: Repair any codes that are present. Refer to the appropriate topic in this Troubleshooting Manual. Ensure that the repair eliminates the problem.

  STOP.

Diagnostic Functional Tests

i02431648

5 Volt Engine Pressure Sensor Supply Circuit - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the +5 V sensor supply.

Use this procedure to troubleshoot the system when one of the following diagnostic codes is active or easily repeated:

- 262-03 5 Volt Sensor DC Power Supply short to +batt
- 262-04 5 Volt Sensor DC Power Supply short to ground

The Electronic Control Module (ECM) supplies a regulated voltage of 5.0 ± 0.2 VDC to the following sensors:

- Atmospheric pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor
- Intake manifold pressure sensor

The supply for the +5 V engine pressure sensor is routed from the ECM to terminal A of each pressure sensor connector. The sensor return from the ECM connector goes to terminal B of each sensor connector. The 5 V sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

Note: The sensors are not protected from overvoltage. A short from the supply line to the +Battery may damage the sensors. If the CID-FMI 262-03 is logged, it is possible that all of the sensors have been damaged. Repair the 5 V sensor supply and check for any active diagnostic codes for the sensor in order to determine if a sensor has failed.

A +5 V diagnostic code is probably caused by a short circuit to ground or a short circuit to another voltage source in the harness. The next likely cause is a problem with a sensor. The least likely cause is a problem with the ECM.

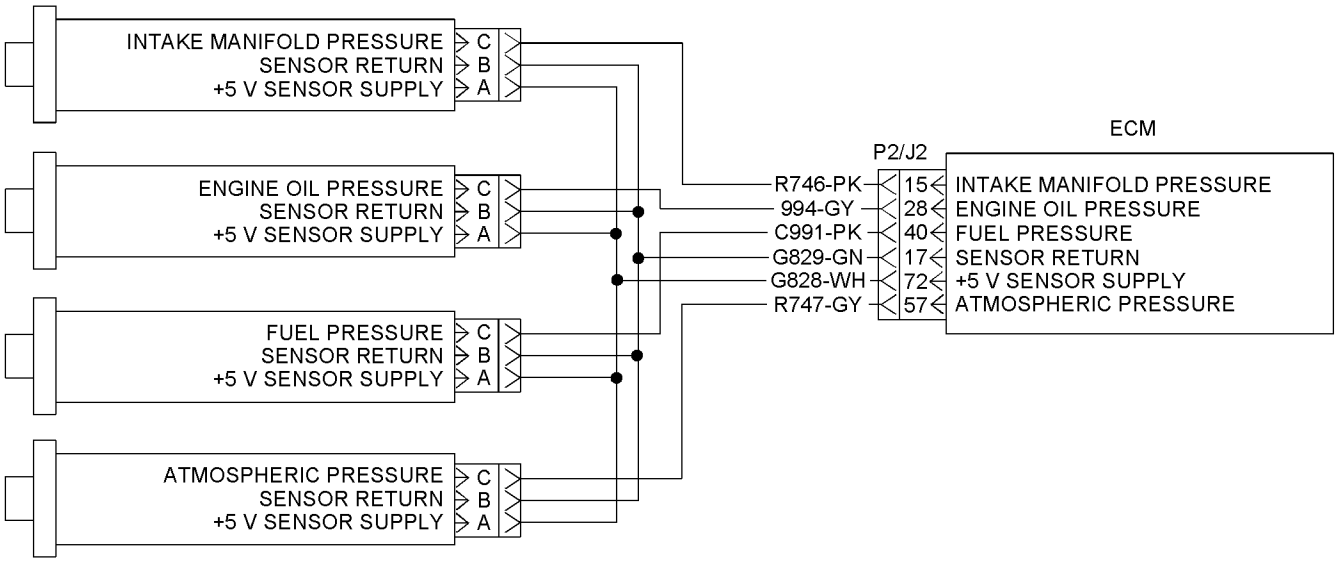


Illustration 15 g01215328

Schematic for the 5 volt pressure sensor supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

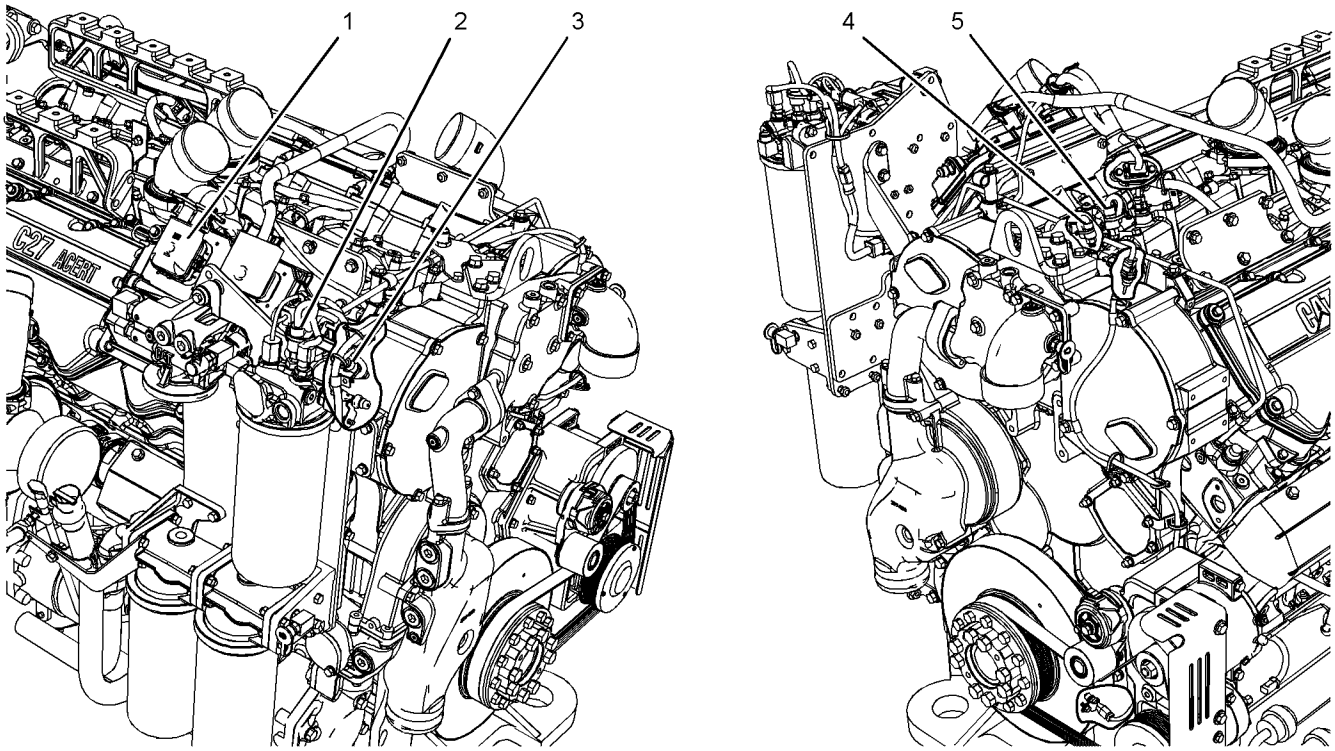


Illustration 16 g01215338

Right side engine view and left side engine view

(1) J2/P2 ECM conntector
(2) Fuel pressure sensor
(3) Engine oil pressure sensor
(4) Atmospheric pressure sensor
(5) Intake manifold pressure sensor

B. Thoroughly inspect ECM connectors (1). Also, thoroughly inspect the connectors for each pressure sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

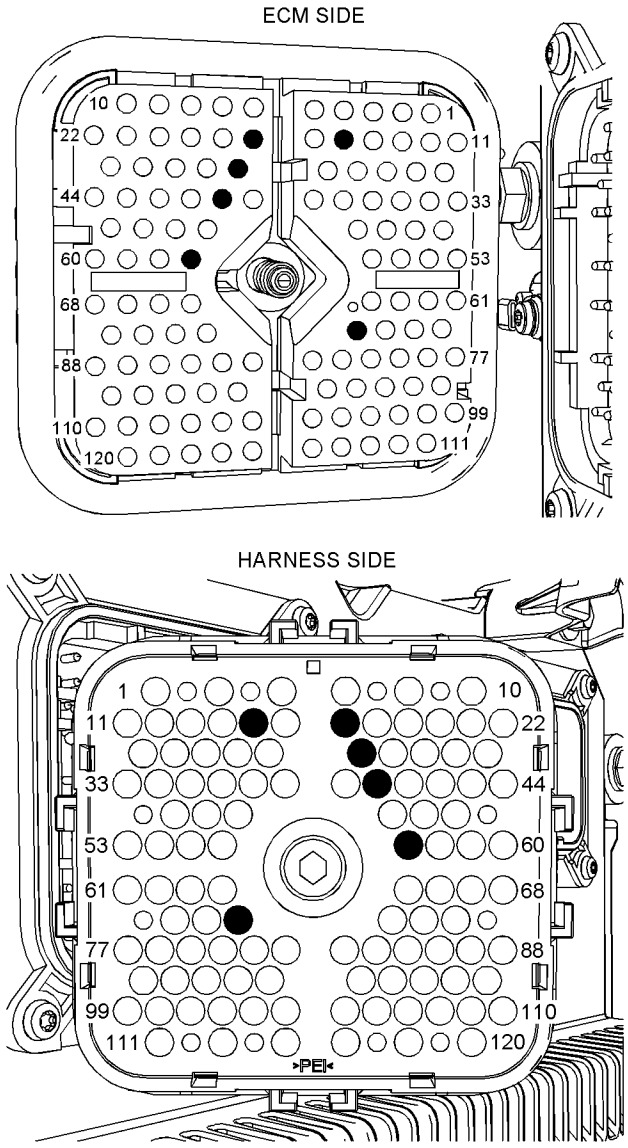


Illustration 17 g01204484

P2 terminal locations

(P2-15) Intake manifold pressure sensor
(P2-17) Sensor return
(P2-28) Engine oil pressure
(P2-40) Fuel pressure
(P2-57) Atmospheric pressure
(P2-72) +5 V supply

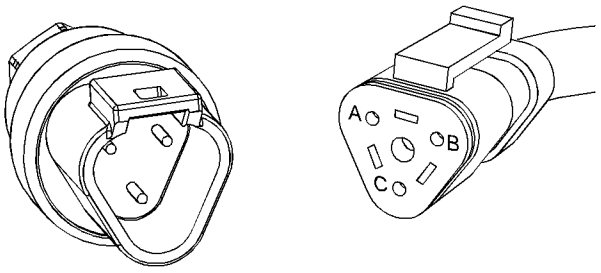


Illustration 18 g01215393

Sensor connector

(Terminal A) +5 V supply
(Terminal B) Sensor return
(Terminal C) Sensor signal

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connectors that are associated with the circuit.

D. Check the allen head screw of each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasion and for pinch points from the pressure sensors back to the ECM.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The harness and connectors appear to be OK.There may be a problem in the harness between the ECM and the sensor connector. Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Restore electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Check for an active 262-03 code and an active 262-04 code.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

D. Remove electrical power from the ECM.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: If any of the above codes are logged and the engine is not running properly, refer to Troubleshooting, “Troubleshooting Without a Diagnostic Code”.

  If the engine is running properly at this time, there may be an intermittent problem in the harness. This may be causing the codes to be logged. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – Either the 262-03 or 262-04 diagnostic code is active at this time.There is a problem with the circuit for the sensor supply. There may be a problem with the ECM. Proceed to Test Step 3.

Test Step 3. Disconnect the Pressure Sensors and Check for Active Diagnostic Codes

A. Restore electrical power to the ECM.

B. Monitor the active diagnostic code screen on Cat ET while you disconnect each pressure sensor connector. Check for an active 262-03 code or an active 262-04 code.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

a. Disconnect the following sensors one at a time:

- Atmospheric pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor
- Intake manifold pressure sensor

Remove electrical power from the ECM.

Expected Result:

The diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The 262-03 or 262-04 diagnostic code deactivates when a particular sensor is disconnected.

  Repair: Connect the suspect sensor. If the code returns, replace the sensor. Connect all of the connectors. Verify that the problem is resolved.

  STOP.

- Not OK – The 262-03 or 262-04 diagnostic code remains active after all of the sensors are disconnected. The sensors are not the cause of the diagnostic code. Leave the sensors disconnected. Proceed to Test Step 4.

Test Step 4. Check the Supply Voltage at the ECM

A. Disconnect the J2/P2 ECM connectors.

B. Fabricate two jumper wires that are long enough to be used as test leads at the ECM connectors. Crimp connector sockets to one end of each jumper wire.

C. Remove the wires from terminal locations P2-72 (5 V sensor supply) and P2-17 (sensor return). Install a jumper wire into each of these terminal locations.

D. Connect the J2/P2 ECM connectors.

E. Restore electrical power to the ECM.

F. Measure the voltage between the jumper wire in P2-72 (5 V sensor supply) and the jumper wire in P2-17 (sensor return).

G. Remove electrical power from the ECM.

Expected Result:

The voltage measurement is 5.0 ± 0.2 VDC at the J2/P2 ECM connectors.

Results:

- OK – The voltage measurement is 5.0 ± 0.2 VDC at the ECM.

Repair: The ECM is operating correctly. There is a problem with the supply wires in the engine harness. Repair the harness wiring and/or the connector. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

- Not OK – The voltage measurement is not 5.0 ± 0.2 VDC at the ECM connectors.

  Repair: The ECM is not producing the correct supply voltage. There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02933545

Cat Data Link Circuit - Test

SMCS Code: 1901-038

System Operation Description:

This procedure is used for the following diagnostic codes:

- 296-09 Unable to communicate with Transmission ECM
- 296-12 See Service Manual
- 296-14 Transmission Control special instruction
- 596-09 Implement Control abnormal update rate
- 596-12 Wrong Response from Implement ECM
- 800-09 VIMS Main Module abnormal update rate
- 800-14 VIMS Main Module special instruction

The Cat Data Link provides data communication line between the different control modules that are on the machine. The Cat Data Link is used to communicate information from the engine's Electronic Control Module (ECM) to the other electronic systems. The Cat Data Link is also used for communication between the control modules and Caterpillar Electronic Technician (ET).

The ECM communicates with Cat ET in order to share status information and diagnostic information. Cat ET can also be used to configure the ECM parameters. This information will not be available if communication fails across the Cat Data Link.

The ECM sends information to the electronic dash displays in order to communicate the engine's operating status to the operator of the machine. The ECM also communicates with other machine control modules in order to perform machine functions. The following modules are available for this application. These modules communicate over the Cat Data Link:

- Engine ECM
- Implement ECM
- Power train ECM
- Gateway module
- Driver information display
- Machine Security System (MSS)
- Payload control system

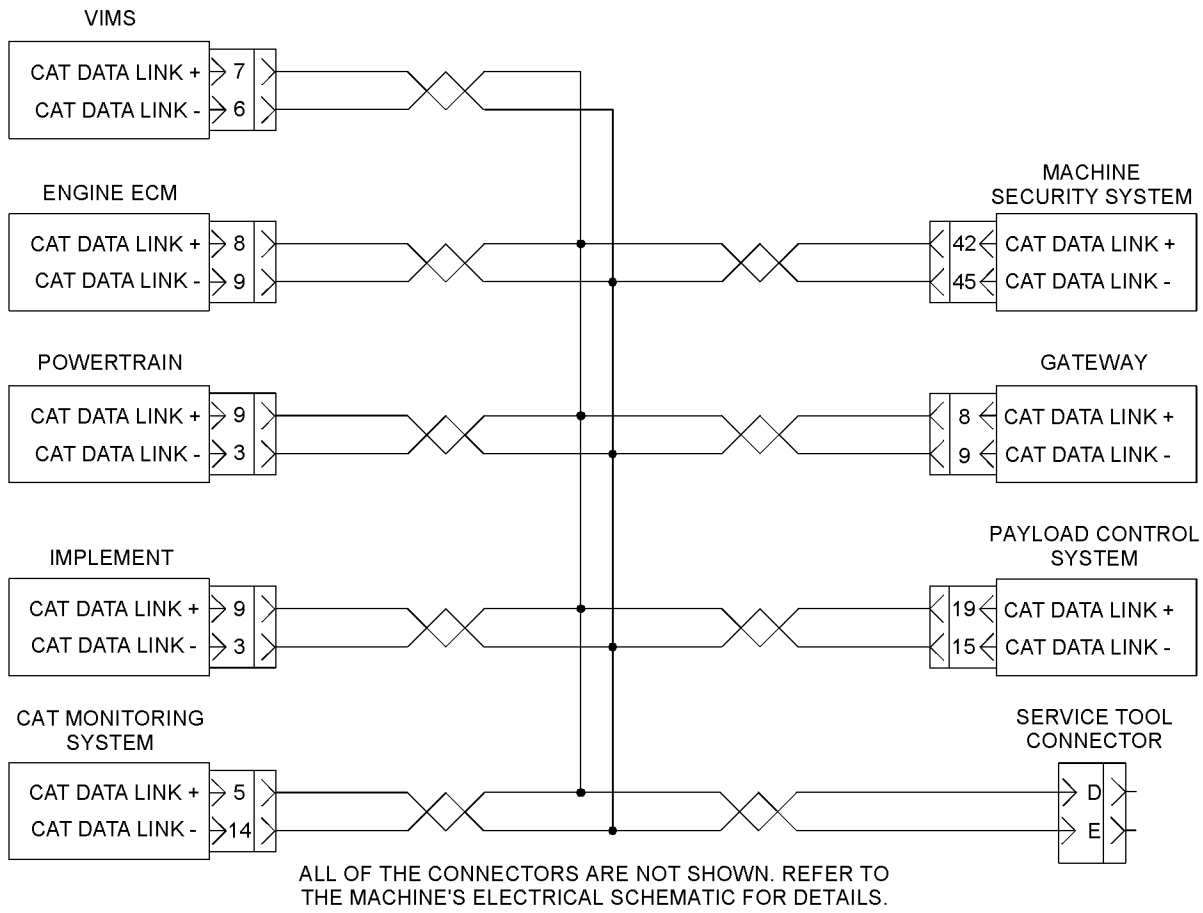


Illustration 19 g01454958

Schematic for the Cat Data Link (typical example)

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the engine ECM.

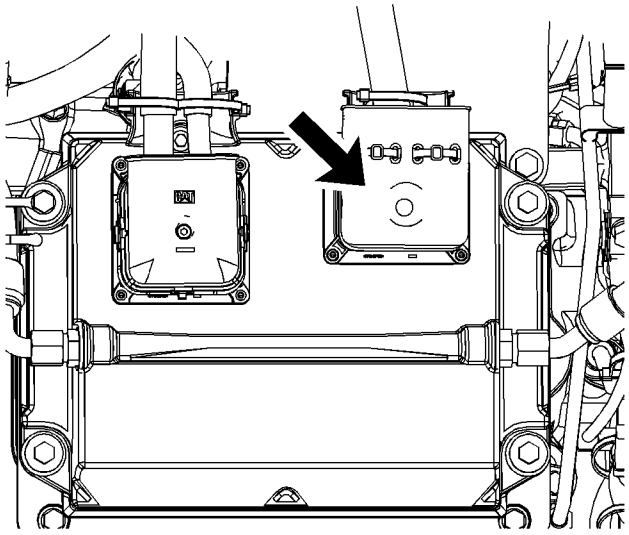


Illustration 20 g01214624

J1/P1 ECM connectors (typical left side engine view)

B. Thoroughly inspect the J1/P1 ECM connectors. Inspect all of the connectors to other modules that are on the Cat Data Link. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

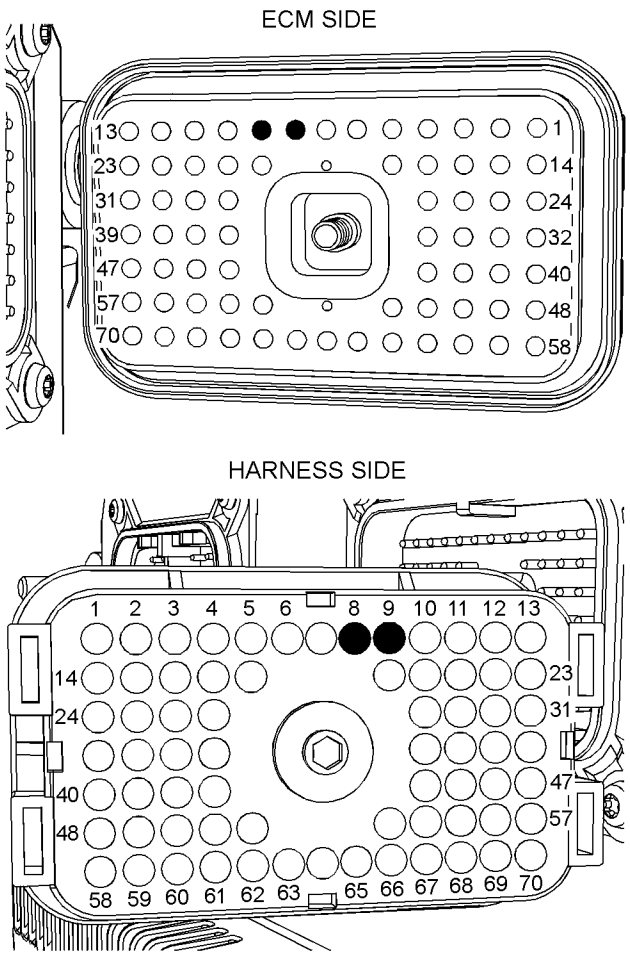


Illustration 21 g01207225

Terminals at the P1 ECM connector for the Cat Data Link

(P1-8) Cat Data Link +
(P1-9) Cat Data Link −

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.

D. Check the allen head screw for each of the ECM connectors for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All of the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and connectors appear to be OK.Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP. STOP

Test Step 2. Check for Shorts in the Harness

A. Disconnect the J1/P1 ECM connectors.

B. Disconnect all control modules from the Cat Data Link.

C. Disconnect Cat ET from the service tool connector .

Note: Wiggle the harness during the following measurements in order to reveal an intermittent condition.

D. Measure the resistance from P1-8 to every terminal on the P1 ECM connector.

E. Measure the resistance from P1-8 to the chassis ground.

F. Measure the resistance from P1-9 to every terminal on the P1 ECM connector.

G. Measure the resistance from P1-9 to the chassis ground.

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK – Each check of the resistance indicates an open circuit.There does not appear to be a short in the harness. Proceed to Test Step 3.
- Not OK – At least one check of the resistance does not indicate an open circuit.

Repair: There is a short circuit in one of the harnesses. There may be a problem with a connector. Repair the wiring and/or the connector. Replace parts, if necessary. Verify that the problem is resolved.

STOP. Repair Complete

Test Step 3. Check for an Open in the Harness

A. Fabricate a jumper wire that is long enough to create a short across two terminals at the service tool connector. Crimp connector sockets to each end of the jumper wire.

B. Install the jumper wire between terminals D and E at the service tool connector.

C. Measure the resistance between P1-8 and P1-9.

D. Measure the resistance at the connectors of all of the other control modules.

Expected Result:

The resistance is less than 5 Ohms for each measurement.

Results:

- OK – The resistance is less than 5 Ohms for each measurement.

  Repair: The Cat Data Link does not have an open in the harness. The problem seems to be resolved. There may be an intermittent electrical problem in the wiring harness. There may be a problem with a connector. Inspect the harness and the connectors carefully. If an intermittent problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – The resistance is greater than 5 Ohms for one or more of the measurements. There is excessive resistance or an open circuit in the harness or the connectors.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Verify that the problem is resolved.

  STOP. Repair Complete

i02930083

Compression Brake Solenoid Circuit - Test

SMCS Code: 5479-038-BRK

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the compression brake solenoids.

Use this procedure for the following diagnostic codes:

- 2533-05 Compression Brake Low/High Solenoid #1 current below normal
- 2533-06 Compression Brake Low/High Solenoid #1current above normal
- 2534-05 Compression Brake Low/High Solenoid #2 current below normal
- 2534-06 Compression Brake Low/High Solenoid #2 current above normal
- 2535-05 Compression Brake Medium/High Solenoid #1 current below normal
- 2535-06 Compression Brake Medium/High Solenoid #1 current above normal
- 2536-05 Compression Brake Medium/High Solenoid #2 current below normal
- 2536-06 Compression Brake Medium/High Solenoid #2 current above normal

The compression brake uses the engine in order to provide auxiliary braking. The compression brake reduces engine overspeed, brake oil temperature, and the wear of brake components. When the compression brake is activated, fuel injection and ether are disabled and all three compression brake solenoids are activated. The throttle lock will also disengage.

The compression brake can operate in either automatic mode or manual mode. Automatic mode is selected when the compression brake switch is released. Manual mode is selected when the compression brake switch is pressed. The compression brake will activate when engine speed is above the trip point. The compression brake will remain active until the engine speed falls below the kickout speed.

The transmission control has ultimate control over the system for the compression brake. The engine ECM communicates engine speed and the status for the compression brake switch to the transmission control. The transmission control checks parameters in order to determine optimum conditions before engaging the compression brakes. The transmission control then commands the engine ECM to turn on all solenoids. A problem with communications between the engine ECM and the transmission control will affect operation of the compression brake. The transmission control will restrict operation to the automatic mode during an active fault for the compression brake switch.

Note: If a problem is suspected with the switches for the retarder solenoid, Refer to Troubleshooting, “Switch Circuits - Test” for troubleshooting information.

Perform this procedure under conditions that are identical to the conditions that exist when the problem occurs. Typically, problems with the compression brake solenoids occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

“Compression Brake Solenoid Test”

The “Compression Brake Solenoid Test” is a diagnostic test that is available on Caterpillar Electronic Technician (ET). Use the “Compression Brake Solenoid Test” to assist in troubleshooting problems in the circuit for the compression brake. The engine speed must be zero before the “Compression Brake Solenoid Test” will function. The engine Electronic Control Module (ECM) will only detect shorts in the circuit for the compression brake when the test is active. “Current high” diagnostic codes (short circuits) will be logged once the test has been deactivated. The ECM will only detect opens in the circuit for the compression brake when the test is not active. The test must be activated and then deactivated before the ECM will detect an open circuit. “Current low” diagnostic codes (open circuits) will be active once the test has been deactivated.

Note: All of the retarder solenoids share a single return circuit. A short circuit or an open circuit in the return wire for the retarder solenoids will cause a problem with all of the solenoids.

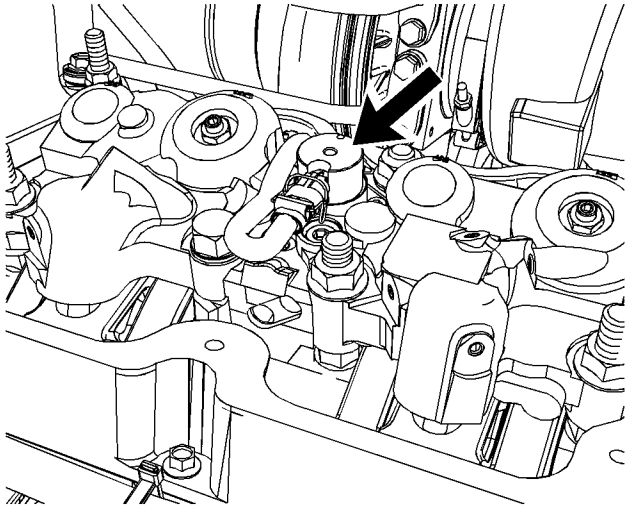


Illustration 22 g01199118

Location of the compression brake solenoid (typical example)

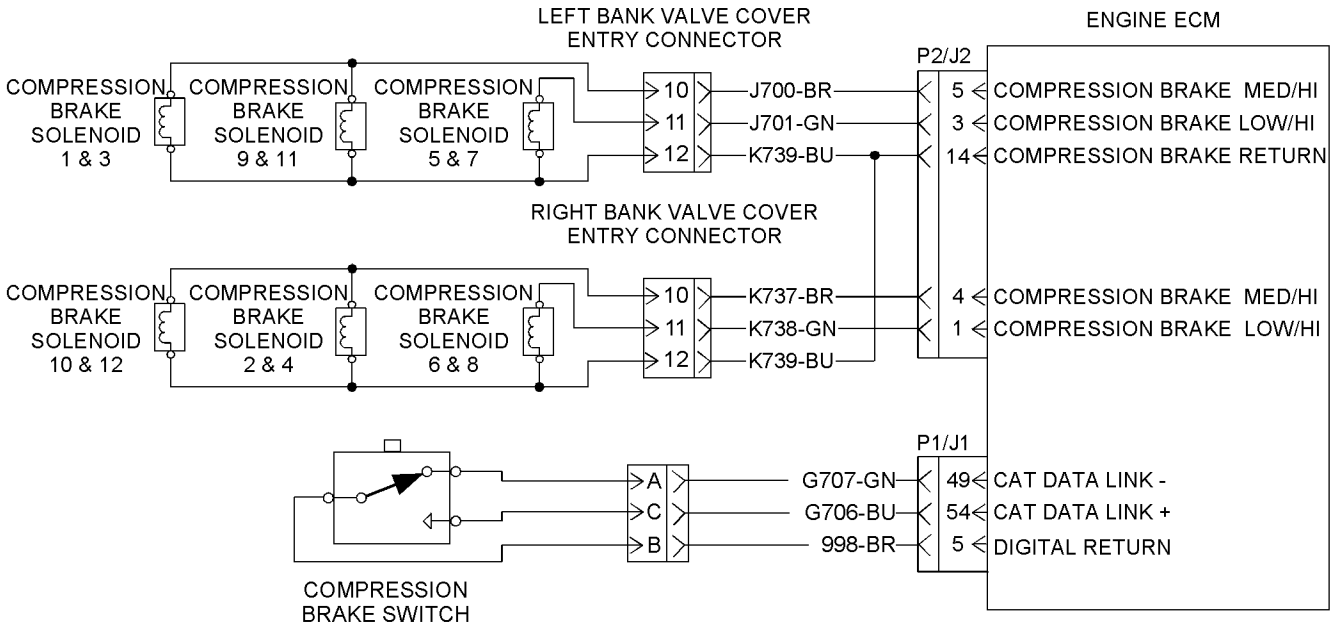


Illustration 23 g01454365

Schematic for the compression brake circuit

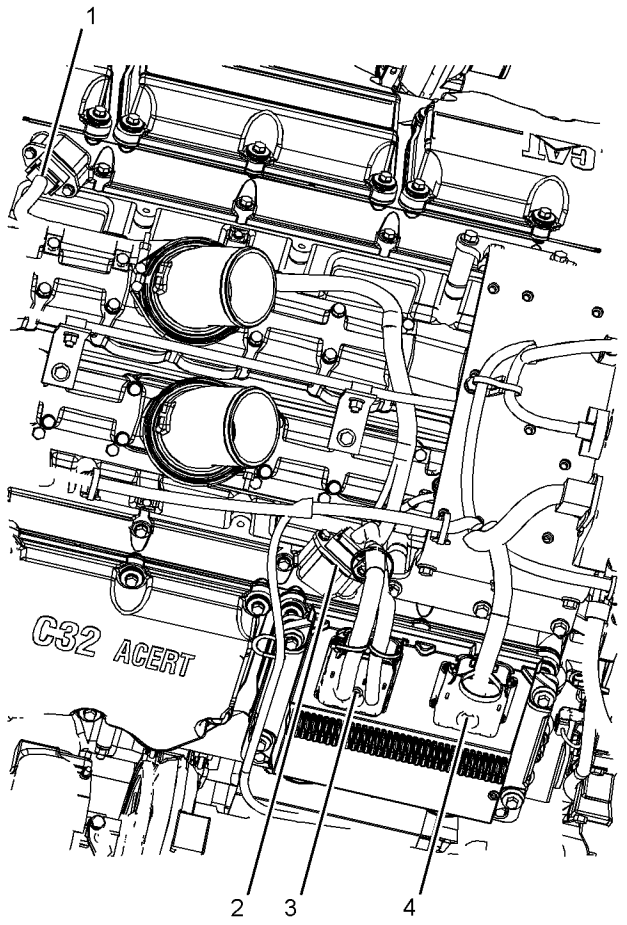


Illustration 24 g01270061

Right top side engine view (typical example)

(1) Connector for the left bank valve cover
(2) Connector for the right bank valve cover
(3) J2/P2 ECM connectors
(4) J1/P1 ECM connectors

Test Step 1. Inspect the Electrical Connectors and the Wiring

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove electrical power from the engine's ECM. A strong electrical shock hazard is present if the electrical power is not removed from the engine ECM.

B. Thoroughly inspect connectors (1) and (2). Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

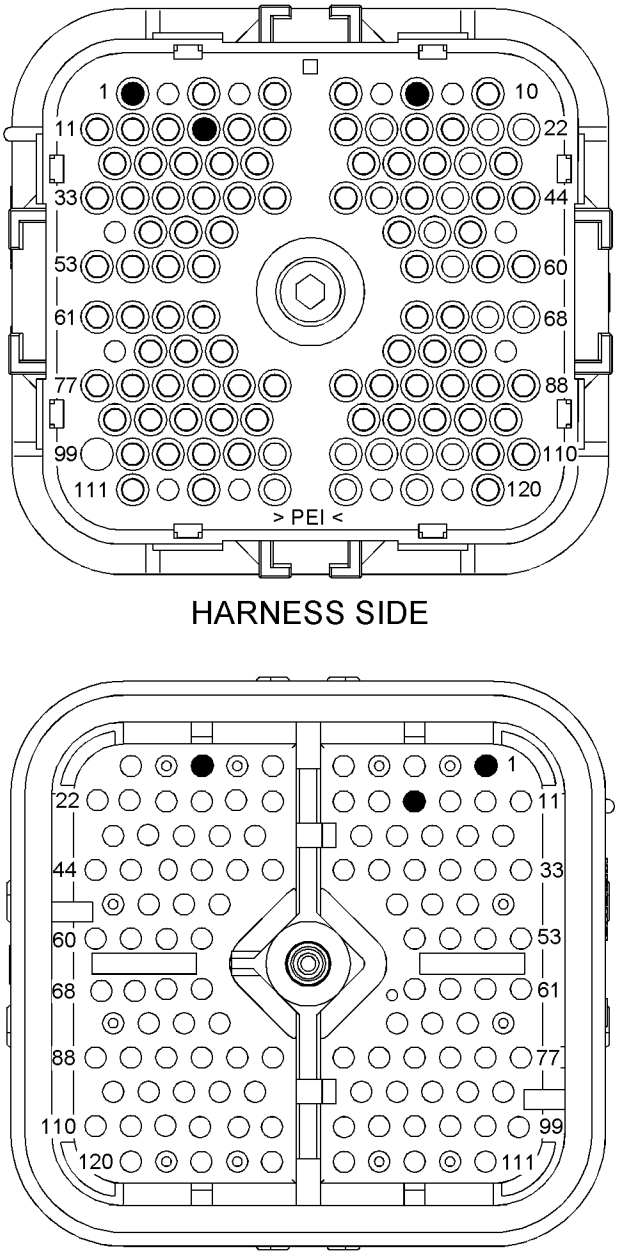


Illustration 25 g01141312

P2Connector for the engine ECM

(P2-1) Compression brake solenoid low/high
(P2-8) Compression brake solenoid med/high
(P2-14) Digital return

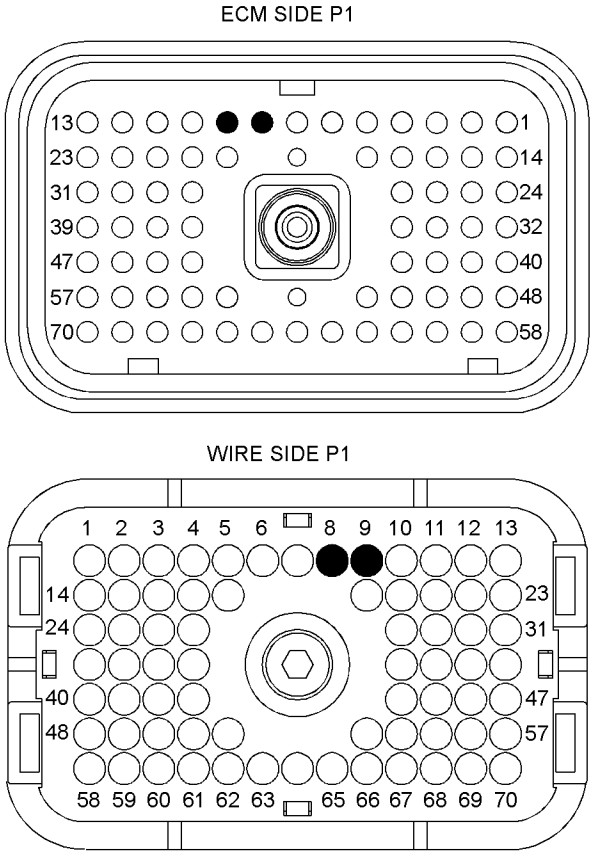


Illustration 26 g01270811

P1Connector for the Engine ECM

(P1-8) Cat data link +
(P1-9) Cat data link −

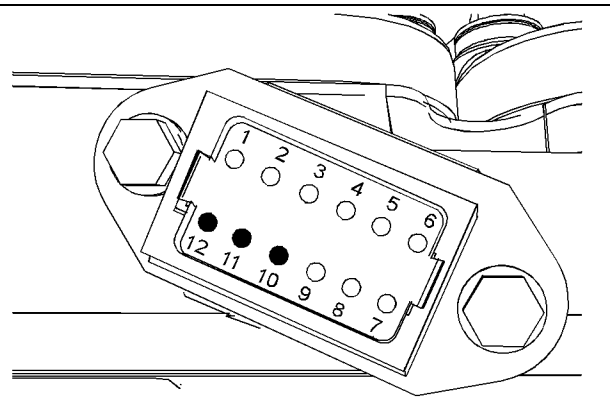


Illustration 27 g01195659

Connector for the left bank valve cover

(10) Compression brake solenoid med/high
(11) Compression brake solenoid low/high
(12) Digital return

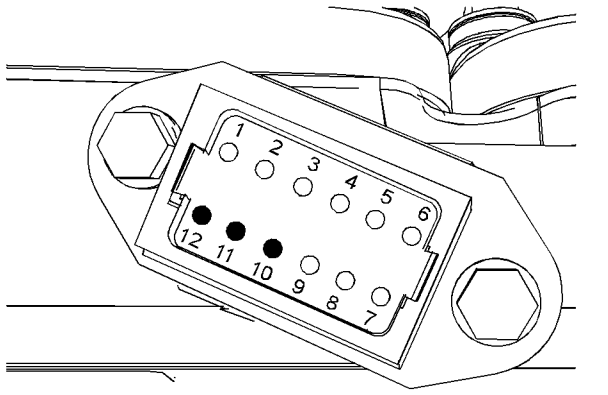


Illustration 28 g01195659

Connector for the right bank valve cover

(10) Compression brake solenoid med/high
(11) Compression brake solenoid low/high
(12) Digital return

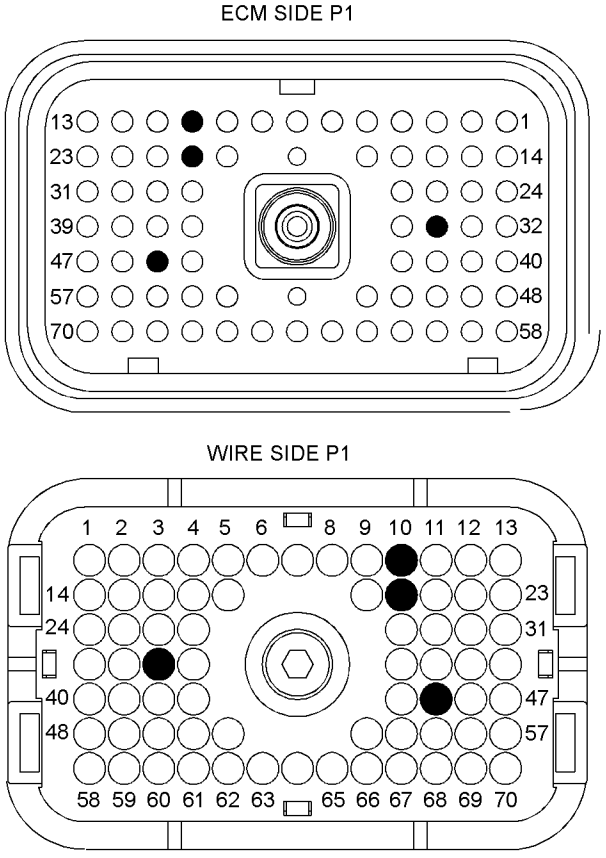


Illustration 29 g01270814

P1Connector for the Brake ECM

(10) Cat data link +
(20) Cat data link−
(34) Compression brake switch
(45) Sensor return

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with injector solenoids.

D. Check the allen head screw for each of the ECM connectors and the machine connectors for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasion and for pinch points from the valve cover back to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion, or of pinch points.

Results:

- OK – The harness and connectors appear to be OK.Proceed to Test Step 12.
- Not OK – There is a problem with the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals for each of the connectors are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes and/or Logged Diagnostic Codes

A. Connect Cat ET to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Access the “Special Tests” under the “Diagnostics” menu.

D. Start the “Compression Brake Solenoid Test” on Cat ET.

E. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

F. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.If a problem is suspected with the “Compression Brake Switch” , proceed to Test Step 9.
- Not OK – A low current diagnostic code (05) is active at this time.Proceed to Test Step 3.
- Not OK – A high current diagnostic code (06) is logged at this time.Proceed to Test Step 5.

Test Step 3. Short the Wires of the Suspect Compression Brake Solenoid at the Valve Cover Connector

A. Turn the keyswitch to the OFF position.

B. Disconnect the valve cover connector for the suspect compression brake solenoid.

C. Fabricate a jumper wire in order to create a short between the supply and the return for the suspect compression brake solenoid.

D. Turn the keyswitch to the ON position.

E. Access the “Special Tests” under the “Diagnostics” menu.

F. Start the “Compression Brake Solenoid Test” on Cat ET.

G. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

H. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

A high current diagnostic code (06) is logged at this time.

Results:

- OK – A high current diagnostic code (06) is logged at this time. The harness wiring between the valve cover connector for the suspect compression brake solenoid and ECM connector P2 is OK. Proceed to Test Step 7.
- Not OK – A low current diagnostic code 05 is active at this time. The ECM did not detect the short at the valve cover connector for the compression brake solenoid.Proceed to Test Step 4.

Test Step 4. Create a Short Circuit at the ECM

A. Turn the keyswitch to the OFF position.

B. Disconnect the J2/P2 ECM connector.

C. Inspect the terminals on the J2 and P2 ECM connectors for damage.

Note: Refer to the Figure 25 for pin locations.

D. Remove the return wire and the supply wire for the suspect compression brake solenoid from the P2 ECM connector.

E. Fabricate a jumper wire in order to short the two pins for the suspect compression brake solenoid at the ECM. Crimp a socket to each end of the jumper wire. Insert the jumper wire into the P2 ECM connector.

F. Reconnect the P2 ECM connector.

G. Turn the keyswitch to the ON position.

H. Access the “Special Tests” under the “Diagnostics” menu.

I. Start the “Compression Brake Solenoid Test” on Cat ET.

J. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

K. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

A high current diagnostic code (06) is logged at this time.

Note: Disconnecting the supply wire for the suspect compression brake solenoid will cause an “Open” in the compression brake solenoid that shares the supply wire with the suspect compression brake solenoid.

Results:

- OK – A high current diagnostic code (06) is logged at this time. The ECM detected the short.

  Repair: Check continuity of the supply wire for the suspect compression brake solenoid between the valve cover connector for the suspect compression brake solenoid and P2. If the wire is open, replace the wire.

  Check continuity of the return wire for the suspect compression brake solenoid between the valve cover connector for the suspect compression brake solenoid and P2. If the wire is open, replace the wire.

  STOP.

- Not OK – A low current diagnostic code 05 is active at this time. The ECM did not detect the short circuit.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

Test Step 5. Open the Wires of the Suspect Compression Brake Solenoid at the Valve Cover Connector

A. Turn the keyswitch to the OFF position.

B. Disconnect the valve cover connector for the suspect compression brake solenoid.

C. Turn the keyswitch to the ON position.

D. Access the “Special Tests” under the “Diagnostics” menu.

E. Start the “Compression Brake Solenoid Test” on Cat ET.

F. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

G. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

A low current diagnostic code (05) is active at this time.

Results:

- OK – A low current diagnostic code (05) is active at this time. The ECM detected the open at the valve cover connector for the compression brake solenoid. The harness wiring between the valve cover connector for the suspect compression brake solenoid and ECM connector P2 is OK. Proceed to Test Step 8.

- Not OK – A high current diagnostic code (06) is logged at this time. The ECM did not detect the open at the valve cover connector for the compression brake solenoid.Proceed to Test Step 6.

Test Step 6. Create an Open at the ECM

A. Turn the keyswitch to the OFF position.

B. Disconnect the P2 ECM connector.

C. Inspect the terminals on the J2 and P2 ECM connectors for damage.

Note: Refer to the Figure 25 for pin locations.

D. Remove the return wire and the supply wire for the suspect compression brake solenoid from the P2 ECM connector.

E. Reconnect the P2 ECM connector.

F. Turn the keyswitch to the ON position.

G. Access the “Special Tests” under the “Diagnostics” menu.

H. Start the “Compression Brake Solenoid Test” on Cat ET.

I. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

J. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

A low current diagnostic code (05) is active at this time.

Results:

- OK – A low current diagnostic code (05) is active at this time. The ECM detected the open at the ECM.

  Repair: Disconnect the P2 ECM connector. Measure the resistance between the supply wire for the suspect compression brake solenoid and every terminal on ECM connector P1 and ECM connector P2. Measure the resistance between the supply wire for the suspect compression brake solenoid and engine ground. If the wire is shorted, replace the wire.

  Measure the resistance between the return wire for the suspect compression brake solenoid and every terminal on ECM connector P1 and ECM connector P2. If the wire is shorted, replace the wire.

  STOP.

- Not OK – A high current diagnostic code (06) is logged at this time. The ECM did not detect the open.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

Test Step 7. Create a Short Circuit at the Compression Brake Solenoid

A. Turn the keyswitch to the OFF position.

B. Remove the valve cover.

C. Reconnect the valve cover connector.

D. Disconnect the connector on the suspect compression brake solenoid.

E. Inspect the terminals on the solenoid connector for damage.

F. Fabricate a jumper wire in order to short the two wires for the suspect solenoid on the solenoid connector. Crimp a pin to each end of the jumper wire.

G. Make sure that the solenoid connector securely holds the jumper wire.

Note: Worn terminals and/or damaged terminals on the solenoid connector could cause an intermittent “Open” .

H. Turn the keyswitch to the ON position.

I. Access the “Special Tests” under the “Diagnostics” menu.

J. Start the “Compression Brake Solenoid Test” on Cat ET.

K. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

L. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

A high current diagnostic code (06) is logged at this time.

Results:

- OK – A high current diagnostic code (06) is logged at this time. The harness wiring between the solenoid connector for the suspect compression brake solenoid and ECM connector P2 is OK.

  Repair: Temporarily connect a new compression brake solenoid to the harness, but do not install the new compression brake solenoid in the engine. Verify that there are no active diagnostic codes for the compression brake solenoid. If there are no active diagnostic

codes for the compression brake solenoid, permanently install the new compression brake solenoid. Clear any logged diagnostic codes.

STOP.

- Not OK – A low current diagnostic code (05) is active at this time. The ECM did not detect the short circuit.

  Repair: Repair the harness between the connector for the compression brake solenoid and the valve cover connector for the suspect compression brake solenoid.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 8. Create an Open Circuit at the Compression Brake Solenoid

A. Turn the keyswitch to the OFF position.

B. Reconnect the valve cover connector.

C. Remove the valve cover.

D. Disconnect the connector on the suspect compression brake solenoid.

E. Inspect the terminals on the solenoid connector for damage.

F. Turn the keyswitch to the ON position.

G. Access the “Special Tests” under the “Diagnostics” menu.

H. Start the “Compression Brake Solenoid Test” on Cat ET.

I. Once Cat ET displays the status of the compression brake solenoid, stop the “Compression Brake Solenoid Test” .

J. Check for active diagnostic codes and/or logged diagnostic codes that are associated with the compression brake solenoids.

Expected Result:

A low current diagnostic code (05) is active at this time.

Results:

- OK – A low current diagnostic code (05) is active at this time. The ECM detected the open at the compression brake solenoid. The harness wiring between the solenoid connector for the suspect compression brake solenoid and ECM connector P2 is OK.

  Repair: Temporarily connect a new compression brake solenoid to the harness, but do not install the new compression brake solenoid in the engine. Verify that there are no active diagnostic codes for the compression brake solenoid. If there are no active diagnostic codes for the compression brake solenoid, permanently install the new compression brake solenoid. Clear any logged diagnostic codes.

  STOP.

- Not OK – A high current diagnostic code (06) is logged at this time. The ECM did not detect the open.

  Repair: Repair the harness between the connector for the compression brake solenoid and the valve cover connector for the suspect compression brake solenoid.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 9. Check the Status of the Compression Brake Switch

Note: A switch input to the brake electronic control module sets the status of the compression brake. The status is off or automatic. Software for the brake electronic control module controls the level of braking. The levels of braking are low, medium and high. The brake electronic control module requests the engine electronic control module in order to actuate the compression brake solenoids. The request is sent over the Cat data link.

A. Turn the keyswitch to the ON position.

B. Use Cat ET in order to connect to the brake ECM.

C. Operate the compression brake switch and monitor the status for the compression brake.

Expected Result:

The status for the compression brake switch changes from the off state to the automatic state.

Results:

- OK – The compression brake switch is operating correctly.

  Repair: If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – There is a problem in the circuit for the compression brake switch. Proceed to Test Step 10.

Test Step 10. Short the Wires at the Compression Brake Switch

A. Turn the keyswitch to the OFF position.

B. Disconnect the connector for the compression brake switch.

C. Insert a jumper wire between the following terminals of the connector on the harness side:

- Terminal 2
- Terminal 3

D. Turn the keyswitch to ON position.

E. Check the status for the compression brake switch on Cat ET.

F. Remove the jumper wire.

G. Check the status for the compression brake switch on Cat ET.

H. Turn the keyswitch to the OFF position.

Expected Result:

The status for the compression brake switch indicates “Automatic” when a jumper wire is installed between terminal 2 and terminal 3.

The status for the compression brake switch indicates “Off” when a jumper wire is removed from terminal 2 and terminal 3.

Results:

- OK – The status changed accordingly.

  Repair: Temporarily replace the switch. Verify that the new switch solves the problem before you permanently install the new switch.

  STOP.

- Not OK – The status did not change accordingly. Proceed to Test Step 11.

Test Step 11. Check for Shorts in the Wiring Harness

A. Turn the keyswitch to OFF position.

B. Disconnect ECM connectors P1and P2.

C. Measure the resistance between P1-34 and every terminal on ECM connector P1 and ECM connector P2.

Expected Result:

The measured resistance indicates an open circuit.

Results:

- OK – The resistance measurement indicates an open circuit.Proceed to Test Step 12.
- Not OK – The resistance measurement indicates a short circuit.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

Test Step 12. Check for an Open in Wiring Harness

A. Disconnect the connector for the compression brake switch.

B. Short the wires of the compression brake switch at the compression brake switch. Insert a jumper wire between the following terminals of the connector for the harness side:

- Terminal 2
- Terminal 3

C. Measure the resistance between J1-34 and J1-45 at the ECM connectors.

Expected Result:

The measured resistance indicates a short circuit.

Results:

- OK – The resistance measurement indicates a short circuit.Proceed to Test Step 13.
- Not OK – The resistance measurement indicates an open circuit. There is an open circuit or excessive resistance in the wiring harness.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

Test Step 13. Short the Input Wires of the Compression Brake Switch at the ECM Connector

A. Disconnect the J1 ECM connector.

B. Remove the wires from J1-34 compression brake switch input and J1-45 sensor return.

C. Fabricate two jumper wires with sockets on one end and insert one into J1-34 and J1-45.

D. Connect a jumper wire between the jumper wires in J1-34 and J1-45.

E. Reconnect the J1 ECM connector.

F. Turn the keyswitch to the ON position.

G. Check the status for the compression brake switch on Cat ET.

H. Disconnect the jumper wire between the jumper wires in J1-34 and J1-45.

Note: Ensure that the jumper wires are electrically isolated from all contact.

I. Check the status for the compression brake switch on Cat ET.

J. Turn the keyswitch to OFF position.

Expected Result:

The status for the compression brake switch indicates “Automatic” when a jumper wire is installed between jumper wires J1-34 and J1-45.

The status for the compression brake switch indicates “Off” when a jumper wire is removed between jumper wires J1-34 andJ1-45.

Results:

- OK – The status changed accordingly.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

- Not OK – The status did not change accordingly.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02434210

Digital Sensor Supply Circuit - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the 8 V digital supply.

This procedure covers the following diagnostic code:

- 41-03 8 Volt DC Supply short to +batt
- 41-04 8 Volt DC Supply short to ground

The digital sensor supply in the Electronic Control Module (ECM) supplies 8.0 ± 0.5 VDC to the throttle position sensor.

The digital sensor supply is output short circuit protected. The ECM is protected from a short to ground and a short to +Battery condition. The digital sensor is not protected.

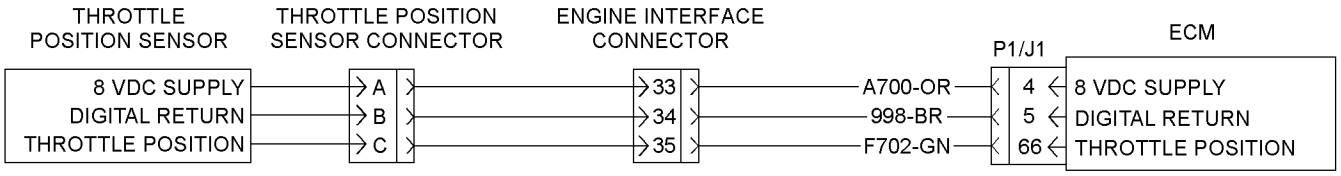


Illustration 30 g01214470

Schematic for digital sensor supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the engine ECM.

B. Thoroughly inspect the J1/P1 ECM connector and the connector for the throttle position sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

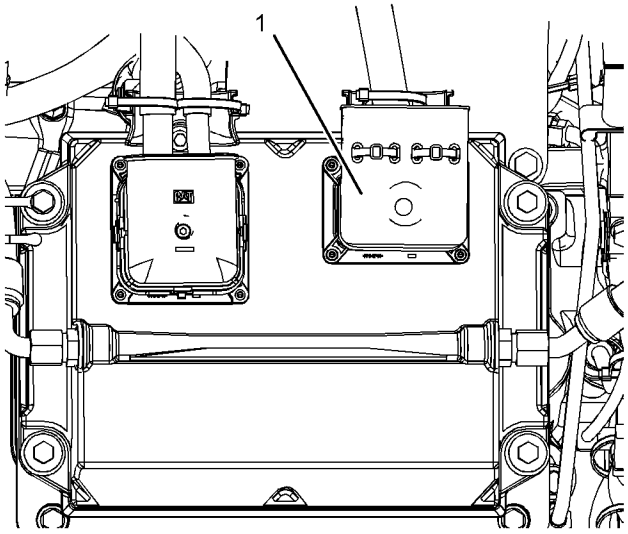


Illustration 31 g01167488

Location of the J1/P1 ECM connectors (typical engine view)

(1) J1/P1 ECM connectors

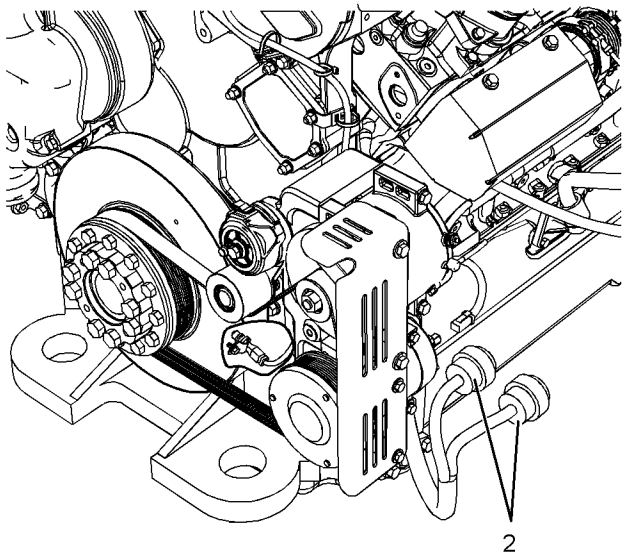


Illustration 32 g01213916

Location of the engine interface connectors (typical left side engine view)

(2) engine interface connectors

C. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect the connector for the digital sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

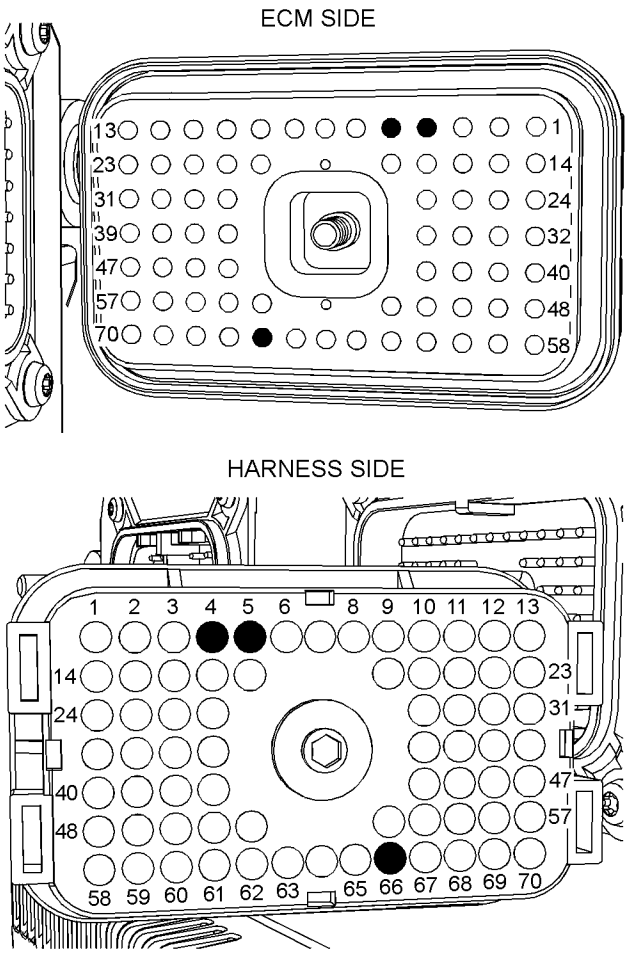


Illustration 33 g01214474

Terminal locations at the P1 ECM connector for the digital sensor supply

(P1-4) 8 VDC supply
(P1-5) Digital return
(P1-66) Throttle position

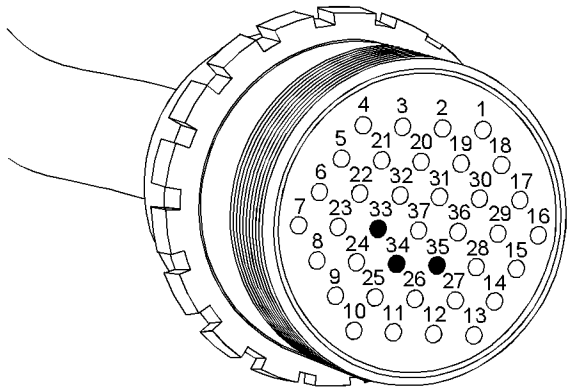


Illustration 34 g01214475

Terminal locations at the engine interface connector for the digital sensor supply

(Terminal 33) 8 VDC supply
(Terminal 34) Digital return
(Terminal 35) Throttle position

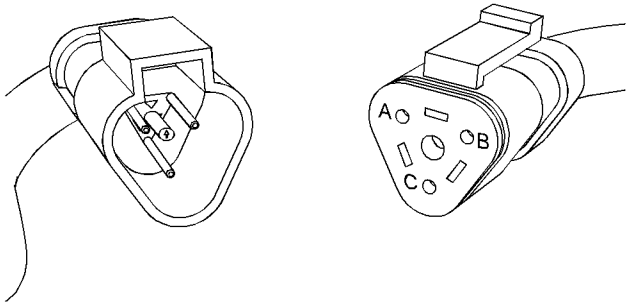


Illustration 35 g01159881

Terminal locations at the sensor connector for the digital sensor supply

(Terminal A) 8 VDC supply
(Terminal B) Digital return
(Terminal C) Throttle position

D. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the connector for the throttle position sensor.

E. Check the allen head screw from each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All of the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and connectors appear to be OK.Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  STOP. STOP

Test Step 2. Check for Active Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the engine ECM.

C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

Expected Result:

There are no active diagnostic codes.

Results:

- OK – No diagnostic code for the digital supply is active.A problem is suspected with a sensor output signal. In order to verify that the sensor is receiving the correct supply voltage, proceed to Test Step 3.
- Not OK – A 41-03 diagnostic code is active.The ECM is detecting a short to the +Battery in the wiring for the digital supply. Proceed to Test Step 3.
- Not OK – A 41-04 diagnostic code is active.The ECM is detecting a short to ground in the wiring for the digital supply. Proceed to Test Step 4.

Test Step 3. Check the Supply Voltage at the Sensor Connector

A. Remove electrical power from the engine ECM.

B. Disconnect the throttle position sensor at the sensor connector.

C. Restore electrical power to the engine ECM.

D. Measure the voltage between terminals A (8 V digital supply) and terminal B (digital return) at the sensor connector.

Expected Result:

The voltage is 8.0 ± 0.5 VDC.

Results:

- OK – The voltage is 8.0 ± 0.5 VDC. The voltage is correct.

  Repair: Restore all wires to the original configuration. Clear all diagnostic codes. The problem seems to be resolved. There may be an intermittent problem in the circuit. If an intermittent problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

  STOP.
- Not OK – The voltage is not 8.0 ± 0.5 VDC.The voltage is incorrect at the sensor connector. Proceed to Test Step 5.

Test Step 4. Disconnect the Sensor Connector and Check for Active Diagnostic Codes

A. Remove electrical power from the engine ECM.

B. Ensure that the throttle position sensor is disconnected at the sensor connector.

C. Restore electrical power to the engine ECM.

D. Use Cat ET to check an active 41-04 diagnostic code.

Note: Wait for 30 seconds after the sensor is disconnected. Check for an active diagnostic code on Cat ET.

Expected Result:

The 41-04 diagnostic code deactivates while the sensor is disconnected from the circuit.

Results:

- OK – The 41-04 diagnostic code deactivates while the sensor is disconnected.

  Repair: The harness and the ECM are OK. There is a problem with the sensor. Replace the sensor. Ensure that the code does not return with the new sensor prior to installing the new sensor. Verify that the repair eliminates the problem.

  STOP.

- Not OK – The 41-04 diagnostic code remains active when the sensor is disconnected from the circuit.Leave the sensor disconnected. Proceed to Test Step 5.

Test Step 5. Check the +8 V Supply Wire at the ECM Connector for a Short in the Harness

A. Remove electrical power from the engine ECM.

B. Disconnect the J1/P1 ECM connectors.

C. Ensure that the throttle position sensor is disconnected at the sensor connector.

Note: Wiggle the harness during the following measurements in order to reveal any intermittent short condition.

D. Measure the resistance between P1-4 (+8 V digital supply) and every terminal on the P1 ECM connector.

E. Measure the resistance between P1-4 (+8 V digital supply) and engine ground.

Expected Result:

Each resistance measurement indicates that an open circuit condition exists.

Results:

- OK – All measurements indicate an open circuit. Leave the connector disconnected. There is not a short circuit in the harness or a short to engine ground. Proceed to Test Step 6.

- Not OK – One of the resistance measurements does not indicate an open circuit condition.

  Repair: The wire for the digital supply is shorted to another wire in the harness or the wire is shorted to engine ground. There may be a problem with a connector in the circuit. Repair the harness and/or the connector. Replace parts, if necessary. Clear all logged diagnostic codes. Restore the wiring to the original configuration. Verify that the repair eliminates the problem.

  STOP.

Test Step 6. Check the +8 V Supply Wire at the ECM Connector for an Open in the Harness

A. Fabricate a jumper wire that is long enough to connect two terminals at the ECM connector. Crimp connector pins to each end of the jumper wire.

B. Install the jumper wire between terminals P1-4 (+8 V digital supply) and P1-5 (digital return) on the harness side of the ECM connector.

Note: Wiggle the harness during the following measurements in order to reveal an intermittent open condition.

C. Measure the resistance between terminal A and terminal B at the connector for the throttle position sensor.

D. Remove the wire jumper.

Expected Result:

The measurement indicates that a short circuit exists in the circuit.

Results:

- OK – A short circuit exists in the circuit.The digital sensor and the harness are OK. Connect the connector for the digital sensors. Proceed to Test Step 7.

- Not OK – A measurement indicates that an open circuit or excessive resistance exists in the circuit for the digital supply.

  Repair: There is a problem in the harness or in a connector between the ECM connector and the connector for the digital supply. Repair the harness and/or the connector. Replace parts, if necessary. Clear all logged diagnostic codes. Return the wiring to the original configuration. Verify that the repair eliminates the problem.

  STOP.

Test Step 7. Check the +8 V Supply at the ECM

A. Fabricate two jumper wires that are long enough to provide a test circuit at the ECM connector. Crimp a connector socket to one end of each of the jumper wires.

B. Remove the wires from terminal locations P1-4 (+8 V digital supply) and P1-5 (digital return) at the ECM connector. Install one of the jumper wires into each of these terminal locations.

C. Connect the J1/P1 ECM connectors.

D. Restore electrical power to the engine ECM.

E. Measure the voltage between the wire jumper wires.

F. Remove electrical power from the engine ECM.

G. Reconnect all wires to the original configuration.

Expected Result:

The voltage is 8.0 ± 0.5 VDC.

Results:

- OK – The voltage is 8.0 ± 0.5 VDC. The voltage is correct.

  Repair: The problem seems to be resolved. There may be an intermittent problem with the harness or with a connector. If an intermittent condition is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – The voltage is not 8.0 ± 0.5 VDC.

  Repair: The voltage is incorrect at the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i06595732

Electrical Connectors - Inspect

SMCS Code: 7553-040-WW

System Operation Description:

Most electrical problems are caused by poor connections. The following procedure will assist in detecting problems with connectors and with wiring. If a problem is found correct the condition and verifies that the problem is resolved.

Intermittent electrical problems are sometimes resolved by disconnecting and reconnecting connectors. It is very important to check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 1U-5804 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. Refer to “SEHS9615, ServicingDeutschHDand DT Style Connectors”.
- Always use a 147-6456 Wedge Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Always use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire in order to access to a circuit for measurements.
- If a wire is cut, always install a new terminal for the repair.

⚠ WARNING

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

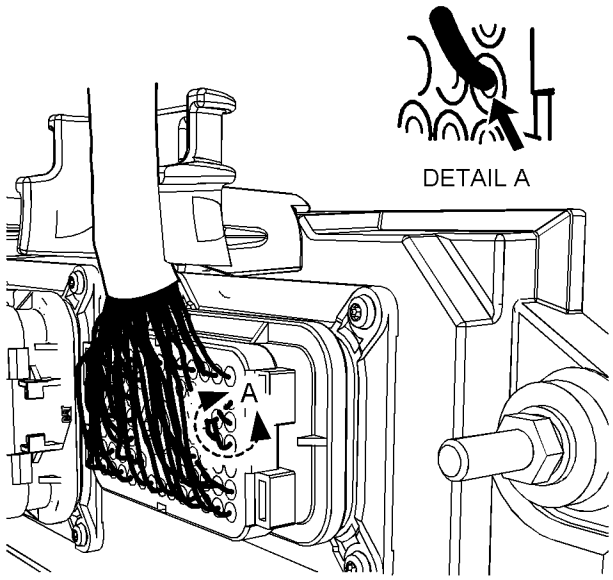


Illustration 36 g01131211

Leaky seal at the connector (typical example)

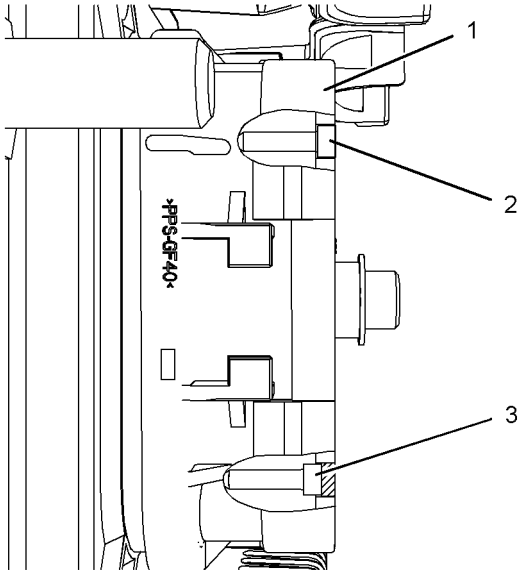


Illustration 37 g01131276

Diagram for the installation of a connector plug (typical example)

(1) Electronic Control Module (ECM) connector
(2) Correctly inserted plug
(3) Incorrectly inserted plug

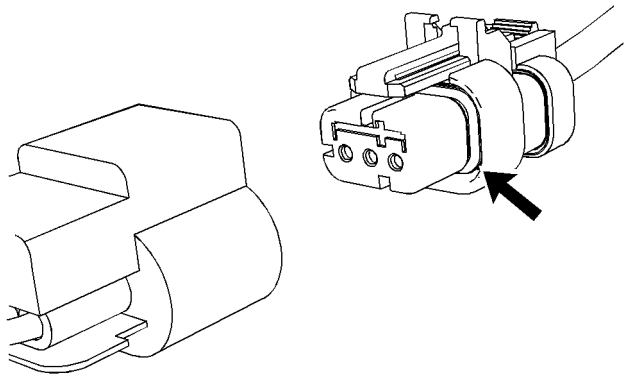


Illustration 38 g01131019

Seal for a three-pin connector (typical example)

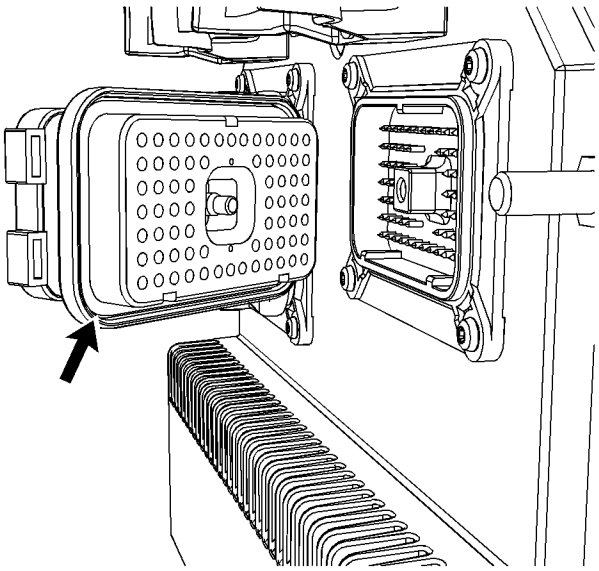


Illustration 39 g01131165

Seal for ECM connector (typical example)

Table 41

Troubleshooting Test Steps	Values	Results
1. Check Connectors for Moisture and Corrosion **A.** Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. Refer to Illustration 36 . This will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly. **B.** Ensure that the sealing plugs are in place. If any of the plugs are missing, replace the plug. Ensure that the plugs are inserted correctly into the connector. Refer to Illustration 37 . **C.** Disconnect the suspect connector and inspect the connector seal. Ensure that the seals are in good condition. If necessary, replace the connector. **D.** Thoroughly inspect the connectors for evidence of moisture entry. **Note:** It is normal to see some minor seal abrasion on connector seals. Minor seal abrasion will not allow the entry of moisture. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will recur. Simply drying the connector will not fix the problem. Check the following items for the possible moisture entry path: • Missing seals • Improperly installed seals • Nicks in exposed insulation • Improperly mated connectors Moisture can also travel to a connector through the inside of a wire. If moisture is found in a connector, thoroughly check the connector's harness for damage. Also check other connectors that share the harness for moisture. **Note:** The ECM is a sealed unit. If moisture is found in an ECM connector, the ECM is not the source of the moisture. Do not replace the ECM.	Connectors	**Result:** The harness wiring, connectors, and seals are in good condition. Proceed to Test Step 2. **Result:** A problem has been found with the harness or the connectors. **Repair:** Repair the connectors or the wiring, as required. Ensure that all of the seals are properly in place. Ensure that the connectors have been reattached. If corrosion is evident on the pins, sockets or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. If moisture was found in the connectors, run the engine for several minutes and check again for moisture. If moisture reappears, the moisture is wicking into the connector. Even if the moisture entry path is repaired, it may be necessary to replace the wires. Verify that the repair eliminates the problem. STOP

(continued)

(Table 41, contd)

2. Check the Wires for Damage to the Insulation **A.** Carefully inspect each wire for signs of abrasion, of nicks, and of cuts. Inspect the wires for the following conditions: • Exposed insulation • Rubbing of a wire against the engine • Rubbing of a wire against a sharp point **B.** Check all of the wiring harness fasteners in order to verify that the harness is properly secured. Also check all of the fasteners in order to verify that the harness is not compressed. Pull back the harness sleeves in order to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This damages the wires that are inside the harness.	Wiring	**Result:** The harness is OK. Proceed to Test Step 3. **Result:** There is damage to the harness. **Repair:** Repair the wires or replace the wires, as required. Verify that the repair eliminates the problem. STOP
3. Inspect the Connector Terminals **A.** Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are properly aligned in the connector and verify that the terminals are properly located in the connector.	Connector Terminals	**Result:** The terminals are OK. Proceed to Test Step 4. **Result:** The terminals of the connector are damaged. **Repair:** Repair the terminals and/or replace the terminals, as required. STOP

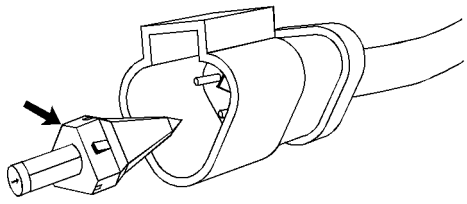


Illustration 40 g01131435

Receptacle lock wedge (typical example)

Table 42

Troubleshooting Test Steps	Values	Results
4. Perform a Pull Test on Each Wire Terminal Connection **A.** Ensure that the locking wedge for the connector is installed properly. Terminals cannot be retained inside the connector if the locking wedge is not installed properly. **B.** Perform the 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.	45 N (10 lb)	**Result:** All terminals pass the pull test. Proceed to Test Step 5. **Result:** A wire has been pulled from a terminal or a terminal has been pulled from the connector. **Repair:** Use the 1U-5804 Crimp Tool to replace the terminal. Replace damaged connectors, as required. Verify that the repair eliminates the problem. STOP

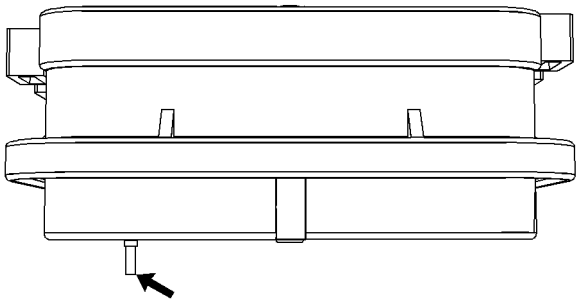


Illustration 41 g01131604

Diagram for testing pin retention (typical example)

Table 43

Troubleshooting Test Steps	Values	Results
5. Check Individual Pin Retention into the Socket **A.** Verify that the sockets provide good retention for the pins. Insert a new pin into each socket one at a time in order to check for a good grip on the pin by the socket.	Pin Retention	**Result:** The terminals are OK. Proceed to Test Step 6. **Result:** Terminals are damaged. **Repair:** Use the 1U-5804 Crimp Tool to replace the damaged terminals. Verify that the repair eliminates the problem. STOP
6. Check the Locking Mechanism of the Connectors **A.** Ensure that the connectors lock properly. After locking the connectors, ensure that the two halves cannot be pulled apart. **B.** Verify that the latch tab of the connector is properly latched. Also verify that the latch tab of the connector returns to the locked position.	Locking Mechanism of the Connectors	**Result:** The connectors are in good repair. Proceed to Test Step 7. **Result:** The connector's locking mechanism is damaged or missing. **Repair:** Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem. STOP

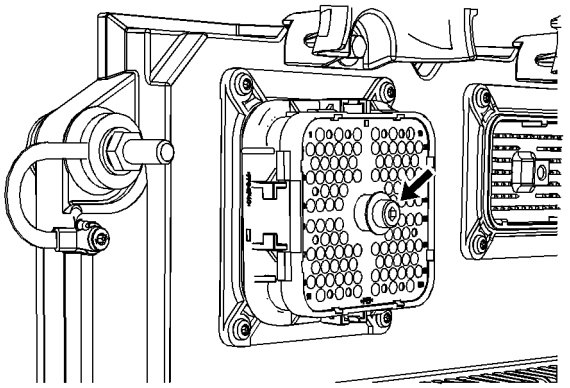


Illustration 42 g01132827

Allen head screw for the 120 pin ECM connector (typical example)

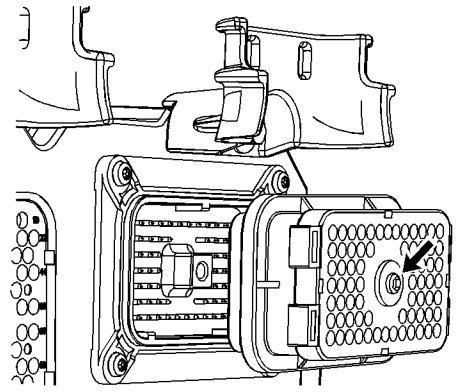


Illustration 43 g01132849

Allen head screw for the 70 pin ECM connector (typical example)

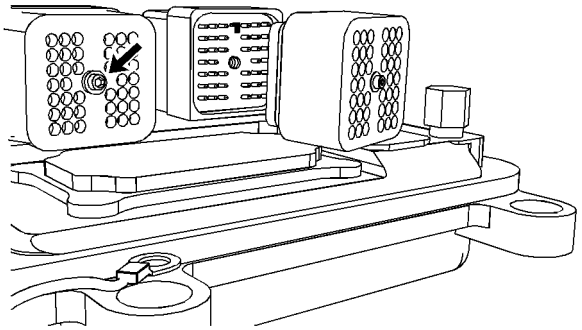


Illustration 44 g01132863

Allen head screw for the 40 pin ECM connector (typical example)

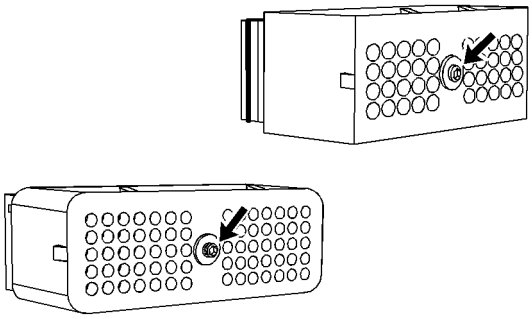


Illustration 45 g01133047

Allen head screw for the 40 pin customer connector and the 70 pin customer connector (typical example)

Table 44

Troubleshooting Test Steps	Values	Results
7. Check the Allen Head Screws on the Connectors **Note:** Visually inspect the allen head screws for the ECM connectors. Ensure that the threads on each allen head screw are not damaged. **A.** Connect the ECM connectors. **1.** Torque the allen head bolt for the 120 pin ECM connector to 7.0 ± 0.5 N·m (60 ± 4 lb in). **2.** Torque the allen head screw for the 70 pin ECM connector to 6.0 + 1.5 - 0.5 N·m (55 + 13 - 4 lb in). **3.** Torque the allen head screw for the 40 pin ECM connector to 2.25 ± 0.25 N·m (20 ± 2 lb in). **B.** Connect the customer connector. **1.** Torque the allen head screw for the 40 pin customer connector and the 70 pin customer connector to 2.25 ± 0.25 N·m (20 ± 2 lb in).	Allen Head Screws	**Result:** The ECM connectors and the customer connector is properly connected. Proceed to Test Step 8. **Result:** The allen head screws for the ECM connector or the customer connector is damaged. **Repair:** Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem. STOP
8**. Perform the "Wiggle Test" On Cat ™ ET.** **A.** Select the "Wiggle Test" from the diagnostic tests on Cat ET. **B.** Choose the appropriate group of parameters to monitor. **C.** Press the "Start" button. Wiggle the wiring harness in order to reproduce intermittent problems. **Note:** If an intermittent problem exists, the status will be highlighted and an audible beep will be heard.	Wiggle Test	**Result:** No intermittent problems were found. The harness and connectors appear to be OK. Return the unit to service. **Result:** At least one intermittent problem was indicated. **Repair:** Repair the harness or the connector. Verify that the repair eliminates the problem. STOP

i02431087

The procedure corrected the issue. Return to service.

Results:

- The procedure did not correct the issue.

  Repair: Contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

  STOP.

Electrical Power Supply Circuit - Test

SMCS Code: 1401-038

System Operation Description:

Use this test to troubleshoot any suspect problems with power to the Electronic Control Module (ECM).

This procedure covers the following diagnostic codes:

- 168-00 “System Voltage High”
- 168-01 “System Voltage Low”
- 168-02 “System Voltage intermittent/erratic”

Use this test if there are intermittent engine shutdowns or if a difficulty in starting is not accompanied by loss of electrical accessories. Engine shutdowns that are accompanied by a loss of other electrical accessories indicate a problem in the keyswitch. This does not indicate a problem in the wiring at the engine's ECM. Verify that there are no problems with the starting system or the charging system before you use this test.

Unswitched battery voltage is supplied to the ECM at P1-48, P1-52, and P1-55. The negative battery is supplied to the ECM at P1-61, P1-63, and P1-65. Circuit protection is provided for the unswitched battery voltage through a 15 Amp circuit breaker.

The ECM receives the keyswitch power at P1-70 when the keyswitch is in the ON position or the START position. When the ECM detects battery voltage at this input, the ECM powers up. When battery voltage is removed from this input, the ECM powers down. Circuit protection is provided for the keyswitch power through a 10 Amp circuit breaker.

The engine ECM requires the keyswitch to be in the ON position in order to maintain communications with Caterpillar Electronic Technician (ET).

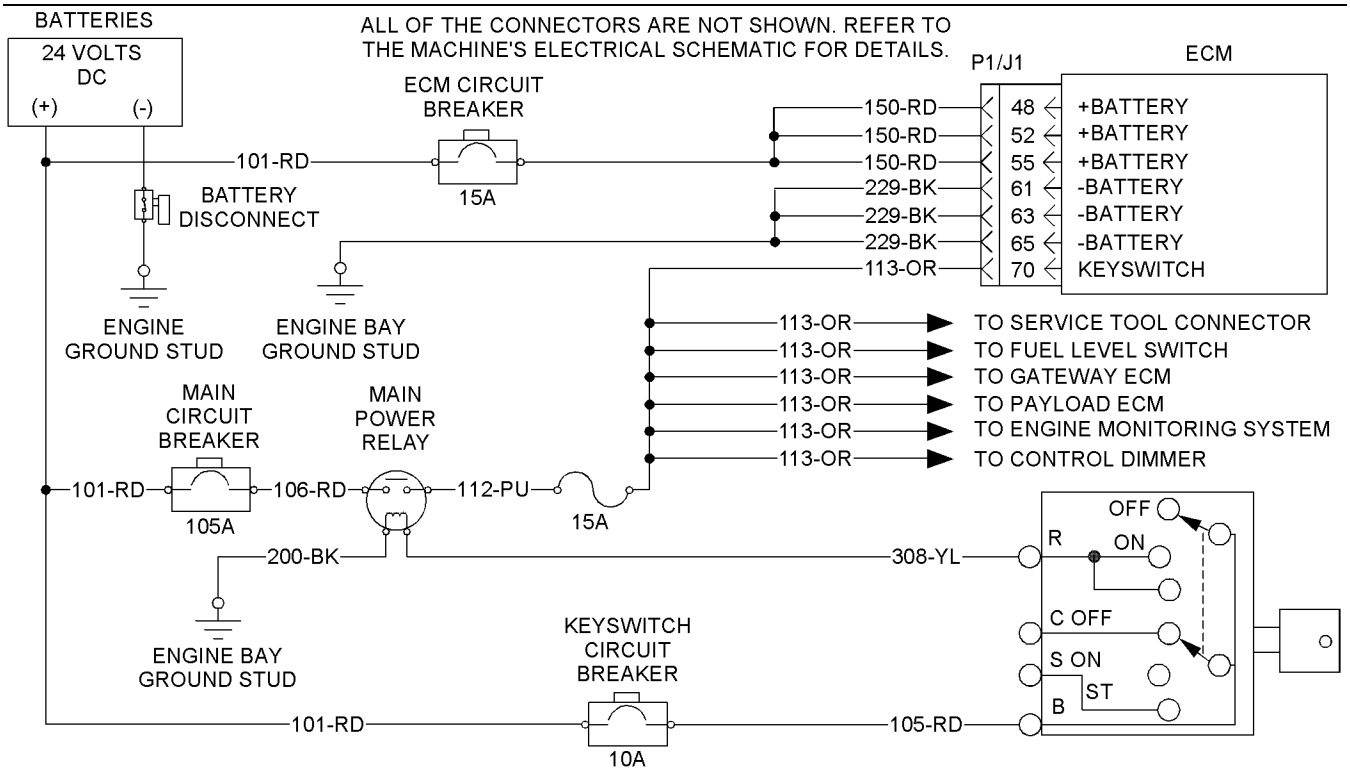


Illustration 46 g01214691

Schematic for the electrical power supply circuit

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

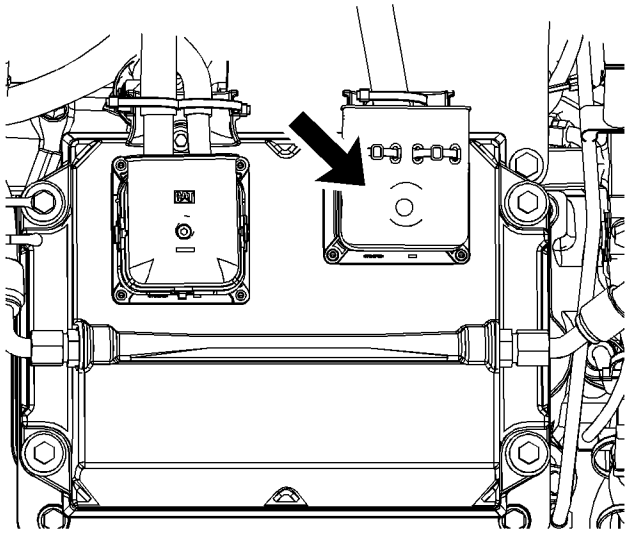


Illustration 47 g01214624

Location of the J1/P1 ECM connectors

B. Thoroughly inspect the J1/P1 ECM connectors. Inspect all of the connectors that are in the circuit. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

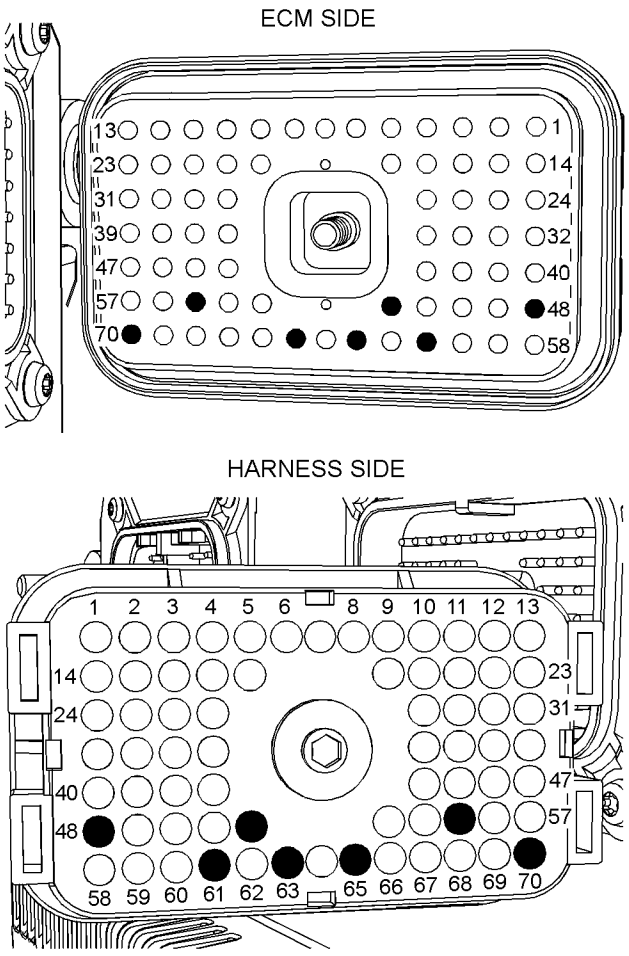


Illustration 48 g01214699

P1 connections for the electrical power supply circuit

(P1-48) +Battery
(P1-52) +Battery
(P1-55) +Battery
(P1-61) −Battery
(P1-63) −Battery
(P1-65) −Battery
(P1-70) Keyswitch

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.

D. Check the allen head screw for each of the ECM connectors for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely inserted and coupled. The harness and wiring are free of corrosion, of abrasion, and of pinch points. All connections and grounds are tight and free of corrosion.

Results:

- OK – The harness and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Battery Voltage at the ECM

A. Turn the keyswitch to the OFF position.

B. Disconnect the J1/P1 ECM connector.

C. Turn the keyswitch to the ON position.

D. Measure the voltage between P1-48 (unswitched +Battery) and P1-61 (−Battery).

E. Measure the voltage between P1-52 (unswitched +Battery) and P1-63 (−Battery).

F. Measure the voltage between P1-55 (unswitched +Battery) and P1-65 (−Battery).

G. Measure the voltage between P1-70 (keyswitch) and P1-63 (−Battery).

H. Turn the keyswitch to the OFF position.

Expected Result:

The measured voltage is between 22 VDC and 27 VDC.

Results:

- OK – The measured voltage is within the specifications that are given.

  Repair: The ECM is receiving the correct voltage. There may be an intermittent electrical problem in a harness or in a connector. If an intermittent condition is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Unswitched power out of range – The voltage is not correct for one of the unswitched battery circuits at the ECM.Proceed to Test Step 3.
- Keyswitch power out of range – The voltage is not correct for the keyswitch circuit at the ECM. Proceed to Test Step 4.

Test Step 3. Check the Batteries

A. Measure the no-load battery voltage at the battery posts.

B. Load test the batteries. Use the 4C-4911 Battery Load Tester. Refer to Special Instruction, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries” and Special Instruction, SEHS7633, “Battery Test Procedure”.

Expected Result:

The batteries pass the load test. The measured voltage is the minimum specification for a 24V system.

Results:

- OK – The batteries pass the load test.

  Repair: The batteries are OK. There is an open circuit or excessive resistance in the wiring or connections between the batteries and the ECM. Verify that the circuit breaker for the ECM is not tripped. Verify that the connection at the engine ground stud is clean and tight and that the battery disconnect switch is functioning properly. Repair the connectors or wiring and/or replace the connectors or wiring.

  Verify that the original problem has been resolved.

  STOP.

- Not OK – The battery voltage is low or the batteries did not pass the load test.

  Repair: Recharge or replace the faulty batteries. Verify that the repair eliminates the problem.

  If the low battery voltage is suspected of being caused by a faulty alternator, refer to Troubleshooting, “Alternator (Charging Problem)”.

  STOP.

Test Step 4. Check the Voltage from the Keyswitch to the ECM

A. Remove the wire from the terminal R of the keyswitch.

B. Turn the keyswitch to the ON position.

C. Measure the voltage on terminal B of the keyswitch to the engine ground stud.

D. Measure the voltage on terminal R of the keyswitch to the engine ground stud.

E. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch.

  Repair: If voltage is present on terminal R but not present at terminal P1-70 of the ECM connector, there is a problem in the wiring harness between the keyswitch and the ECM. There may be a problem in a connector. Repair the wiring and/or the connector. Replace parts, if necessary. Refer to Illustration 46 for wiring information. Verify that the problem is eliminated.

  STOP.

- Not OK – Voltage is not present on terminal B at the keyswitch.

  Repair: If voltage is not present on terminal B, there is a problem in the circuit between the battery and the keyswitch. There may be a problem with a connector. Repair the circuit. Replace parts, if necessary. Check the circuit protection for the circuit. Verify that the problem is eliminated.

  STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

  Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

i02431007

Engine Fan Control Solenoid Circuit - Test

SMCS Code: 5479-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the engine fan control solenoid for the engine cooling fan.

This procedure covers the following diagnostic codes:

- 291-05 Engine Cooling Fan Solenoid open circuit
- 291-06 Engine Cooling Fan Solenoid short to ground

The Electronic Control Module (ECM) controls the speed of the engine cooling fan in order to provide the following benefits:

- Increased productivity
- Reduced noise
- Improved fuel economy
- Reduced overcooling of the engine

The ECM monitors engine coolant temperature, intake manifold air temperature, and hydraulic oil temperature in order to determine the correct speed for the engine cooling fan.

The ECM controls the speed of the fan by controlling the current to the engine fan control solenoid. As the current to the control solenoid is changed, the angle of the fan pump's swashplate changes proportionally. This changes the output of hydraulic oil from the fan pump to the cooling fan.

If the ECM detects a system fault, the ECM provides minimum current to the solenoid. This ensures a maximum fan speed while the fault condition exists.

An override is available with the Caterpillar Electronic Technician (ET). This allows the fan to be manually changed from the minimum to the maximum possible rpm.

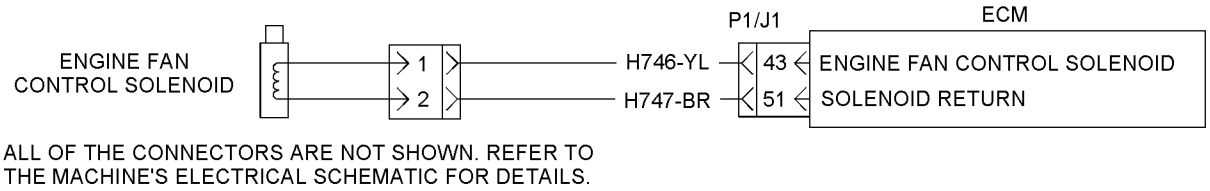


Illustration 49 g01194820

Schematic for the engine fan control solenoid

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the engine ECM.

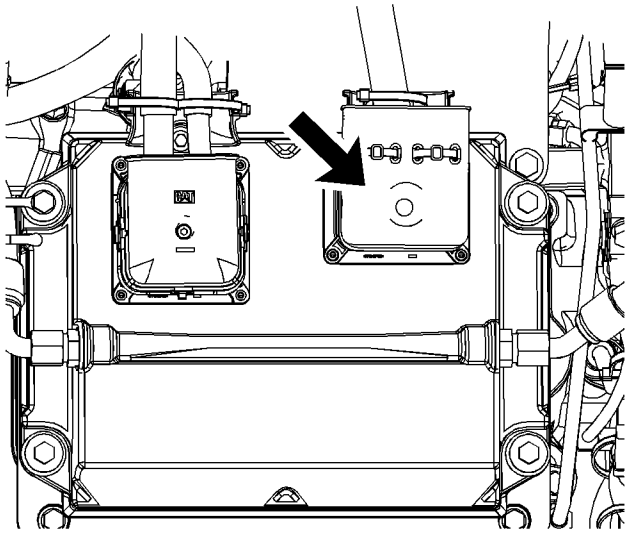


Illustration 50 g01214624

Location of the J1/P1 ECM connector (typical engine view)

B. Thoroughly inspect the J1/P1 ECM connectors. Inspect all of the other connectors that are in the circuit for the engine fan control solenoid. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

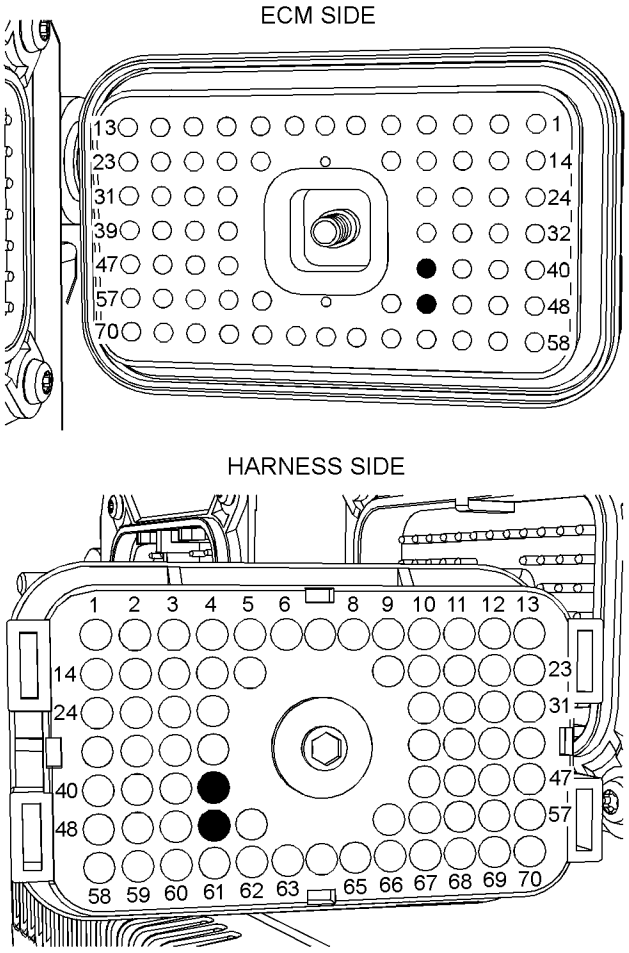


Illustration 51 g01214661

P1 ECM connector

(P1-43) Engine fan control solenoid
(P1-51) Solenoid return

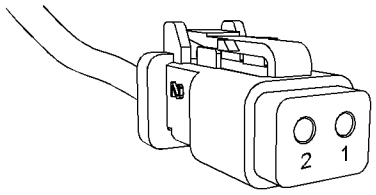


Illustration 52 g01155187

Connector for the fan control solenoid

(1) Signal
(2) Return

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.

D. Check the allen head screw on each of the ECM connectors for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Remove electrical power from the engine ECM.

B. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

C. Restore electrical power to the engine ECM.

D. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

E. Determine if the problem is related to an open circuit diagnostic code 05 or a short circuit diagnostic code 06.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: The problem may have been related to a faulty connection in the harness. Carefully inspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – An open circuit diagnostic code (05) is active at this time.Proceed to Test Step 4.
- Not OK – A short circuit diagnostic code (06) is active at this time.Proceed to Test Step 3.

Test Step 3. Disconnect the Connector for the Engine Fan Control Solenoid in Order to Create an Open Circuit

A. Remove electrical power from the engine ECM.

B. Disconnect the connector for the engine fan control solenoid.

C. Restore electrical power to the engine ECM.

D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active open circuit diagnostic code (05) for the engine fan control solenoid.

Note: Wait at least 30 seconds for activation of the diagnostic codes.

E. Remove electrical power from the engine ECM.

Expected Result:

An open circuit diagnostic code 05 is now active for the engine fan control solenoid.

Results:

- OK – A short circuit diagnostic code (06) was active before disconnecting the connector. An open circuit diagnostic code (05) became active after disconnecting the connector.

Repair: There is a problem with the fan control solenoid. Replace the fan control solenoid. Verify that there are no active diagnostic codes for the new engine fan control solenoid. Clear any logged diagnostic codes.

STOP.

- Not OK – There is a short circuit between the connector for the engine fan control solenoid and the ECM. There may be a problem with the ECM. Leave the connector disconnected.Proceed to Test Step 5.

Test Step 4. Create a Short at the Connector for the Engine Fan Control Solenoid

A. Remove electrical power from the engine ECM.

B. Fabricate a jumper wire that is long enough to short the terminals of the connector for the engine fan control solenoid. Crimp connector pins to each end of the jumper wire.

C. Disconnect the connector for the engine fan control solenoid.

D. Install the jumper wire between terminal 1 (engine fan control solenoid) and terminal 2 (solenoid return) on the harness side of the connector.

E. Restore electrical power to the engine ECM.

F. Monitor the “Active Diagnostic Codes” screen on Cat ET before installing the jumper wire and after installing the jumper wire.

Note: Wait at least 30 seconds for activation of the short circuit diagnostic code (06).

G. Remove the jumper wire.

H. Remove electrical power from the engine ECM.

Expected Result:

A short circuit diagnostic code 06 is active when the jumper wire is installed. An open circuit diagnostic code 05 is active when the jumper wire is removed.

Results:

- OK – A short circuit diagnostic code 06 is active when the jumper wire is installed. An open circuit diagnostic code 05 is active when the jumper wire is removed.

  Repair: There is a problem with the fan control solenoid. Replace the fan control solenoid. Verify that there are no active diagnostic codes for the new engine fan control solenoid. Clear any logged diagnostic codes.

  STOP.

- Not OK – The open circuit diagnostic code 05 remains active with the jumper in place.There is an open circuit in the harness between the ECM and the connector for the engine fan control solenoid. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Disconnect the J1/P1 ECM connector.

B. Fabricate two jumper wires that are long enough to provide a test circuit at the ECM connector. Crimp connector sockets to one end of each of the jumper wires.

C. Remove the wire from terminal location P1-43 (engine fan control solenoid) at the ECM connector. Install one of the jumper wires into this terminal location.

D. Remove the wire from terminal location P1-51 (fan return) at the ECM connector. Install the other jumper wire into this terminal location.

E. Connect the J1/P1 ECM connectors.

F. Create an open in the circuit for the demand fan at the ECM:

a. In order to ensure that an open circuit condition exists, ensure that the loose ends of the jumper wires are not in contact with the engine ground or each other.

b. Restore electrical power to the engine ECM.

c. Monitor the “Active Diagnostic Code” screen on Cat ET.

Note: Wait at least 30 seconds for activation of the open circuit diagnostic code (05).

The correct status is an active open circuit diagnostic code (05) for the engine fan control solenoid.

d. Remove electrical power from the engine ECM.

G. Create a short in the circuit for the demand fan at the ECM:

a. Short circuit the jumper wires at the ECM connector.

b. Restore electrical power to the engine ECM.

c. Monitor the “Active Diagnostic Code” screen on Cat ET.

Note: Wait at least 30 seconds for activation of the short circuit diagnostic code (06).

The correct status is an active short circuit diagnostic code (06) when the two jumper wires are short circuited.

d. Remove electrical power from the engine ECM.

H. Restore all wiring to the original configuration.

Expected Result:

An open circuit diagnostic code 05 is active when the jumper wires for the engine fan control solenoid are open. A short circuit diagnostic code 06 is active when the wires for the engine fan control solenoid are short circuited.

Results:

- OK – An open circuit diagnostic code 05 is active when the jumper wires for the engine fan control solenoid are open. A short circuit diagnostic code 06 is active when the jumper wires for the engine fan control solenoid are short circuited.

  Repair: The ECM is operating properly. The problem is in the harness wiring between the ECM and the connector for the engine fan control solenoid. There may be a problem in a connector. Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

- Not OK – One of the following conditions exists: The open circuit diagnostic code 05 is not active when the wires for the engine fan control solenoid are open. The short circuit diagnostic code 06 is not active when the jumper wires for the engine fan control solenoid are short circuited.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02932943

Engine Oil Renewal Solenoid Circuit - Test

SMCS Code: 1349-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the system for the engine oil renewal solenoid.

This procedure covers the following diagnostic codes:

- 2271-05 Engine Oil Renewal System Actuation Soleniod current below normal
- 2271-06 Engine Oil Renewal System Actuation Soleniod current above normal

The Electronic Control Module (ECM) adds a controlled amount of engine oil to the fuel by energizing the engine oil renewal solenoid. The engine oil is added to the fuel and burned during combustion. The need to drain the engine oil at a typical oil change interval is avoided.

The ECM energizes the engine oil renewal solenoid which injects the engine oil into the return line for the fuel.

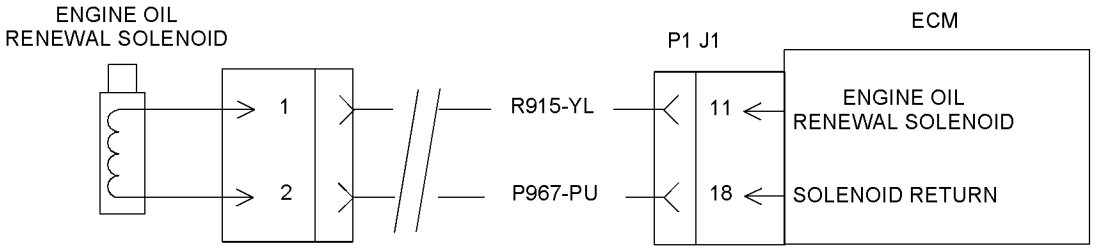


Illustration 53 g01264034

Typical schematic

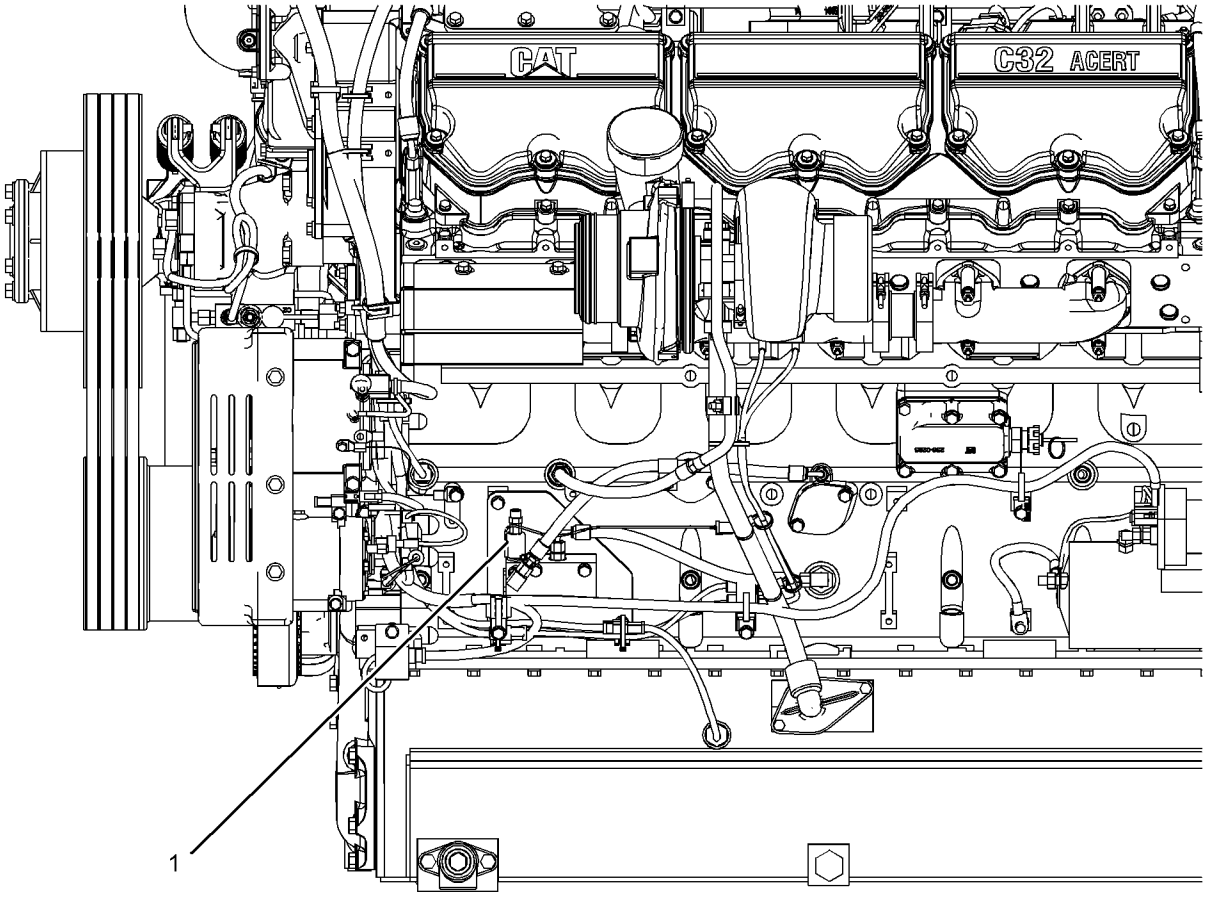


Illustration 54 g01270974

(1) Engine oil renewal solenoid

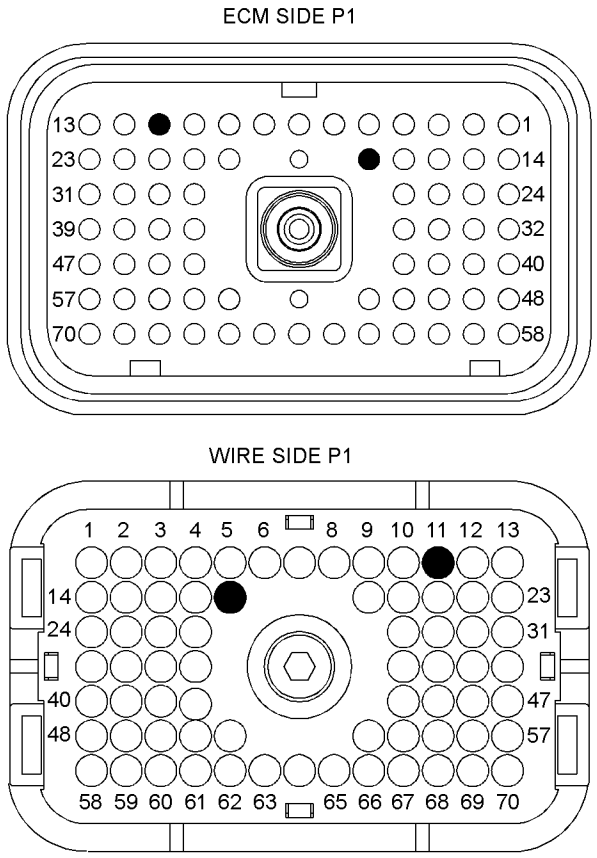


Illustration 55 g01264035

P1 ECM connector

(P1-18) Solenoid return
(P1-11) Engine oil renewal solenoid

Test Step 1. Inspect Electrical Connectors and Wiring

A. Remove the electrical power from the ECM.

B. Thoroughly inspect the ECM connector J1/P1. Inspect all of the other connectors for the circuit. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.

D. Check the ECM connector (allen head screw) for the proper torque. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.

E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring are OK.Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore the electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

D. Determine if the problem is related to an open circuit diagnostic code (05) or a short circuit diagnostic code (06).

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: The problem may have been related to a faulty connection in the harness. Carefully reinspect the connectors and wiring. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – A short circuit diagnostic code (06) is active at this time.Proceed to Test Step 3.
- Not OK – An open circuit diagnostic code (05) is active at this time.Proceed to Test Step 4.

Test Step 3. Disconnect the Connector for the Engine Oil Renewal Solenoid in Order to Create an Open Circuit

A. Remove the electrical power from the ECM.

B. Disconnect the connector for the engine oil renewal solenoid.

C. Restore the electrical power to the ECM. Wait at least 30 seconds for activation of the diagnostic codes.

D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active open circuit diagnostic code (05) for the engine oil renewal solenoid.

E. Remove the electrical power from the ECM.

Expected Result:

An open circuit diagnostic code (05) is now active for the engine oil renewal solenoid.

Results:

- OK – A short circuit diagnostic code (06) was active before disconnecting the connector. An open circuit diagnostic code (05) became active after disconnecting the connector.

  Repair: Temporarily connect a new engine oil renewal solenoid to the harness, but do not install the new engine oil renewal solenoid. Verify that there are no active diagnostic codes for the solenoid. If there are no active diagnostic codes for the solenoid, permanently install the new solenoid. Clear any logged diagnostic codes.

  STOP.

- Not OK – There is a short circuit between the solenoid harness connector and the ECM. Leave the solenoid connector disconnected.Proceed to Test Step 5.

Test Step 4. Create a Short at the Connector for the Engine Oil Renewal Solenoid

A. Remove the electrical power from the ECM.

B. Install a jumper wire with Deutsch sockets on each end between terminal 1 (engine oil renewal solenoid) and terminal 2 (solenoid return) on P506. Connect the jumper on the harness side of the connector.

C. Restore the electrical power to the ECM.

D. Wait at least 30 seconds for activation of the short circuit diagnostic code (06).

Note: Monitor the “Active Diagnostic Codes” screen on Cat ET before installing the jumper wire and after installing the jumper wire.

E. Remove the jumper wire.

F. Remove the electrical power from the ECM.

Expected Result:

A short circuit diagnostic code (06) is active when the jumper wire is installed. An open circuit diagnostic code (05) is active when the jumper wire is removed.

Results:

- OK – The engine harness and the ECM are OK.

  Repair: Temporarily connect a new engine oil renewal solenoid to the harness, but do not install the new engine oil renewal solenoid. Verify that there are no active diagnostic codes for the solenoid. If there are no active diagnostic codes for the solenoid, permanently install the new solenoid. Clear any logged diagnostic codes.

  STOP.

- Not OK – The open circuit diagnostic code (05) remains active with the jumper in place. The open circuit is between the ECM and the connector for the engine oil renewal solenoid.Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Disconnect the J1/P1 ECM connector.

B. Remove the wire for the engine oil renewal solenoid from P1-43. Install a jumper wire with Deutsch sockets on each end into P1-43.

C. Remove the wire for the engine oil renewal solenoid from P1-51. Install a jumper wire with Deutsch sockets on each end into P1-51.

a. Reconnect the ECM connector.

b. Restore the electrical power to the ECM. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

An open circuit diagnostic code (05) should be active for the engine oil renewal solenoid.

D. Check the operation of the ECM by creating a short at the ECM.

a. Install a wire jumper between the jumper wire for the engine oil renewal solenoid and the jumper wire for the solenoid return.

b. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

A short circuit diagnostic code (06) should be active when the wire jumper is installed.

c. Remove the wire jumpers. Reconnect all wires and connectors.

Expected Result:

An open circuit diagnostic code (05) is active when the wire from the engine oil renewal solenoid is removed from the ECM connector. A short circuit diagnostic code (06) is active when the wire for the engine oil renewal solenoid is connected to the solenoid return.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the connector for the engine oil renewal solenoid.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

- Not OK – One of the following conditions exists: The open circuit diagnostic code (05) is not active when the wire for the engine oil renewal solenoid is disconnected. The short circuit diagnostic code (06) is not active when the wire jumper is installed.

  Repair: Replace the ECM. Refer to electronic troubleshooting Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02934989

Engine Pressure Sensor Open or Short Circuit - Test

SMCS Code: 1439-038-PX

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Atmospheric pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor
- Intake manifold pressure sensor

This procedure covers the following open circuit diagnostic codes and short circuit diagnostic codes:

- 94-03 Fuel Pressure open/short to +batt
- 94-04 Fuel Pressure short to ground
- 100-03 Engine Oil Pressure open/short to +batt
- 100-04 Engine Oil Pressure short to ground
- 274-03 Atmospheric Pressure open/short to +batt
- 274-04 Atmospheric Pressure short to ground
- 1589-03 Turbocharger Inlet Air Pressure Sensor : Voltage Above Normal
- 1589-04 Turbocharger Inlet Air Pressure Sensor : Voltage Below Normal
- 1785-03 Intake Manifold Pressure Sensor voltage high
- 1785-04 Intake Manifold Pressure Sensor voltage low
- 1785-10 Intake Manifold Pressure Sensor : Abnormal Rate of Change
- 1795-03 Turbo #2 Outlet Pressure Sensor : Voltage Above Normal
- 1795-04 Turbo #2 Outlet Pressure Sensor : Voltage Below Normal
- 1795-10 Turbo #2 Outlet Pressure Sensor : Abnormal Rate of Change

The 5 volt sensor supply provides power to all 5 volt sensors. The Electronic Control Module (ECM) supplies 5.0 ± 0.2 VDC to terminal A of each sensor connector. The sensor return from the ECM connector goes to terminal B of each sensor connector. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage in order to detect a problem in the signal circuit. When the ECM detects the presence of a voltage that is above a threshold on the signal circuit, the ECM will generate a 03 diagnostic code for the sensor.

If the sensor is disconnected at the sensor connector, the presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are OK. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates a problem in the signal wire. If the sensor is disconnected at the sensor connector and the voltage at the sensor connector is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

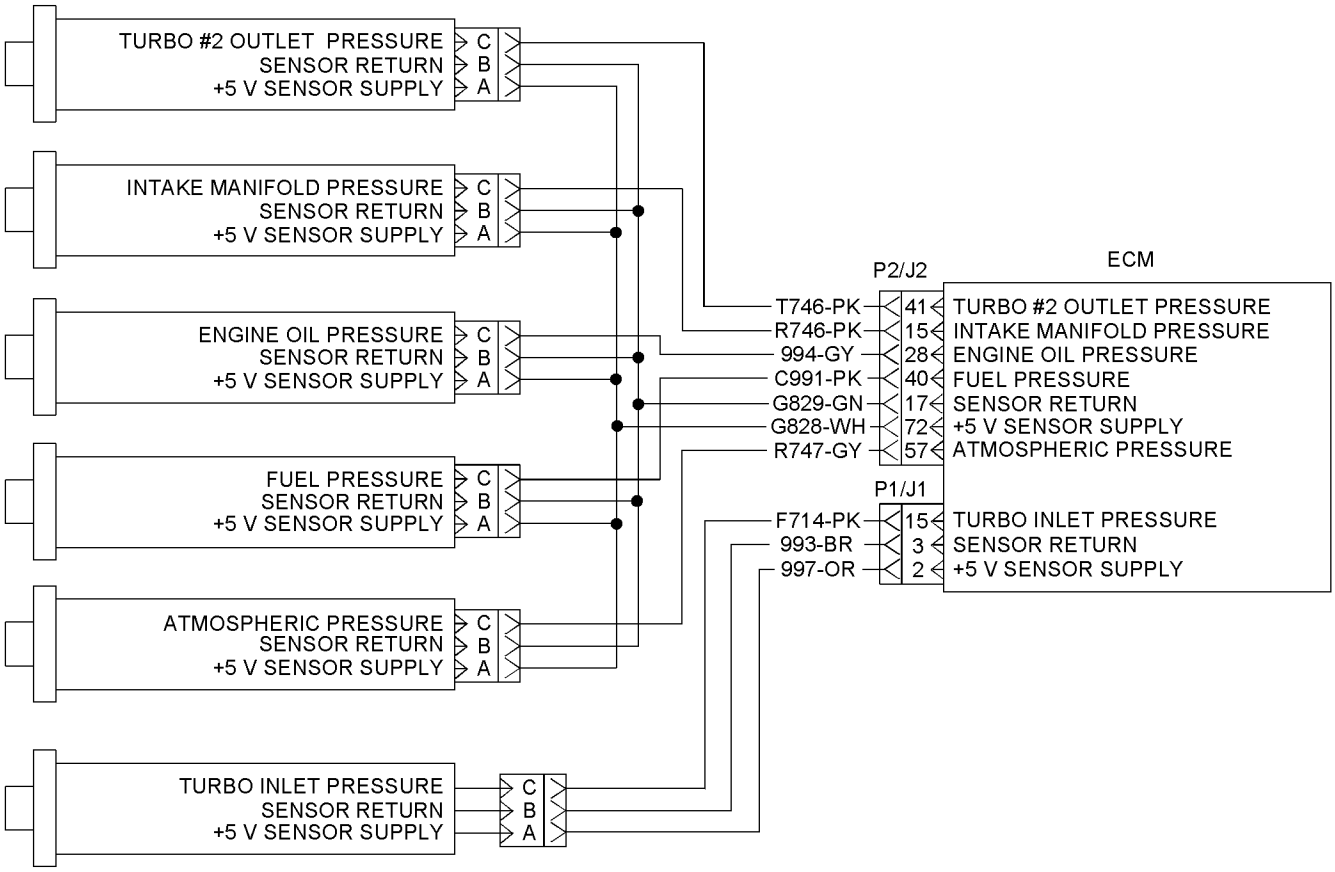


Illustration 56 g01455647

Schematic for the engine pressure sensors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

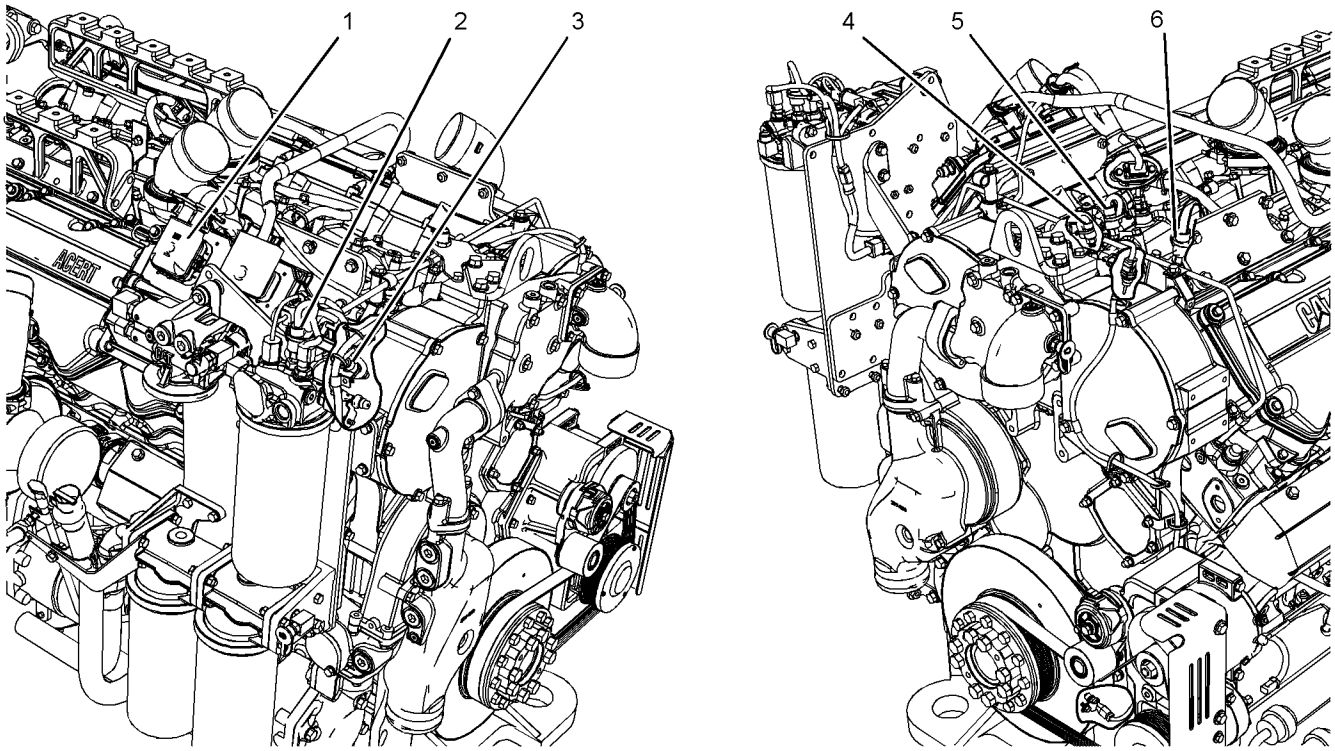


Illustration 57 g01455624

Sensor locations (typical engine views)

(1) J2/P2 ECM conntector
(2) Fuel pressure sensor
(3) Engine oil pressure sensor
(4) Atmospheric pressure sensor
(5) Intake manifold pressure sensor
(6) Turbocharger #2 outlet pressure sensor

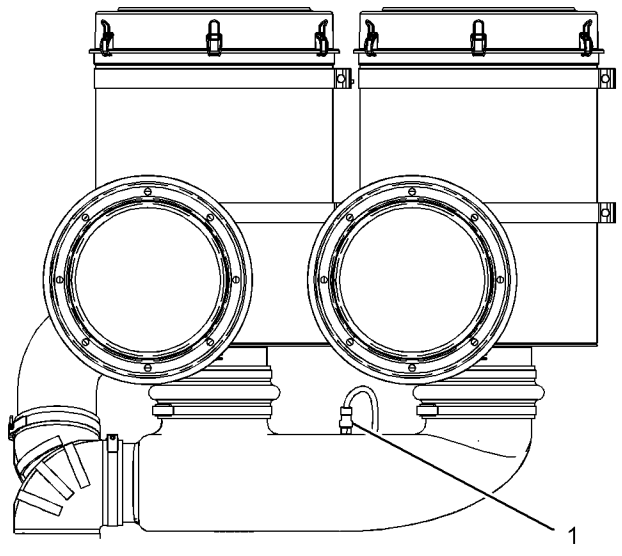


Illustration 58 g01455634

Typical location

(7) Turbocharger inlet air pressure sensor

B. Thoroughly inspect ECM connectors (1). Also, thoroughly inspect the connectors for each pressure sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

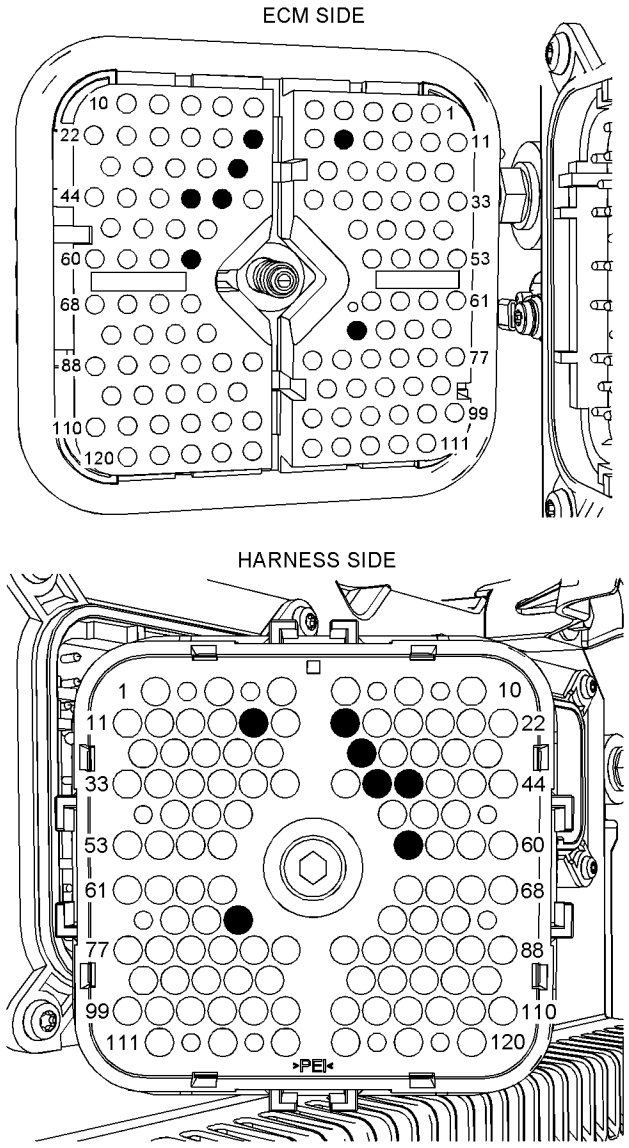


Illustration 59 g01455656

P2 terminal locations

(P2-15) Intake manifold pressure
(P2-17) Sensor return
(P2-28) Engine oil pressure
(P2-40) Fuel pressure
(P2-41) Turbocharger outlet pressure (No. 2)
(P2-57) Atmospheric pressure
(P2-72) +5 V sensor supply

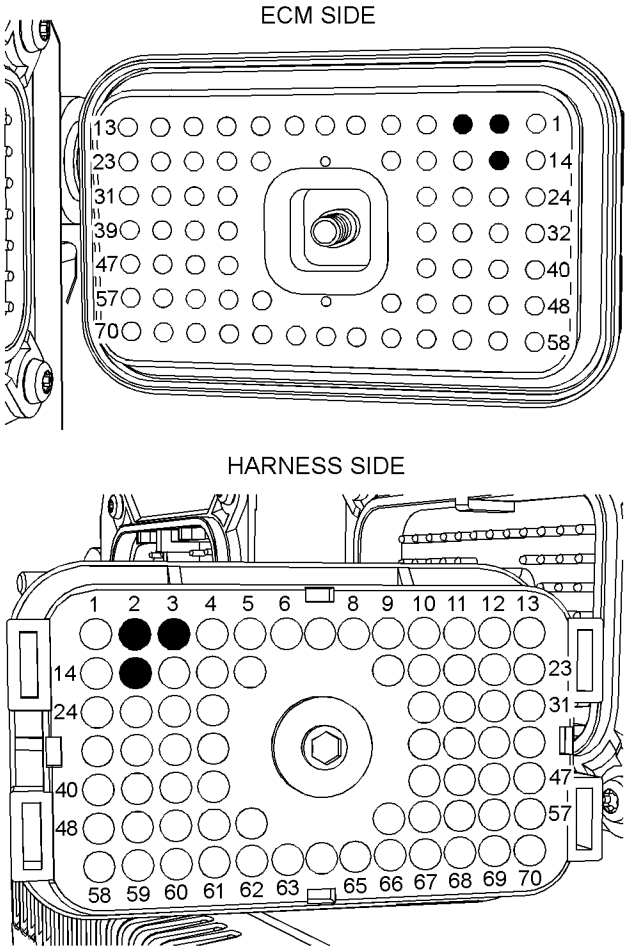


Illustration 60 g01455657

P1 terminal locations

(P1-2) +5 sensor supply
(P1-3) Sensor return
(P1-15) Turbocharger inlet pressure

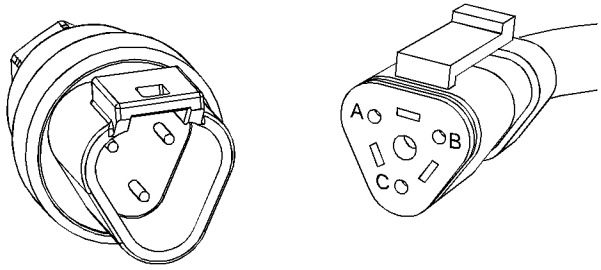


Illustration 61 g01215393

Sensor connector

(Terminal A) +5 V sensor supply
(Terminal B) Sensor return
(Terminal C) Sensor signal

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connectors and on each of the wires in the pressure sensor connectors.

D. Check the allen head screw for each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasion and for pinch points from the pressure sensors back to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring appear to be OK. There may be a problem with the harness or a connector. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Supply Voltage at the Sensor Connector

A. Remove electrical power from the ECM.

B. Disconnect the harness connectors for the following sensors:

- Atmospheric pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor
- Intake manifold pressure sensor

C. Restore electrical power to the ECM.

Note: The original diagnostic code may not stay active. An open circuit diagnostic code for the sensor supply may become active when all of the sensors are disconnected. Ignore the active codes at this time and continue with this test step.

Note: Be sure to wiggle the harness during the following measurements in order to reveal an intermittent condition.

D. Measure the voltage between terminals A and B at each sensor connector on the engine harness.

E. Remove electrical power from the ECM.

F. Connect all of the sensors.

Expected Result:

Each voltage measurement is 5.0 ± 0.2 VDC.

Results:

- OK – Each voltage measurement is 5.0 ± 0.2 VDC.The supply voltage is correct at the sensor connectors. Proceed to Test Step 3.
- Not OK – At least one voltage measurement is not 5.0 ± 0.2 VDC.

  Repair: There is a problem with the circuit for the +5 V sensor supply. Refer to Troubleshooting, “5 Volt Engine Pressure Sensor Supply Circuit - Test” for information that is related to troubleshooting the circuit.

  STOP.

Test Step 3. Check for Active Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Look for an active diagnostic code that is related to one of the engine pressure sensors.

Note: Wait at least 30 seconds so that any codes may become active.

D. Determine if the problem is related to an open circuit diagnostic code (03) or a short circuit diagnostic code (04).

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active for the engine pressure sensors.

  Repair: The original problem seems to be resolved. The problem may have been related to a faulty connection in the harness. Carefully

reinspect the connectors and the wiring. If an intermittent electrical problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – A 03 diagnostic code is active at this time.The ECM is detecting an open circuit condition in the sensor wiring. Proceed to Test Step 5.
- Not OK – A 04 diagnostic code is active at this time.The ECM is detecting a short circuit condition in the sensor wiring. Proceed to Test Step 4.

Test Step 4. Disconnect the Suspect Sensor in Order to Create an Open Circuit

A. Remove electrical power from the ECM.

B. Disconnect the sensor connector of the sensor with the short circuit diagnostic code (04).

C. Restore electrical power to the ECM.

D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active open circuit diagnostic code (03) while the sensor is disconnected.

Note: Wait at least 30 seconds for activation of the diagnostic codes.

E. Remove electrical power from the ECM.

Expected Result:

A 03 diagnostic code became active after the suspect sensor was disconnected.

Results:

- OK – A 04 diagnostic code was active before the suspect sensor was disconnected. A 03 diagnostic code became active after the suspect sensor was disconnected.

  Repair: There may be a problem with a sensor. Connect a new sensor to the harness. Verify that there are no active diagnostic codes for the new sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

  STOP.

- Not OK – When the suspect sensor is disconnected, a 04 diagnostic code remains active.There is a problem in the circuit between the harness connector for the sensor and the ECM. There may be a problem with the ECM. Leave the sensor disconnected. Proceed to Test Step 6.

Test Step 5. Create a Short at the Suspect Sensor Connector

A. Remove electrical power from the ECM.

B. Fabricate a jumper wire that is long enough to short the terminals at the sensor connector. Crimp a connector pin to each end of the jumper wire.

C. Install the jumper wire between terminal B (sensor return) and terminal C (sensor signal) on the harness side of the suspect sensor's connector.

D. Restore electrical power to the ECM.

E. Monitor the “Active Diagnostic Codes” screen on Cat ET. Check for an active short circuit diagnostic code (04) while the jumper wire is installed.

Note: Wait at least 30 seconds for activation of the diagnostic code.

F. Remove electrical power from the ECM.

G. Remove the jumper wire.

Expected Result:

A 04 diagnostic code was active when the jumper wire was installed.

Results:

- OK – A 04 diagnostic code was active when the jumper wire was installed.

  Repair: There is a problem with the sensor. Connect a new sensor to the harness. Verify that there are no active diagnostic codes for the new sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

  STOP.

- Not OK – The 03 diagnostic code remains active with the jumper in place.There is a problem in the harness between the ECM and the sensor connector. There may be a problem with the ECM. Proceed to Test Step 6.

Test Step 6. Test the Operation of the ECM

A. Remove electrical power from the ECM.

B. Fabricate a jumper wire that is long enough to create a test circuit from the ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.

C. Disconnect the J2/P2 ECM connector.

D. Remove the suspect sensor's signal wire from the ECM connector. Install the jumper wire into this terminal location at the ECM connector.

E. Connect the ECM connectors.

F. Check the operation of the ECM by creating an open for the circuit:

a. Hold the loose end of the jumper wire away from any ground source in order to create an open circuit condition.

b. Restore electrical power to the ECM.

c. Monitor the “Active Diagnostic Code” screen on Cat ET. Check the suspect sensor for an active 03 diagnostic code.

Note: Wait at least 30 seconds in order for the code to become active.

d. Remove electrical power from the ECM.

G. Check the operation of the ECM by creating a short for the circuit:

a. Connect the jumper wire to the engine ground stud.

b. Restore electrical power to the ECM.

c. Monitor the “Active Diagnostic Code” screen on Cat ET. Check the suspect sensor for an active 04 diagnostic code while the jumper wire is installed.

Note: Wait at least 30 seconds in order for the code to become active.

d. Remove electrical power from the ECM.

H. Remove the jumper wire. Return the wiring to the original configuration.

Expected Result:

A 03 diagnostic code is active when the loose end of the jumper wire is open. A 04 diagnostic code is active when the loose end of the jumper wire is connected to the engine ground stud.

Results:

- OK – A 03 diagnostic code is active when the loose end of the jumper wire is open. A 04 diagnostic code is active when the loose end of the jumper wire is connected to the engine ground stud.

  Repair: The ECM is operating properly. The problem is in the wiring harness between the ECM and the sensor connector. If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the wiring harness. Replace parts, if necessary.

  STOP.

- Not OK – One of the following conditions exists: The 03 diagnostic code is not active when the loose end of the jumper wire is open. The 04 diagnostic code is not active when the loose end of the jumper wire is grounded.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02940224

Engine Shutdown Switch Circuit - Test

SMCS Code: 7332-038

System Operation Description:

This procedure covers the following diagnostic codes:

- 267-03 Remote Shutdown Input open/short to +batt
- 267-04 Remote Shutdown Input short to ground

The engine shutdown switch allows the operator to shut down the engine from outside of the cab at ground level. When the switch is toggled to the STOP position, the engine shuts down. The Electronic Control Module (ECM) remains powered. The engine shutdown switch must be returned to the RUN position and the electrical power to the ECM must be cycled before the engine will be allowed to restart.

The status of the engine shutdown switch can be observed using Caterpillar Electronic Technician (ET).

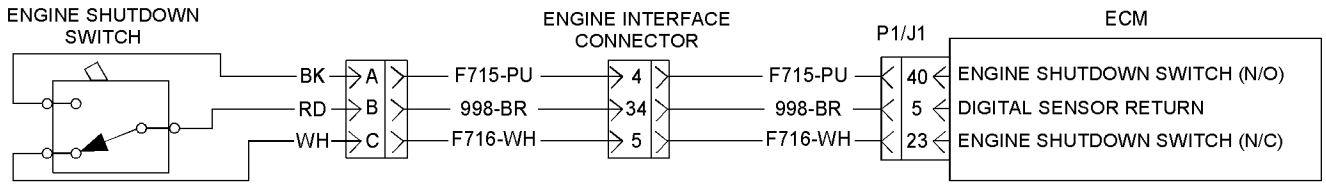


Illustration 62 g01213913

Schematic for engine shutdown switch

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the engine ECM.

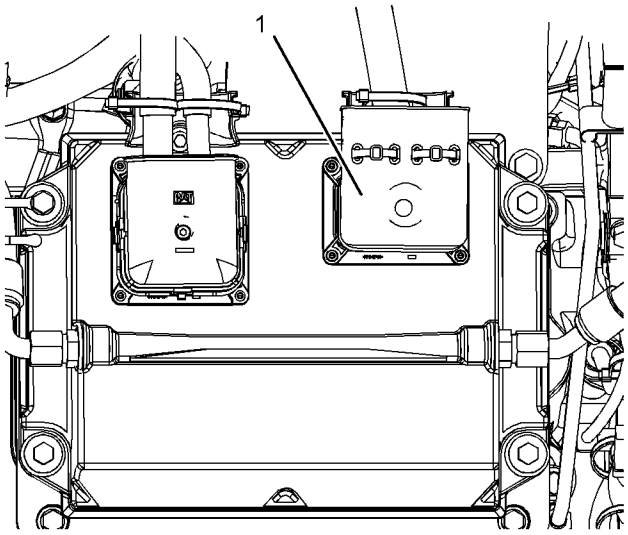


Illustration 63 g01167488

Location of the P1 ECM connector (typical engine view)

(1) J1/P1 ECM connectors

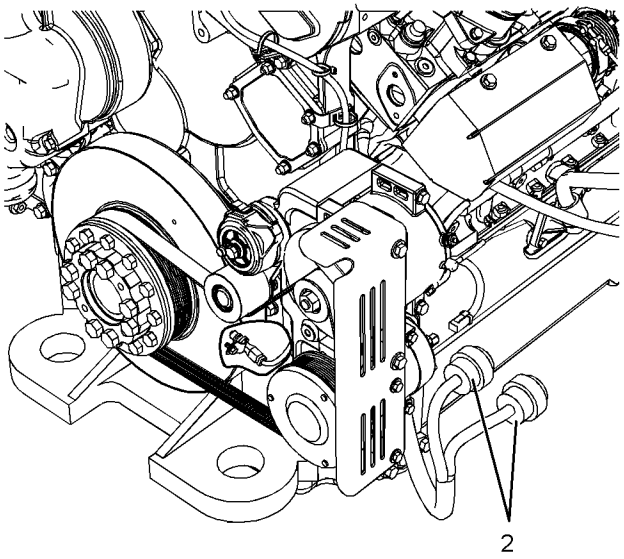


Illustration 64 g01213916

Location of the engine interface connectors (typical left side engine view)

(2) Engine interface connectors

B. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect the connectors for the engine shutdown switch. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

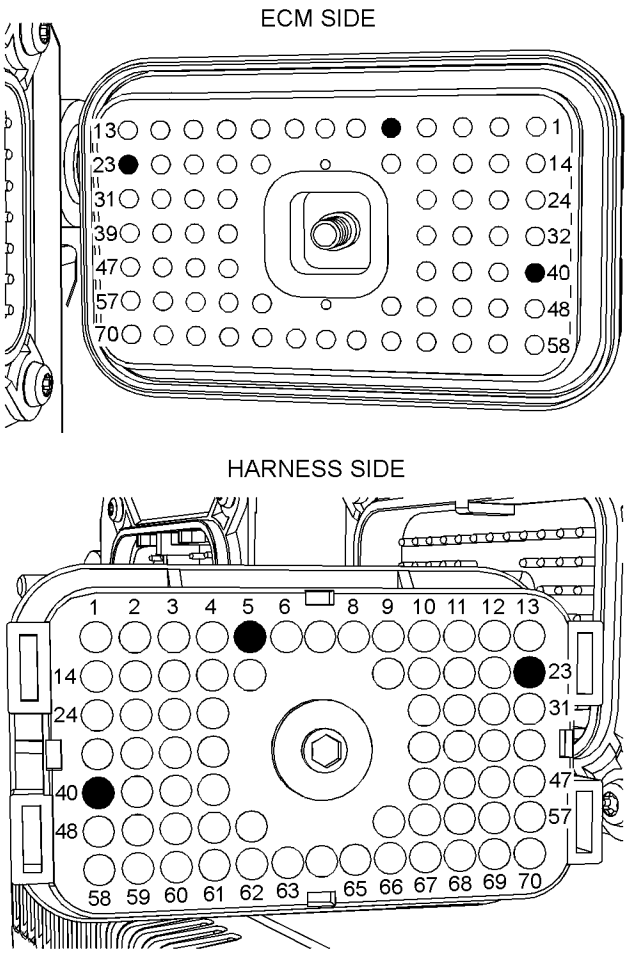


Illustration 65 g01213917

Terminal locations at the P1 ECM connector

(P1-5) Digital sensor return
(P1-23) Engine shutdown switch (N/C)
(P1-40) Engine shutdown switch (N/O)

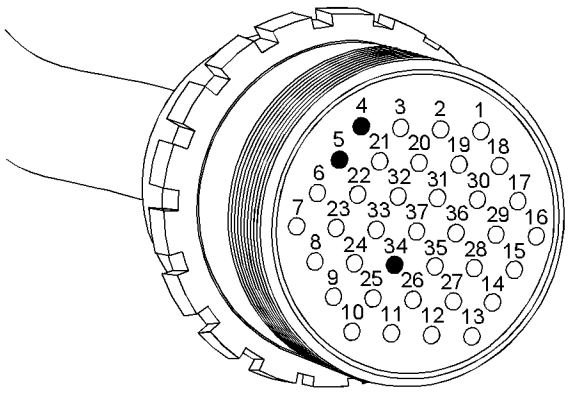


Illustration 66 g01213918

Terminal locations at the engine interface connectors

(Terminal 4) Engine shutdown switch (N/O)
(Terminal 5) Engine shutdown switch (N/C)
(Terminal 34) Digital return

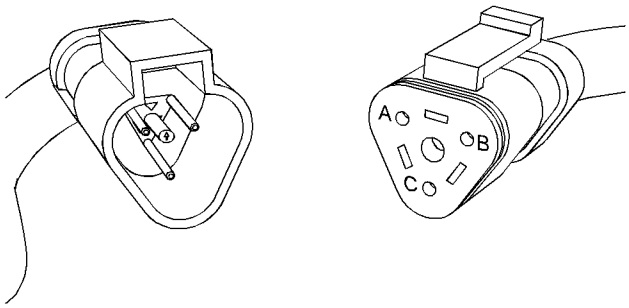


Illustration 67 g01159881

Harness connector for the engine shutdown switch

(Terminal A) Engine shutdown switch (N/O)
(Terminal B) Digital return
(Terminal C) Engine shutdown switch (N/C)

C. Perform a 45 N (10 lb) pull test on each of the wires for the engine shutdown switch.

D. Check the torque of the allen head screw on the ECM connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points from the switch back to the ECM.

Expected Result:

All of the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and the connectors appear to be OK.Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or wiring.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Status of the Shutdown Switch on Cat ET

A. Connect Cat ET to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Monitor the status screen on Cat ET while you operate the shutdown switch. Observe the status for the shutdown switch.

Note: Wait at least 30 seconds for the status of the switch to change.

Expected Result:

The status of the shutdown switch reads “ON” with the shutdown switch in the STOP position. The status of the shutdown switch reads “OFF” when the shutdown switch is in the RUN position.

Results:

- OK – The status of the shutdown switch reads “ON” with the shutdown switch in the STOP position. The status of the shutdown switch reads “OFF” when the shutdown switch is in the RUN position. The shutdown switch is operating normally.

  Repair: The circuit for the shutdown switch appears to be operating correctly. There may be an intermittent problem in the harness or in a connector. If an intermittent problem is suspected, refer to Troubleshooting, “Inspecting Electrical Connectors”.

  STOP. OK

- Not OK – The status of the switch does not read “ON” with the shutdown switch in the STOP position. The status of the shutdown switch does not read “OFF” when the shutdown switch is in the RUN position.There is a problem with the circuit for the shutdown switch. There may be a problem with the ECM. Proceed to Test Step 3.

Test Step 3. Short the Terminals at the Harness Connector for the Shutdown Switch

A. Turn the keyswitch to the OFF position.

B. Fabricate a jumper wire that is long enough to short circuit two terminals at the harness connector for the shutdown switch. Crimp connector pins to each end of the jumper wire.

C. Disconnect the harness connector for the shutdown switch.

D. Check the status of the shutdown switch while the circuit is shorted to the RUN position.

a. Install the jumper wire between terminals B (digital return) and C (engine shutdown switch (N/C)) at the harness connector for the switch.

b. Turn the keyswitch to the ON position.

c. Observe the status of the shutdown switch on Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is “OFF” .

d. Turn the keyswitch to the OFF position.

E. Check the status of the shutdown switch while the circuit is shorted to the STOP position.

a. Install the jumper wire between terminals A (engine shutdown switch (N/O)) and B (digital return) at the harness connector for the switch.

b. Turn the keyswitch to the ON position.

c. Observe the status of the shutdown switch on Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is “ON” .

F. Turn the keyswitch to the OFF position.

G. Remove the jumper wire from the harness connector.

Expected Result:

The switch status on Cat ET agrees with the test results that are stated above.

Results:

- OK – The switch status on Cat ET agrees with the test results.

  Repair: There is a problem with the shutdown switch. Replace the shutdown switch. Verify that the new shutdown switch solves the problem.

  STOP. Repair Complete

- Not OK – The switch status on Cat ET does not agree with the test results that are stated above. The problem is in the harness between the ECM and the harness connector for the switch. There may be a problem with the switch. Proceed to Test Step 4.

Test Step 4. Short the Terminals for the Shutdown Switch at the ECM

A. Disconnect the J1/P1 ECM connectors.

B. Fabricate three jumper wires that are long enough to short circuit terminals at the P1 ECM connector. Crimp connector sockets to one end of each of the jumper wires.

C. Remove the wires from terminal locations P1-5, P1-23, and P1-40 at the ECM connector. Install a jumper wire into each of these terminal locations.

D. Check the status of the shutdown switch while the circuit is shorted to the RUN position.

a. Short circuit the ends of the jumper wires that are in terminal locations P1-5 (digital return) and P1-40 (engine shutdown switch (N/C)) at the ECM connector.

Note: Ensure that the jumper wire that is in terminal location P1-23 is not in contact with any ground source. The circuit for this terminal must be open.

b. Turn the keyswitch to the ON position.

c. Observe the status of the shutdown switch on Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is “OFF” .

d. Turn the keyswitch to the OFF position.

E. Check the status of the shutdown switch while the circuit is shorted to the STOP position.

a. Short circuit the ends of the jumper wires that are in terminal locations P1-5 (digital return) and P1-23 (engine shutdown switch (N/O)) at the ECM connector.

Note: Ensure that the jumper wire that is in terminal location P1-40 is not in contact with any ground source. The circuit for this terminal must be open.

b. Turn the keyswitch to the ON position.

c. Observe the status of the shutdown switch on Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is “ON” .

F. Turn the keyswitch to the OFF position.

G. Restore the wiring to the original configuration.

Expected Result:

The switch status on Cat ET agrees with the test results that are stated above.

Results:

- OK – The switch status on Cat ET agrees with the test results.

  Repair: There is a problem in the harness between the ECM and the harness connector for the shutdown switch. There may be a problem with a connector. Repair the harness and/or the connector. Replace parts, if necessary. Verify that the repair resolves the original problem.

  STOP. Repair Complete

- Not OK – The switch status on Cat ET does not agree with the test results that are stated above.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02540812

Engine Speed/Timing Sensor Circuit - Test

SMCS Code: 1439-038-VF; 1912-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Primary engine speed/timing sensor
- Secondary engine speed/timing sensor

This procedure covers the following diagnostic codes:

- 190-08 Engine Speed Signal abnormal
- 342-08 Secondary Engine Speed signal abnormal

The engine uses two engine speed/timing sensors. The primary engine speed/timing sensor detects the reference for engine speed and timing from a timing ring with a notched pattern that has been machined onto a portion of the crankshaft gear. The signal from the primary engine speed/timing sensor is also used by the ECM as a control reference during a timing calibration.

The secondary engine speed/timing sensor detects the reference for engine speed and timing from a timing ring with a notched pattern that has been machined onto a portion of the camshaft gear.

The Electronic Control Module (ECM) counts the time between pulses that is created by the sensor as each gear rotates in order to determine rpm. Timing is provided by the unique pattern of notches in the timing ring.

Under normal operation, the secondary engine speed/timing sensor is used to determine timing for starting purposes. The secondary engine speed/timing sensor is used to determine when the piston in the No. 1 cylinder is at the top of the compression stroke. When the timing has been established, the primary engine speed/timing sensor is then used to determine engine speed.

When the timing has been established, the ECM triggers each injector in the correct firing order at the correct time. The actual timing and duration of each injection is based on engine rpm and on load.

If the engine is running and the signal from one sensor is lost, no change in engine performance will be noticed. If the engine is running and the signals from both sensors are lost, fuel injection will be terminated and the engine will be shut down by the ECM.

The engine will start when only one sensor signal is present. The engine will not start if the signals from both sensors are lost.

Both sensors are magnetic sensors. The two sensors are not interchangeable. If a sensor is replaced, a timing calibration is not necessary.

If a replacement of the ECM is required, the ECM parameters and the timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will not be necessary. This feature requires the Caterpillar Electronic Technician (ET) and this feature is only possible if the existing ECM can communicate with Cat ET. Use the “Copy Configuration - ECM Replacement” feature on Cat ET.

A timing calibration is necessary after the ECM software has been updated. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate” for information that is related to timing calibration.

Complete all of the following tasks when you install a speed/timing sensor:

- Ensure that an O-ring is installed on the sensor. If the O-ring is damaged or missing, replace the O-ring.
- Lubricate the O-ring with oil.
- Ensure that the sensor is fully seated into the engine before tightening the bracket bolt.
- Ensure that the electrical connector is latched.
- Ensure that the harness is properly secured, and ensure that each tie-wrap is placed in the correct location.

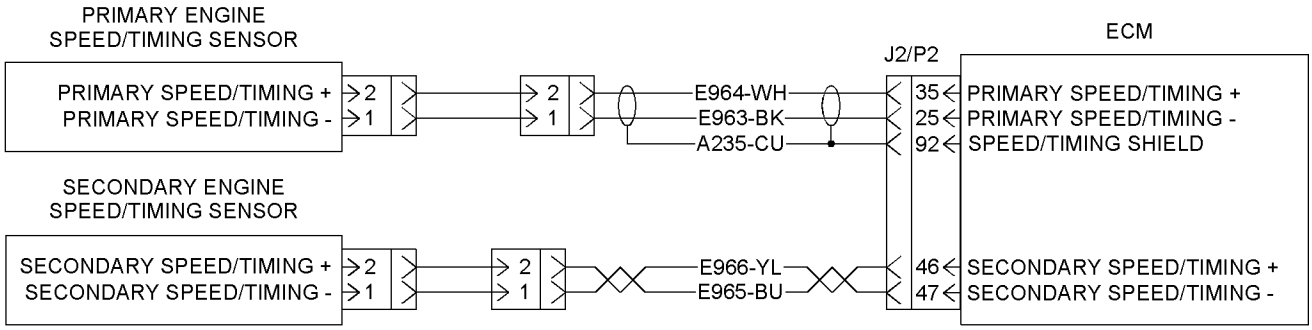


Illustration 68 g01212495

Schematic for the engine speed/timing sensors

Test Step 1. Check for Diagnostic Codes

A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Restore electrical power to the ECM.

C. Start the engine and run the engine until the engine is at the normal operating temperature.

Note: If the engine will not start, monitor the engine rpm on Cat ET while the engine is being cranked. Cat ET may need to be powered from another battery while the engine is being cranked.

D. Look for these codes on Cat ET:

- 190-08
- 342-08

Expected Result:

One or both of the diagnostic codes that are listed above are logged or active.

Note: If the engine will not start and Cat ET displayed 0 rpm during cranking, select “No Engine rpm” .

Results:

- No Engine rpm – Engine rpm is not indicated on Cat ET.Proceed to Test Step 2.
- 190-08 or 342-08 code – There is an active diagnostic code or a logged diagnostic code for an engine speed/timing sensor.Proceed to Test Step 4.
- No codes – Neither code is active or logged.

Repair: Refer to the appropriate symptoms in Troubleshooting, “Troubleshooting Without a Diagnostic Code”.

STOP. STOP

Test Step 2. Check the Installation of the Sensor Assembly

A. Remove electrical power from the ECM.

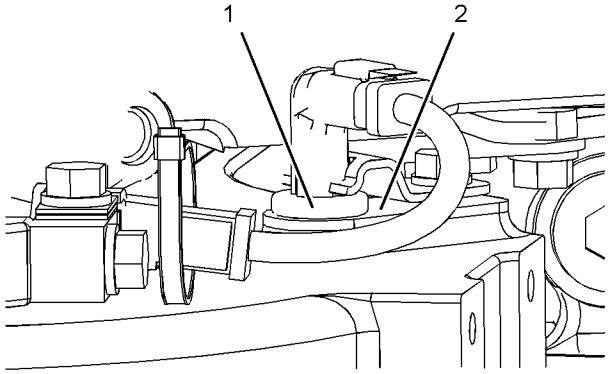


Illustration 69 g01167684

Typical engine speed/timing sensor

(1) Mounting flange
(2) Mounting surface

B. Visually inspect each sensor assembly without removing the sensor assembly from the engine. Ensure that flange (1) is installed squarely against surface (2).

C. Remove the suspect sensor assembly from the engine.

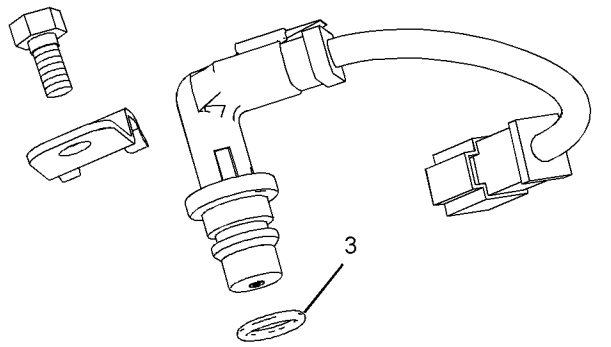


Illustration 70 g01167704

Typical engine speed/timing sensor

(3) O-ring

D. Ensure that one O-ring (3) is installed on the sensor. Check the O-ring for damage. Replace the O-ring, if necessary.

Results:

- OK – The sensor's components are OK.

  Repair: Perform the following procedure in order to properly install the sensor assembly:

  A. Lubricate the O-ring with engine oil.

  B. Fully seat the sensor assembly in the engine.

  Note: If the sensor assembly will not fully seat into the engine, replace the sensor assembly.

  C. Tighten the bracket bolt.

  D. Connect the sensor's electrical connectors. Verify that the connectors are latched on both sides.

  E. Ensure that the harness is properly secured, and that the tie-wraps are placed in the correct location.

  Proceed to Test Step 3.

- Not OK – At least one of the sensor assembly's components is not OK.

  Repair: Obtain a new sensor assembly. Perform the following procedure in order to properly install the sensor assembly:

  A. Lubricate each O-ring with engine oil.

  B. Fully seat the sensor assembly in the engine.

  Note: If the sensor assembly will not fully seat into the engine, replace the sensor assembly.

  C. Tighten the bracket bolt.

  D. Connect the sensor's electrical connectors. Verify that the connector is latched.

  E. Ensure that the harness is properly secured, and that the tie-wraps are placed in the correct location.

  Verify that the problem is resolved.

  STOP. STOP

Test Step 3. Inspect the Electrical Connectors and the Wiring

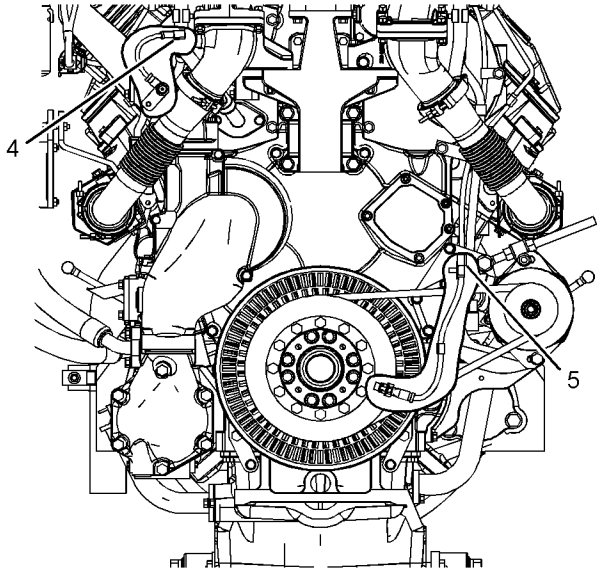


Illustration 71 g01167708

Location of the engine speed/timing sensors (typical front engine view)

(4) Harness connectors for the secondary engine speed/timing sensor
(5) Harness connectors for the primary engine speed/timing sensor

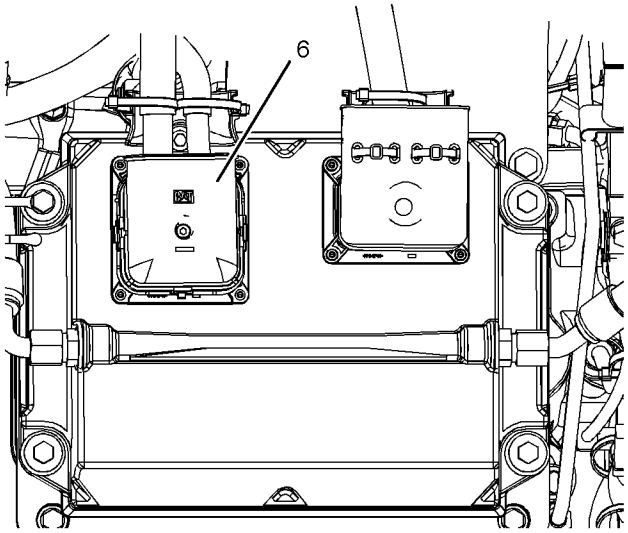


Illustration 72 g01167873

(6) J2/P2 ECM connector

A. Thoroughly inspect connectors (4), (5), and (6). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

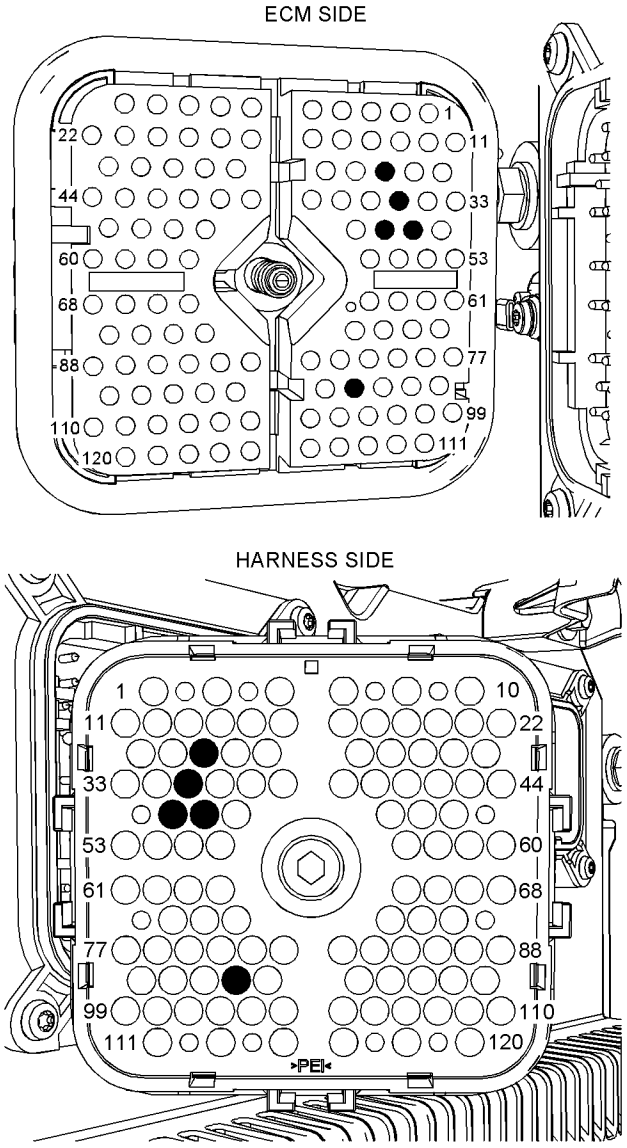


Illustration 73 g01212538

P2 terminals that are associated with the engine speed/timing sensors

(P2-25) Primary engine speed/timing −
(P2-35) Primary engine speed/timing +
(P2-46) Secondary engine speed/timing +
(P2-47) Secondary engine speed/timing −
(P2-92) Speed/timing shield

B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the engine speed/timing sensors.

C. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

D. Check the harness and the wiring for abrasion and for pinch points from each sensor back to the ECM.

Expected Result:

All of the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and connectors appear to be OK.Proceed to Test Step 4.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP. STOP

Test Step 4. Measure the Sensor Resistance through the Engine Harness

A. Disconnect the J2/P2 ECM connectors.

B. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between P2-25 (primary engine speed/timing +) and P2-35 (primary engine speed/timing -).

b. Check for an intermittent open circuit or for a short circuit by moving the harness while you take the resistance measurement. Pull the wires that are directly behind the sensor or shake the wires that are directly behind the sensor.

Resistance at 25 °C (77 °F) . . . 75 to 230 Ohms

C. If you are troubleshooting a problem with the secondary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between P2-47 (secondary engine speed/timing +) and P2-46 (secondary engine speed/timing -).

b. Check for an intermittent open circuit or for a short circuit by moving the harness while you take the resistance measurement. Pull the wires that are directly behind the sensor or shake the wires that are directly behind the sensor.

Resistance at 25 °C (77 °F) . . . . . .600 to 1800 Ohms

Expected Result:

The resistance measurement is within the specifications.

Results:

- OK – The resistance measurement is within the specifications.

  Repair: Neither a short circuit nor an open circuit is indicated in the circuit. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP. STOP

- Not OK – The readings are not within the specifications. The sensor resistance is not within the acceptable range when the sensor resistance is measured through the engine harness.Proceed to Test Step 5.

Test Step 5. Measure the Resistance of the Sensor

A. Disconnect the harness connector for the suspect sensor.

B. Thoroughly inspect the sensor's connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

C. Measure the sensor's resistance between terminals 1 and 2.

Resistance for primary engine speed/timing sensor at 25 °C (77 °F) . . . . . 75 to 230 Ohms

Resistance for secondary engine speed/timing sensor at 25 °C (77 °F) . . . . . 600 to 1800 Ohms

Expected Result:

The resistance measurement is within specifications.

Results:

- OK – The reading is within the specification. There is a problem with the wiring between the engine speed/timing sensor and the ECM. There may be a problem with a connector.

  Repair: Repair the wiring and/or the connector. Replace parts, if necessary. Verify that the problem is resolved.

  STOP. STOP

- Not OK – The reading is not within the specification. There is an electrical problem with the engine speed/timing sensor.

  Repair: Perform the following procedure in order to check and install the new sensor assembly:

  A. Before you install the new sensor assembly, measure the resistance of the new sensors.

  If the resistance measurements of the new sensors are within the specifications, install the new sensor assembly in the engine according to the following procedure:

  a. Loosen the bolt and remove the bolt that holds the sensor to the engine.

  b. Ensure that an O-ring is installed on the new sensor assembly. Verify that the O-ring is free of damage.

  c. Prior to installation, lubricate the O-ring with clean engine oil.

  d. Seat the sensor and tighten the bolt.

  If the sensor will not seat, replace the sensor.

  e. Ensure that the harness is secured in the proper location.

  B. Verify that the repair eliminates the problem.

  STOP. STOP

i02934771

Engine Temperature Sensor Open or Short Circuit - Test

SMCS Code: 1439-038-TA; 1906-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Engine coolant temperature sensor
- Fuel temperature sensor
- Intake manifold air temperature sensor
- Intake manifold #2 air temperature sensor

This procedure covers the following diagnostic codes:

- 110-03 Engine Coolant Temperature open/short to +batt
- 110-04 Engine Coolant Temperature short to ground
- 172-03 Intake Manifold Air Temp open/short to +batt
- 172-04 Intake Manifold Air Temp short to ground
- 174-03 Fuel Temperature open/short to +batt
- 174-04 Fuel Temperature short to ground
- 1796-03 Intake Manifold #2 Air Temperature Sensor voltage above normal
- 1796-04 Intake Manifold #2 Air Temperature Sensor voltage below normal

The troubleshooting procedures for the diagnostic codes of each temperature sensor are identical. The temperature sensors are passive sensors that have two terminals. The temperature sensors do not require supply voltage from the Electronic Control Module (ECM).

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage in order to detect a problem in the signal circuit. When the ECM detects the presence of a voltage that is above a threshold on the signal circuit, the ECM will generate an open circuit diagnostic code (03) for the sensor.

If the sensor is disconnected at the sensor connector, the presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are OK. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates a problem in the signal wire. If the sensor is disconnected at the sensor connector and the voltage at the sensor connector is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

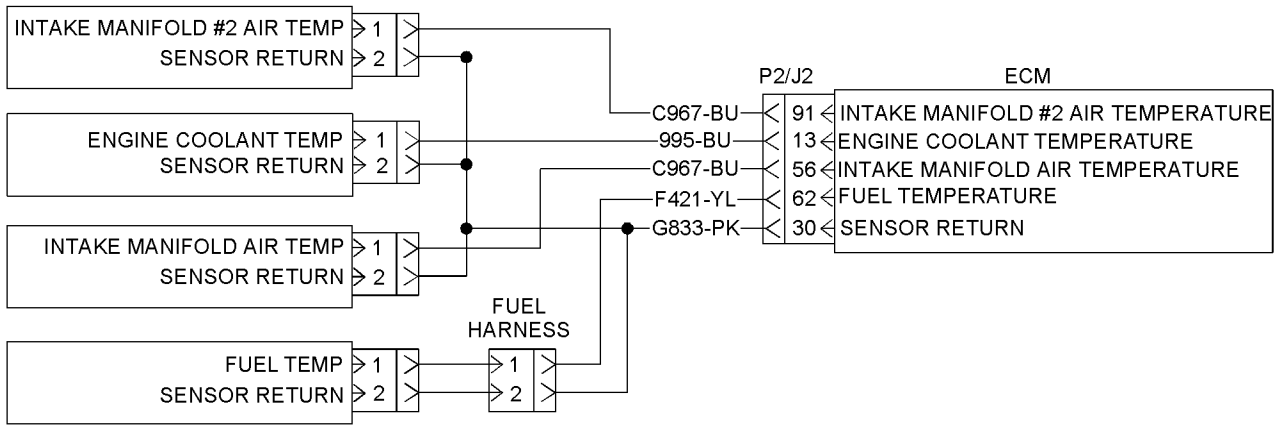


Illustration 74 g01455542

Schematic for the engine temperature sensors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

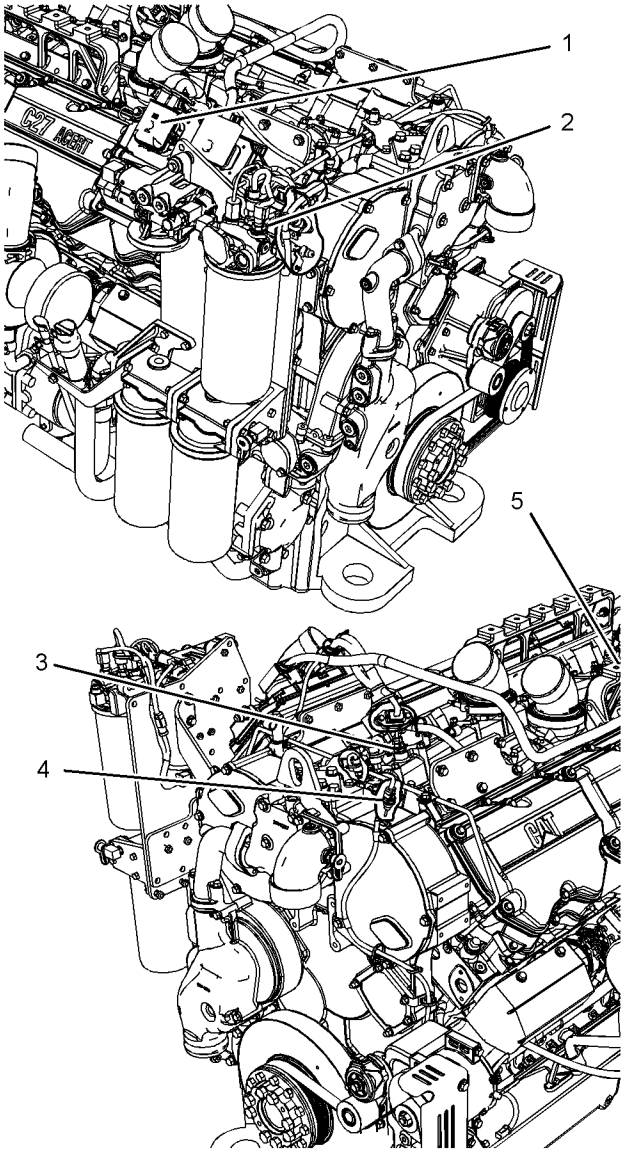


Illustration 75 g01455664

Locations of the engine temperature sensors (typical left side engine view)

(1) J2/P2 ECM connectors
(2) Fuel temperature sensor
(3) Intake manifold air temperature sensor
(4) Engine coolant temperature sensor
(5) Intake manifold #2 air temperature sensor

B. Thoroughly inspect ECM connectors (1). Also, thoroughly inspect the connectors for sensors (2), (3), and (4). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

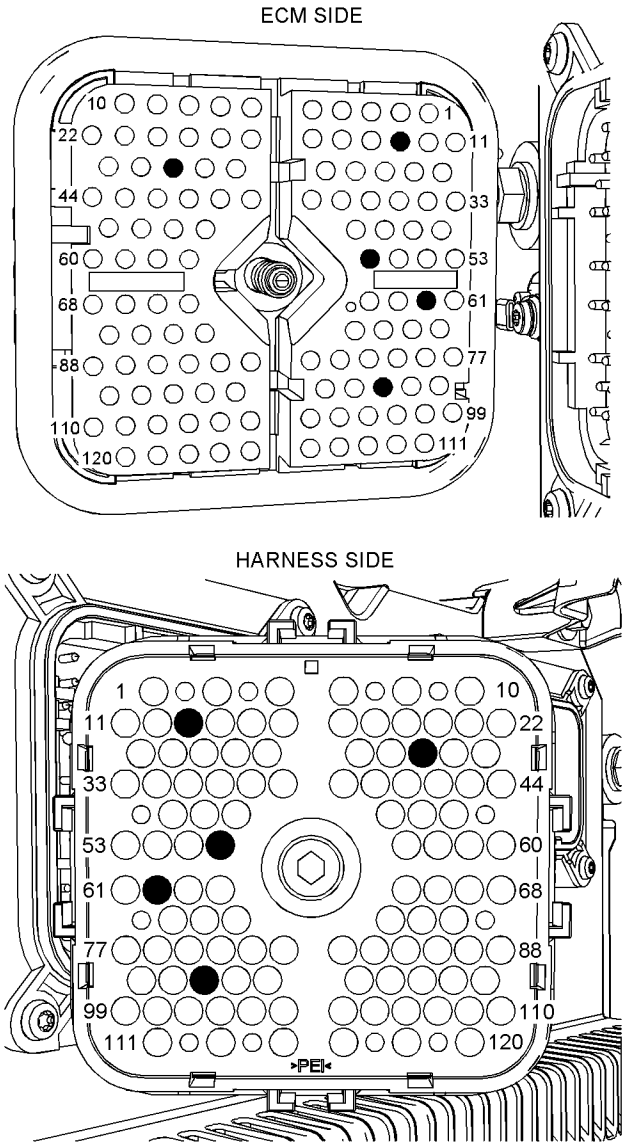


Illustration 76 g01455665

P2 terminals that are associated with the engine temperature sensors

(P2-13) Engine coolant temperature
(P2-30) Sensor return
(P2-56) Intake manifold air temperature
(P2-62) Fuel temperature
(P2-91) Intake manifold #2 air temperature sensor

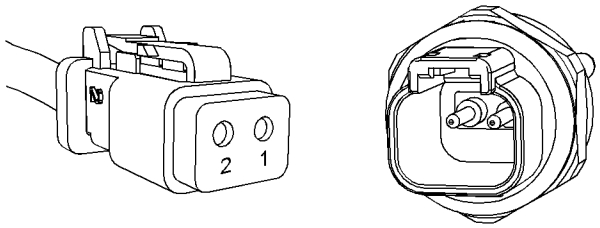


Illustration 77 g01215524

Harness connector for the temperature sensors

(1) Sensor signal
(2) Sensor return

C. Perform a 45 N (10 lb) pull test on each of the wires at the connectors for the temperature sensors.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasions and for pinch points from each sensor to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The connectors and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP. STOP

Test Step 2. Check for Active Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Check for an active open circuit diagnostic code 03 or an active short circuit diagnostic code (04).

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: The problem appears to be resolved. The problem may have been related to a faulty connection in the harness. Carefully reinspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect” for additional information.

  STOP.

- Not OK – A 03 diagnostic code is active at this time.The ECM detects an open circuit condition. Proceed to Test Step 4.
- Not OK – A 04 diagnostic code is active at this time.The ECM detects a short circuit condition. Proceed to Test Step 3.

Test Step 3. Create an Open Circuit by Disconnecting the Sensor Connector

A. Remove electrical power from the ECM.

B. Disconnect the suspect sensor from the harness at the sensor connector.

C. Restore electrical power to the ECM.

D. Access the “Active Diagnostic Codes” screen on Cat ET. Check for an active 03 diagnostic code for the suspect sensor.

Note: Wait at least 30 seconds for activation of the diagnostic codes.

E. Remove electrical power from the ECM.

Expected Result:

A 03 diagnostic code is now active for the suspect sensor.

Results:

- OK – A 03 diagnostic code became active after the sensor was disconnected.

Repair: The problem is with the sensor. Connect a new sensor to the harness connector. Verify that there are no active diagnostic codes for the new sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – The 04 diagnostic code is still present while the sensor is disconnected from the harness. The problem is not with the sensor. There is a problem in the harness between the ECM and the sensor connector. There may be a problem with the ECM. Leave the suspect sensor disconnected. Proceed to Test Step 5.

Test Step 4. Short the Terminals at the Suspect Sensor's Harness Connector

A. Remove electrical power from the ECM.

B. Disconnect the suspect sensor at the harness connector.

C. Fabricate a jumper wire that is long enough to short circuit the two terminals at the connector for the suspect sensor. Crimp connector pins to each end of the jumper wire.

D. Install the jumper wire between terminal 1 (sensor signal) and terminal 2 (sensor return) on the harness side of the suspect sensor's connector.

E. Restore electrical power to the ECM.

F. Monitor the “Active Diagnostic Codes” screen on Cat ET after installing the jumper wire. Check for an active 04 diagnostic code.

Note: Wait at least 30 seconds for activation of the 04 diagnostic code.

G. Remove electrical power from the ECM.

Expected Result:

A 04 diagnostic code is now active for the suspect sensor.

Results:

- OK – A 04 diagnostic code is active when the jumper wire is installed.

  Repair: The problem is with the sensor. Connect a new sensor to the harness connector. Verify that there are no active diagnostic codes for the new sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

  STOP.

- Not OK – The 03 diagnostic code remains active with the jumper in place.There is an open circuit in the wiring harness between the ECM and the sensor connector. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Remove electrical power from the ECM.

B. Check the operation of the ECM by creating an open circuit at the ECM:

a. Disconnect the J2/P2 ECM connector.

b. Fabricate a jumper wire that is long enough to create a test circuit between the ECM connector and the engine ground stud. Crimp a connector socket to one end of the jumper wire.

c. Remove the signal wire for the suspect sensor from the J2/P2 ECM connector. Install the jumper wire into this terminal location.

d. Connect the ECM connectors.

Hold the loose end of the jumper wire away from any ground source in order to create an open circuit condition.

e. Restore electrical power to the ECM.

f. Monitor the “Active Diagnostic Code” screen on Cat ET. A 03 diagnostic code will become active for the suspect sensor.

Note: Wait at least 30 seconds for activation of the code.

g. Remove electrical power from the ECM.

C. Check the operation of the ECM by creating a short circuit at the ECM:

a. Connect the loose end of the jumper wire to the engine ground stud in order to create a short circuit condition.

b. Restore electrical power to the ECM.

c. Monitor the “Active Diagnostic Code” screen on Cat ET. A 04 diagnostic code will become active when the jumper wire is grounded.

Note: Wait at least 30 seconds for activation of the code.

d. Remove electrical power from the ECM.

D. Restore all wiring to the original configuration.

Expected Result:

A 03 diagnostic code is active when the jumper wire is open. A 04 diagnostic code becomes active when the jumper wire is shorted to the engine ground stud.

Results:

- OK – A 03 diagnostic code is active when the jumper wire is open. A 04 diagnostic code becomes active when the jumper wire is shorted to the engine ground stud.

  Repair: The ECM is working properly. The problem is in the wiring harness between the ECM and the sensor connector. Repair the harness and/or the connectors. Replace parts, if necessary.

  STOP.

- Not OK – One of the following conditions exists: The 03 diagnostic code is not active when the jumper wire is open. The 04 diagnostic code is not active when the wire jumper is shorted to ground.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP. STOP

i02433998

Ether Injection System - Test

SMCS Code: 1456-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the electrical circuit for the ether injection system.

The ether injection system improves cold weather starting of the engine. The Electronic Control Module (ECM) provides total control of the ether injection system.

An override feature on the Caterpillar Electronic Technician (ET) allows the technician to activate the ether system. The test is only functional while the engine is not running. Activate this feature by selecting the “Override Parameters” from the diagnostic menu in Cat ET.

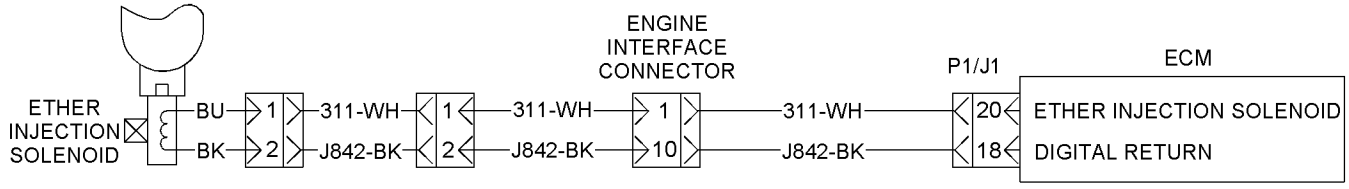


Illustration 78 g01215916

Schematic of the ether injection system

⚠ WARNING

Breathing ether vapors or repeated contact of ether with skin can cause personal injury. Personal injury may occur from failure to adhere to the following procedures.

Use ether only in well ventilated areas.

Do not smoke while changing ether cylinders.

Use ether with care to avoid fires.

Do not store replacement ether cylinders in living areas or in the operator's compartment.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard cylinders in a safe place. Do not puncture or burn cylinders.

Keep ether cylinders out of the reach of unauthorized personnel.

To avoid possible injury, be sure the brakes are applied and all controls are in HOLD or NEUTRAL when starting the engine.

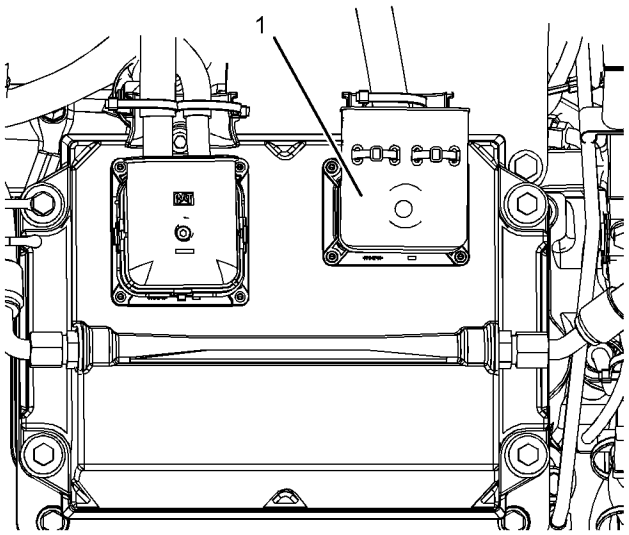


Illustration 79 g01167488

Location of the J1/P1 ECM connectors (typical engine view)

(1) J1/P1 ECM connectors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

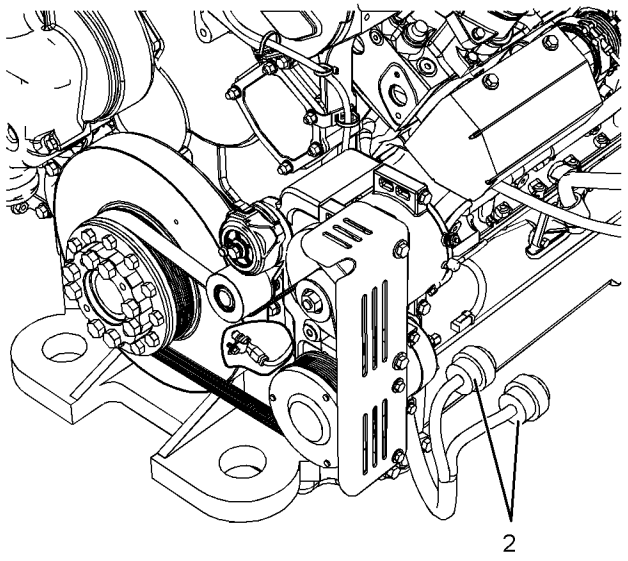


Illustration 80 g01213916

Location of the engine interface connectors (typical left side engine view)

(2) engine interface connectors

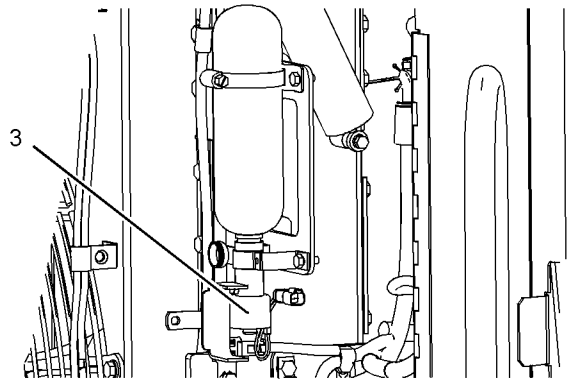


Illustration 81 g01170983

Components for the ether injection system (typical view)

(3) Ether injection solenoid

B. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect the connectors for solenoid (3). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

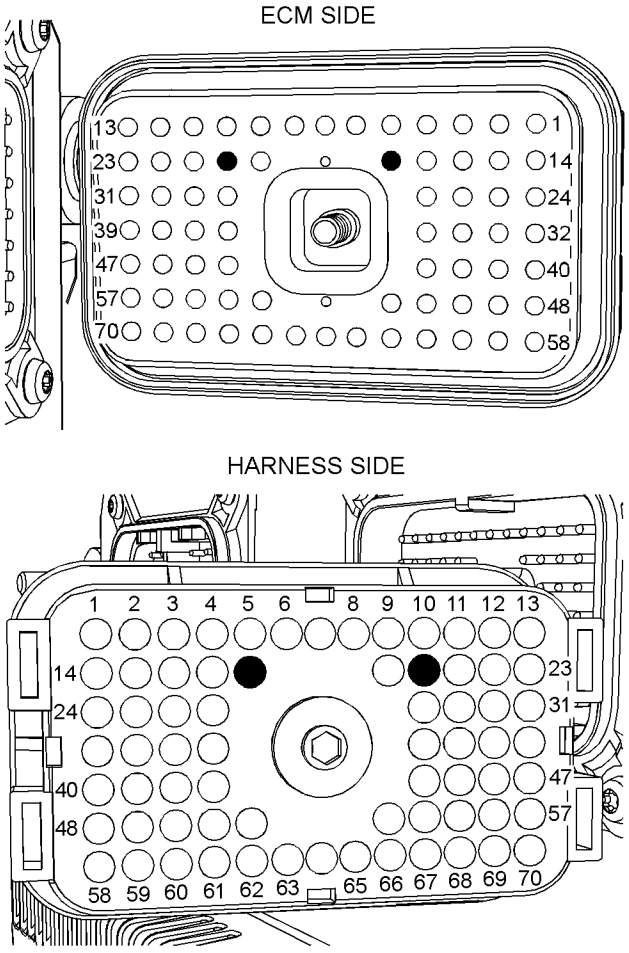


Illustration 82 g01215917

Terminal locations at the P1 ECM connector for the ether injection system

(P1-18) Solenoid return
(P1-20) Ether injection solenoid

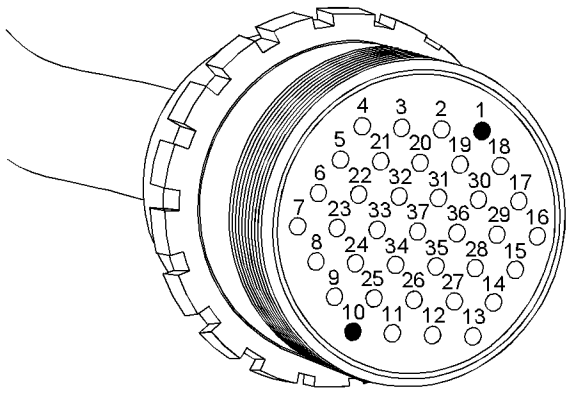


Illustration 83 g01215918

Terminal locations at the engine interface connector for the ether injection solenoid

(Terminal 1) Ether injection solenoid
(Terminal 10) Solenoid return

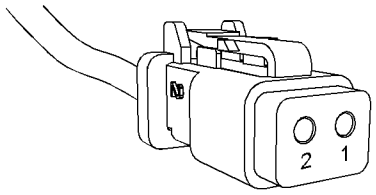


Illustration 84 g01155187

Terminal locations at the connector for the ether injection solenoid

(Terminal 1) Ether injection solenoid
(Terminal 2) Solenoid return

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the ether injection system.

D. Check the torque of the allen head screws for each of the ECM connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points from the ether injection solenoid to the ECM connector.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and the wiring appear to be OK.Proceed to Test Step 2.
- Not OK – The connectors and/or the wiring are not OK.

  Repair: Repair the connectors and/or the wiring. Replace parts, if necessary. Verify that the problem is resolved.

  STOP. STOP

Test Step 2. Check the Ether Canisters for Fluid

A. Ensure that the electrical power is removed from the ECM.

B. Remove the ether canister from the ether valve.

C. Determine if the canister is empty.

Expected Result:

The ether canister is not empty.

Results:

- OK – The ether canister is not empty. Remove the ether canister from the ether valve for the remainder of this test. Proceed to Test Step 3.
- Not OK – The ether canister is empty.

  Repair: Replace the empty ether canister with a full ether canister. Retry the system.

  STOP.

Test Step 3. Check for Signal Voltage at the Harness Connector for the Ether Injection Solenoid

A. Turn the keyswitch to the OFF position.

B. Disconnect the harness connector at the ether injection solenoid.

C. Turn the keyswitch to the ON position.

D. Proceed to the “Diagnostic Overrides” screen on Cat ET.

E. Activate the ether injection system. The system will activate for ten seconds.

F. Check for a signal voltage between the terminals at the harness connector for the ether injection solenoid.

G. Turn the keyswitch to the OFF position.

Expected Result:

The signal voltage is 8.0 ± 0.5 VDC at the connector for the ether injection solenoid.

Results:

- OK – The signal voltage is 8.0 ± 0.5 VDC at the connector for the ether injection solenoid.

  Repair: Voltage is reaching the ether injection solenoid. There is a problem with the solenoid. Connect a new ether solenoid to the harness. Verify that the problem has been corrected prior to installing the new solenoid.

  STOP.

- Not OK – The signal voltage is not 8.0 ± 0.5 VDC at the connector for the ether injection solenoid. There is a problem in the harness or in a connector between the ECM and the connector for the ether injection solenoid. There may be a problem with the ECM. Proceed to Test Step 4.

Test Step 4. Check the Operation of the ECM

A. Disconnect the J1/P1 ECM connectors.

B. Fabricate two jumper wires that are long enough to provide a test circuit at the ECM. Crimp connector sockets onto one end of each of the jumper wires.

C. Remove the wires from terminal locations P1-18 (digital return) and P1-20 (ether injection solenoid) at the ECM connector. Install a jumper wire into each of these terminal locations.

D. Connect the J1/P1 ECM connectors.

E. Turn the keyswitch to the ON position.

F. Proceed to the “Diagnostic Overrides” screen on Cat ET.

G. Activate the ether injection system. The system will activate for ten seconds.

H. Check for a signal voltage between the jumper wires at the ECM connector for the ether injection solenoid.

I. Turn the keyswitch to the OFF position.

J. Restore all of the wiring to the original configuration.

Expected Result:

The signal voltage is 8.0 ± 0.5 VDC at the ECM for the ether injection solenoid.

Results:

- OK – The signal voltage is 8.0 ± 0.5 VDC at the ECM.

  Repair: The ECM is producing the correct signal for the ether injection solenoid. The ECM is OK. The problem is in the harness or in a connector between the ECM and the ether injection solenoid. Repair the wiring harness and/or the connector. Replace parts, if necessary. Verify that the problem has been corrected prior to returning the engine to service.

  STOP.

- Not OK – The signal voltage is not 8.0 ± 0.5 VDC at the ECM.

  Repair: The ECM is not producing the correct signal voltage. There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02432719

Fuel Filter Differential Pressure Switch Circuit - Test

SMCS Code: 1435-038-FI

System Operation Description:

Perform this procedure if you suspect that there is a problem in the circuit for the fuel filter differential pressure switch.

This procedure covers the following event codes:

- E390-1 Fuel Filter Restriction Warning
- E390-2 Fuel Filter Restriction Derate
- E390-3 Fuel Filter Restriction Shutdown

The fuel filter differential pressure switch is used to detect excessive restriction in the fuel filter. The switch is normally closed. When the fuel pressure at the switch reaches 103 ± 14 kPa (15 ± 2 psi) the switch will open. The switch is used in order to detect a plugged fuel filter element. The Electronic Control Module (ECM) will alert the operator of the condition. Use this test in order to verify that the fuel filter differential pressure switch is operating correctly.

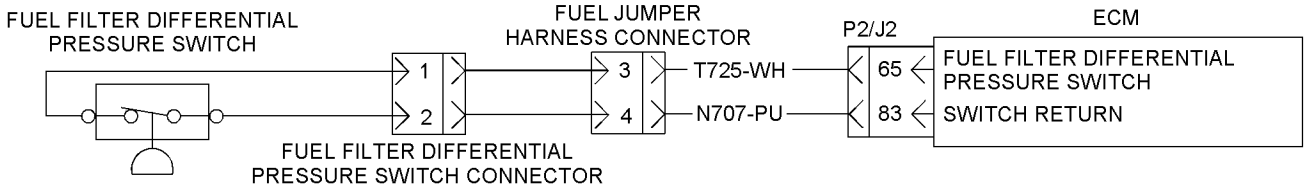


Illustration 85 g01214403

Schematic for fuel filter differential pressure switch

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

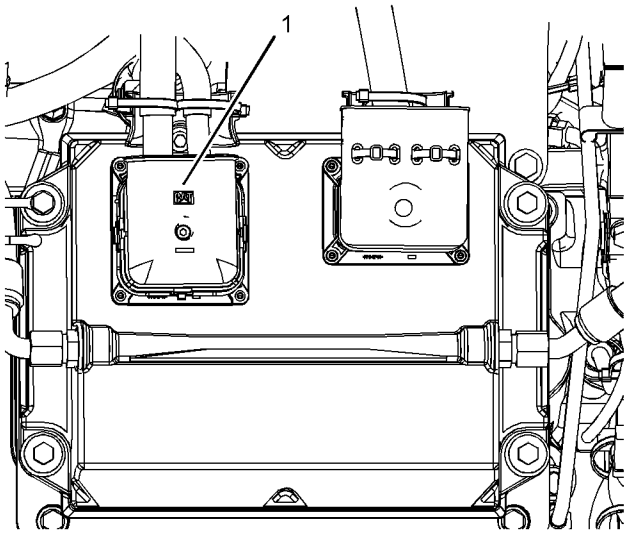


Illustration 86 g01214446

Left side engine view (typical example)

(1) J2/P2 ECM connectors

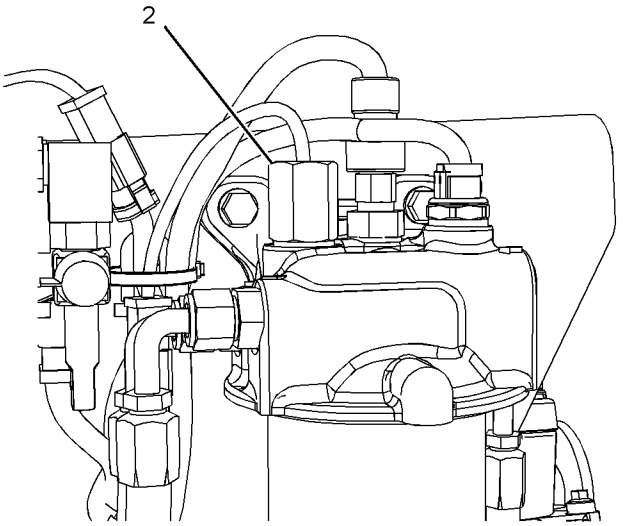


Illustration 87 g01161069

Fuel filter base (typical example)

(2) Fuel filter differential pressure switch

B. Thoroughly inspect connectors (1). Also, thoroughly inspect each connector for switch (2).

Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for details.

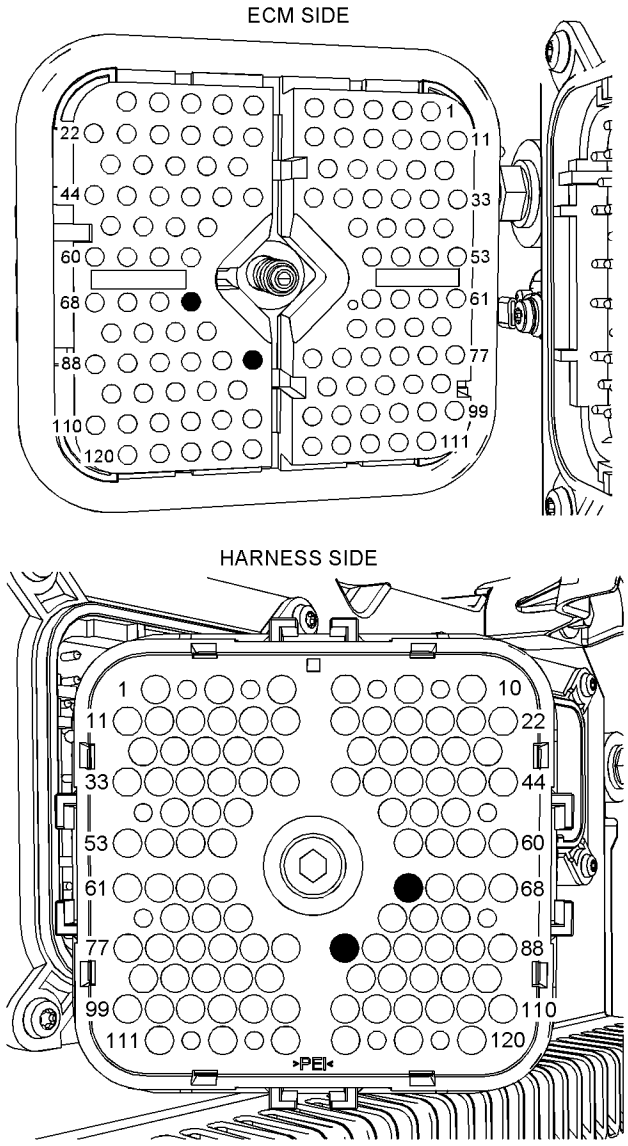


Illustration 88 g01214409

P2 ECM connector

(P2-65) Fuel filter differential pressure switch
(P2-83) Signal return

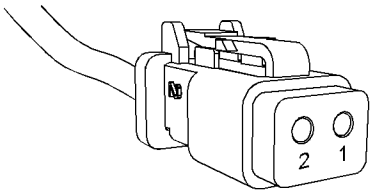


Illustration 89 g01155187

Connector for the fuel filter differential pressure switch

(Terminal 1) Fuel filter differential pressure switch
(Terminal 2) Signal return

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code.

D. Check the allen head screw of each ECM connector for the proper torque. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

E. Check the harness and wiring for abrasions and for pinch points from the switch back to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Switch Circuit at the Harness Connector

A. Fabricate a jumper wire that is long enough to short circuit the terminals at the harness connector for the fuel filter differential pressure switch. Crimp connector pins to each end of the jumper wire.

B. Disconnect the connector for the fuel filter differential pressure switch from the harness. Install the jumper wire across the terminals on the harness side of this connector.

C. Start the engine. Increase the engine speed to high idle.

D. Check for an event code for the engine fuel filter restriction.

E. Shut down the engine. Remove electrical power from the ECM.

Expected Result:

The event code is not active.

Results:

- OK – The event code is not active.

  Repair: The wiring between the connector and the ECM is OK. Replace the fuel filter element. Restart the engine and check for an event code. If the event code is still active, temporarily replace the fuel filter differential pressure switch. Verify that the problem is resolved before permanently replacing the fuel filter differential pressure switch.

  STOP.

- Not OK – The event code is still active.There is an open circuit in the wiring for the fuel filter differential pressure switch between the connector for the fuel filter differential pressure switch and the ECM. There may be a problem with the ECM. Connect the connector for the pressure switch. Proceed to Test Step 3.

Test Step 3. Check the ECM

A. Disconnect the J2/P2 ECM connector.

B. Fabricate a jumper wire that is long enough to create a short between the P2 ECM connector and the engine ground stud. Crimp a connector socket to one end of the jumper wire.

C. Remove the wire from terminal location P2-65 (fuel filter differential pressure switch) at the ECM connector. Install the jumper wire into the terminal location.

D. Secure the other end of the jumper wire to the engine ground stud.

E. Start the engine. Increase the engine speed to high idle.

F. Check for an event code for the engine fuel filter restriction.

G. Shut down the engine. Remove electrical power from the ECM.

Expected Result:

The event code is not active.

Results:

- OK – The event code is not active.

  Repair: The problem is in the harness wiring between the connector for the fuel filter differential pressure switch and the P2 ECM connector. Check the harness connector to the fuel filter differential pressure switch for a good connection. Repair the connectors or wiring and/or replace the connectors or wiring. Verify that the repair eliminates the problem.

  STOP.

- Not OK – The event code is still active.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to electronic troubleshooting Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i03792973

Injector Solenoid Circuit - Test

SMCS Code: 1290-038

System Operation Description:

Use this procedure for the following conditions:

- A suspected problem with an injector solenoid
- You have been directed to this procedure from Troubleshooting, “Troubleshooting without a Diagnostic Code”.
- There is an active diagnostic code for an injector solenoid.

Use this procedure for the following diagnostic codes:

- 1-05 Cylinder #1 Injector open circuit
- 1-06 Cylinder #1 Injector short
- 2-05 Cylinder #2 Injector open circuit
- 2-06 Cylinder #2 Injector short
- 3-05 Cylinder #3 Injector open circuit
- 3-06 Cylinder #3 Injector short
- 4-05 Cylinder #4 Injector open circuit
- 4-06 Cylinder #4 Injector short
- 5-05 Cylinder #5 Injector open circuit
- 5-06 Cylinder #5 Injector short
- 6-05 Cylinder #6 Injector open circuit
- 6-06 Cylinder #6 Injector short
- 7-05 Cylinder #7 Injector open circuit
- 7-06 Cylinder #7 Injector short
- 8-05 Cylinder #8 Injector open circuit
- 8-06 Cylinder #8 Injector short
- 9-05 Cylinder #9 Injector open circuit
- 9-06 Cylinder #9 Injector short

- 10-05 Cylinder #10 Injector open circuit
- 10-06 Cylinder #10 Injector short
- 11-05 Cylinder #11 Injector open circuit
- 11-06 Cylinder #11 Injector short
- 12-05 Cylinder #12 Injector open circuit
- 12-06 Cylinder #12 Injector short

Perform this procedure under conditions that are identical to the conditions that exist when the problem occurs. Typically, problems with the injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

These engines have Electronic Unit Injectors (EUI) that are mechanically actuated and electronically controlled. The Engine Control Module (ECM) sends a high voltage signal to each injector solenoid. The signal is sent with the proper injection duration and injection timing for the current engine load and speed. The injector solenoid is mounted on top of the fuel injector body.

If an open circuit condition is detected in the solenoid circuit, a diagnostic code is generated. The ECM will continue to try to fire the injector. If a short circuit condition is detected, a diagnostic code is generated. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit condition remains, this sequence of events will be repeated until the problem is corrected.

Note: Refer to Illustration 90 . Two injector solenoids share a supply wire. For this reason, an open circuit or a short circuit in a supply wire could cause diagnostic codes for two injector solenoids.

When an injector is replaced, new injector trim files must be programmed into the ECM. If the ECM is replaced, all injector trim files must be programmed into the new ECM. Refer to Troubleshooting, “Injector Trim File” for more information.

The Caterpillar Electronic Technician (ET) includes the following tests that aid in troubleshooting the injector solenoids:

“Cylinder Cutout Test”

The “Cylinder Cutout Test” is used on an engine in order to determine the individual cylinder performance while the engine is running. As one or more cylinders are cut out during the test, the “Cylinder Cutout Test” uses “Fuel Position” in order to evaluate the performance of the cylinders that are cut out. As the different cylinders are cut out, a comparison of the change in “Fuel Position” is used to identify cylinders that are weak or misfiring. One reason for a cylinder that is weak or misfiring is an injector that is malfunctioning.

The “Cylinder Cutout Test” can be used to isolate a malfunctioning injector in order to avoid replacement of injectors that are in good condition.

During the test, when a cylinder is cut out, an increase in “Fuel Position” will be noticed for the remaining cylinders. This increase in “Fuel Position” represents an increase in the amount of fuel that must be delivered by the remaining cylinders in order to maintain the desired engine speed.

When a weak cylinder (malfunctioning injector) is cut out, the increase in “Fuel Position” will not be as large as the increase for a cylinder that has an acceptable level of performance.

Note: Prior to running the “Cylinder Cutout Test” , all active diagnostic codes must be repaired.

“Injector Solenoid Test”

Use the “Injector Solenoid Test” to diagnose an open circuit or a short circuit in the wiring for the injector solenoids. With the engine stopped, the “Injector Solenoid Test” will briefly activate each injector solenoid. An audible click can be heard as each solenoid is activated. After performing the test, Cat ET will indicate the status of the solenoid as “OK” , “Open” , or “Short” .

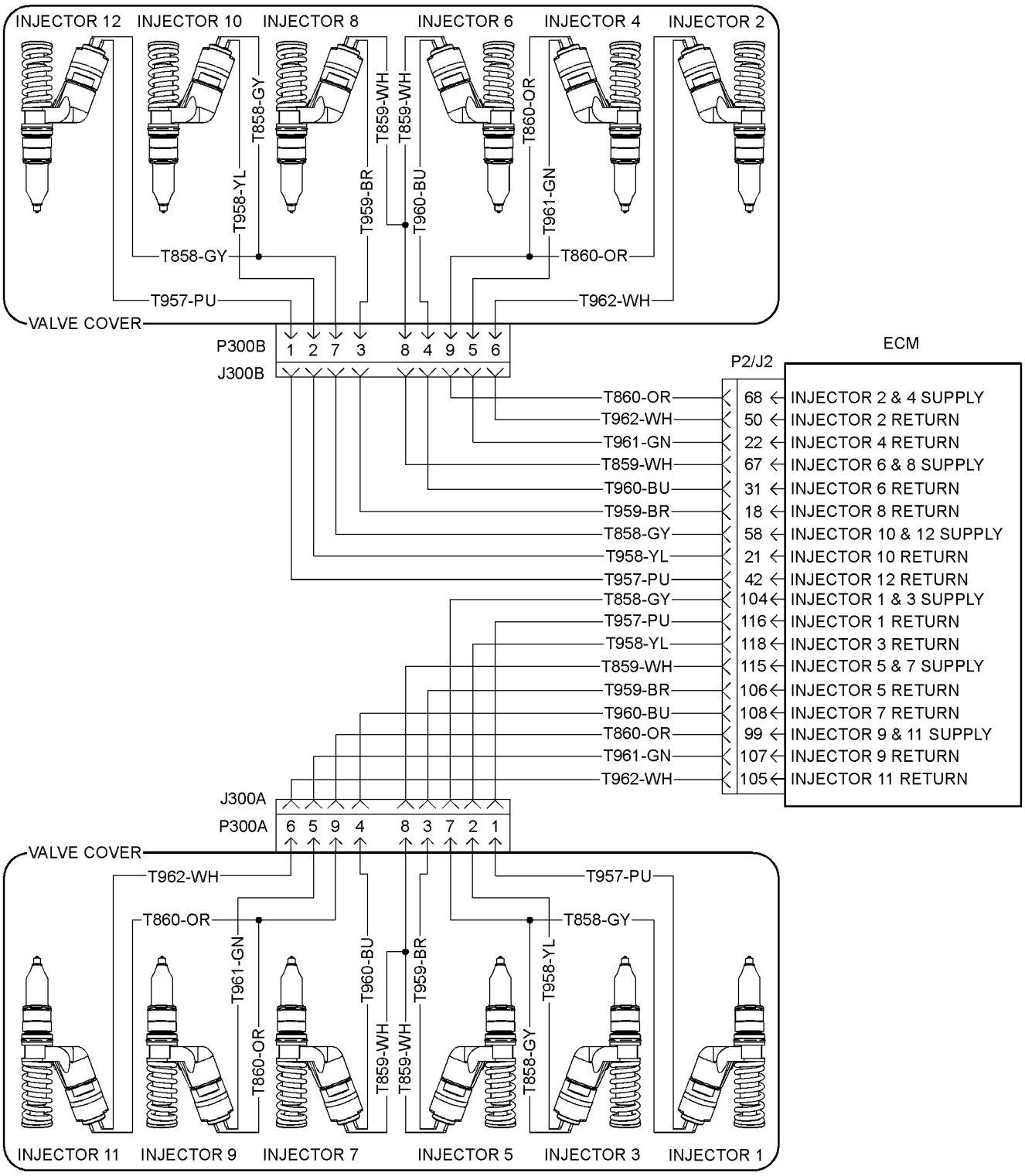


Illustration 90 g02050313

Schematic for the injector solenoids

Test Step 1. Inspect the Electrical Connectors and the Wiring

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

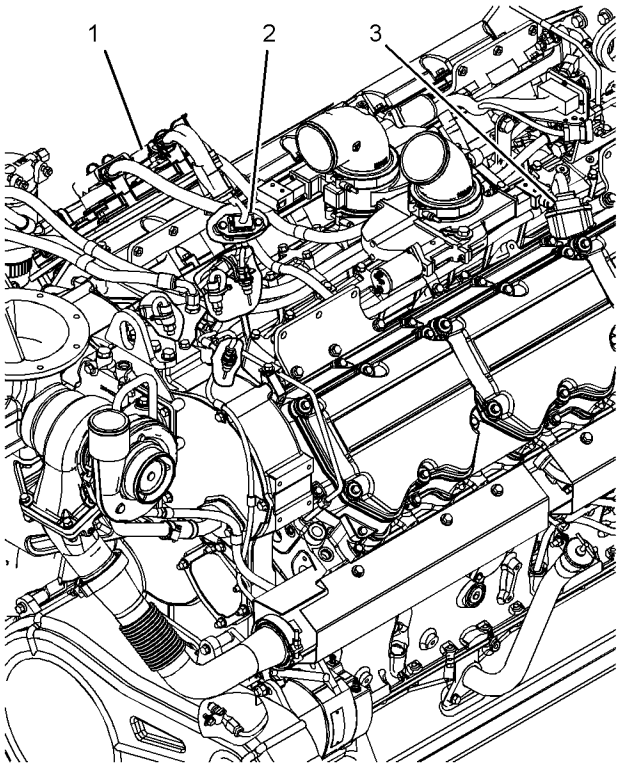


Illustration 91 g01166729

Left side engine view (typical example)

(1) J2/P2 ECM connectors
(2) J300B/P300B injector valve cover entry connectors (right bank)
(3) J300A/P300A injector valve cover entry connectors (left bank)

B. Thoroughly inspect connectors (1), (2), and (3). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

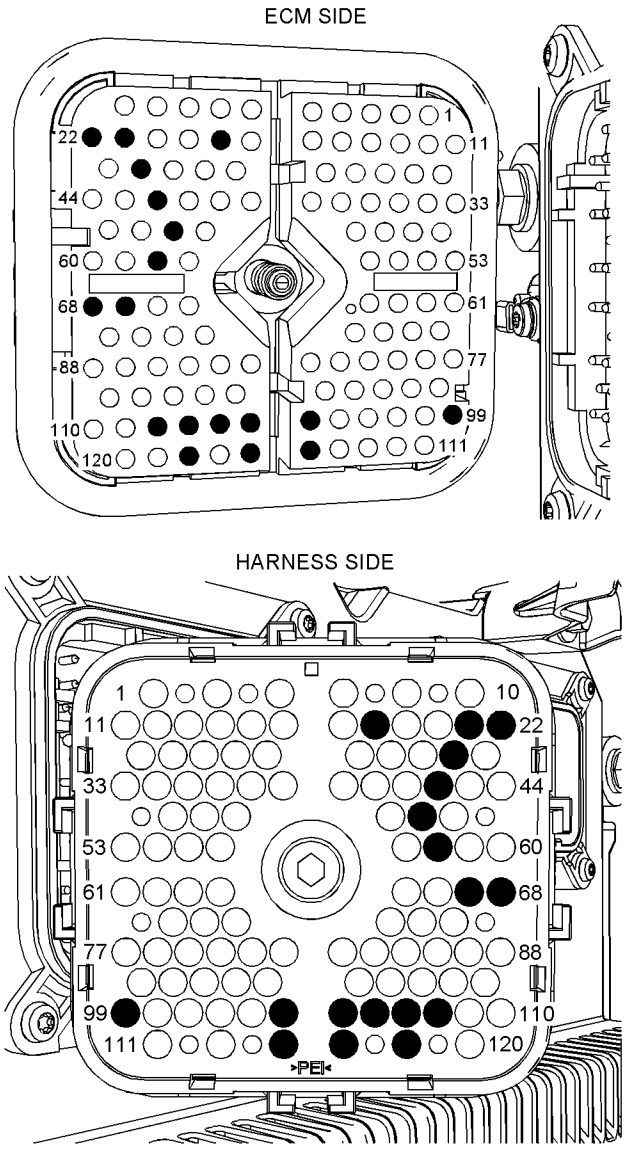


Illustration 92 g01202827

P2 terminals that are associated with the injector solenoids

(P2-18) Injector 8 return
(P2-21) Injector 10 return
(P2-22) Injector 4 return
(P2-31) Injector 6 return
(P2-42) Injector 12 return
(P2-50) Injector 2 return
(P2-58) Injectors 10 & 12 supply
(P2-67) Injectors 6 & 8 supply
(P2-68) Injectors 2 & 4 supply
(P2-99) Injectors 9 & 11 supply
(P2-104) Injectors 1 & 3 supply
(P2-105) Injector 11 return
(P2-106) Injector 5 return
(P2-107) Injector 9 return
(P2-108) Injector 7 return
(P2-115) Injectors 5 & 7 supply
(P2-116) Injector 1 return
(P2-118) Injector 3 return

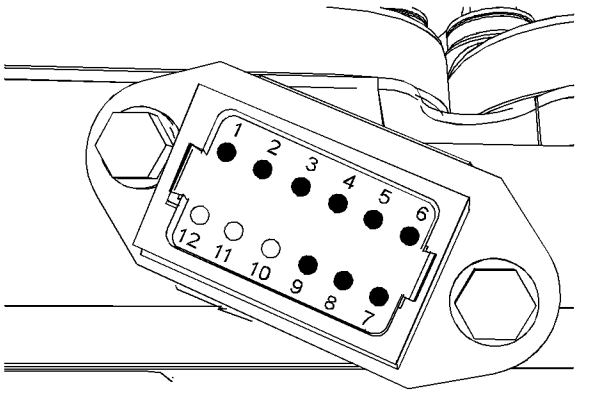


Illustration 93 g01161232

J300A terminals that are associated with the injector solenoids

(J300A-1) Injector 1 return
(J300A-2) Injector 3 return
(J300A-3) Injector 5 return
(J300A-4) Injector 7 return
(J300A-5) Injector 9 return
(J300A-6) Injector 11 return
(J300A-7) Injectors 1 & 3 supply
(J300A-8) Injectors 5 & 7 supply
(J300A-9) Injectors 9 & 11 supply

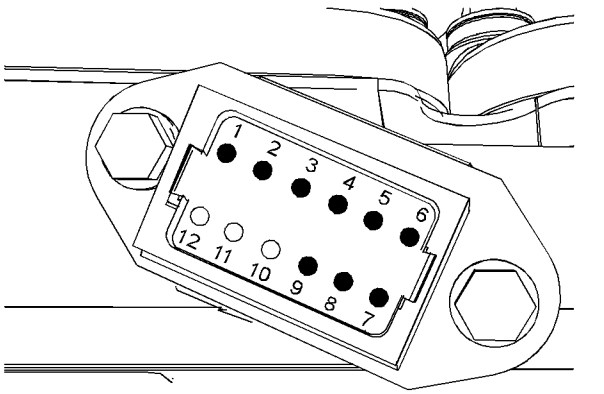


Illustration 94 g01161232

J300B terminals that are associated with the injector solenoids

(J300B-1) Injector 12 return
(J300B-2) Injector 10 return
(J300B-3) Injector 8 return
(J300B-4) Injector 6 return
(J300B-5) Injector 4 return
(J300B-6) Injector 2 return
(J300B-7) Injectors 10 & 12 supply
(J300B-8) Injectors 6 & 8 supply
(J300B-9) Injectors 2 & 4 supply

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with injector solenoids.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points from each P300 connector to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion, or of pinch points.

Results:

- OK – The harnesses and the wiring appear to be OK.Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP. STOP

Test Step 2. Check for Logged Diagnostic Codes for the Injector Solenoids

A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Restore the electrical power to the ECM.

C. Check Cat ET for logged diagnostic codes related to the injector solenoids.

Expected Result:

There are no logged diagnostic codes for the injector solenoids .

Results:

- OK – No diagnostic codes for the injector solenoids are logged.The injector solenoids are operating correctly. There may be a mechanical problem with the injector's fuel delivery. Proceed to Test Step 3.
- Not OK – A diagnostic code is logged for one or more injector solenoid.There is an electrical problem with an injector solenoid or with the circuit. Proceed to Test Step 4.

Test Step 3. Perform the “Cylinder Cutout Test”

A. Start the engine.

B. Allow the engine to warm up to normal operating temperature 77 °C (171 °F).

C. Access the “Cylinder Cutout Test” by accessing the following display screens:

- “Diagnostics”
- “Diagnostic Tests”
- “Cylinder Cutout Test”

D. Shut off all parasitic loads such as air compressors which could affect the results of the test.

E. Follow the instructions that are given on the screen.

F. To start the test, select the start button at the bottom of the screen.

G. Use Cat ET to manually cut out the cylinders in order to identify injectors that may have a performance problem. Highlight a cylinder and select the “Change” button at the bottom of the screen. The injector for that cylinder will be disabled. Check for a difference in the sound, feel, or power of the engine. Also, look for a change to the operating parameters that are displayed on the “Cylinder Cutout Test” screen.

Expected Result:

The cylinder cutout test indicates that all of the injectors are operating correctly.

Results:

- OK – The cylinder cutout test indicates that all of the injectors are operating correctly.

  Repair: If a problem with the fuel system is suspected and diagnostic codes are not active or logged, refer to Systems Operation/Testing and Adjusting for information that is related to the low pressure fuel system.

  STOP. STOP

- Not OK – The cylinder cutout test indicates that at least one of the injectors is not operating correctly. Proceed to Test Step 4.

Test Step 4. Perform the “Injector Solenoid Test”

A. Start the engine.

B. Allow the engine to warm up to normal operating temperature 77 °C (171 °F).

C. Stop the engine.

D. Restore the electrical power to the ECM.

E. Access the “Injector Solenoid Test” by accessing the following display screens:

- “Diagnostics”
- “Diagnostic Tests”
- “Injector Solenoid Test”

F. Activate the “Injector Solenoid Test” .

G. As each solenoid is energized by the ECM, an audible click can be heard at the valve cover. Allow the “Injector Solenoid Test” to continue until each cylinder is activated at least two times.

Expected Result:

All cylinders indicate “OK” on Cat ET.

Results:

- OK – There is not an electronic problem with the injectors at this time.

  Repair: The problem appears to be resolved. There may be an intermittent problem in the harness. The problem may have been caused by a poor electrical connection in a connector.

  If the codes continue to be logged, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  If the engine is misfiring or if the engine has low power, refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable” or Troubleshooting, “Low Power/Poor or No Response to Throttle”.

  STOP. STOP

- Not OK - “Open” – Note the cylinder that indicates “Open” .Proceed to Test Step 5.

- Not OK - “Short” – Note the cylinder that indicates “Short” .Proceed to Test Step 6.

Test Step 5. Check the Harness between the ECM and the Valve Cover Base for an Open Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

B. Disconnect the appropriate P300 connector at the valve cover base.

C. Restore the electrical power to the ECM.

D. Fabricate a jumper wire that will be long enough to short circuit two terminal locations at the P300 connector. Crimp connector pins to both ends of the jumper wire.

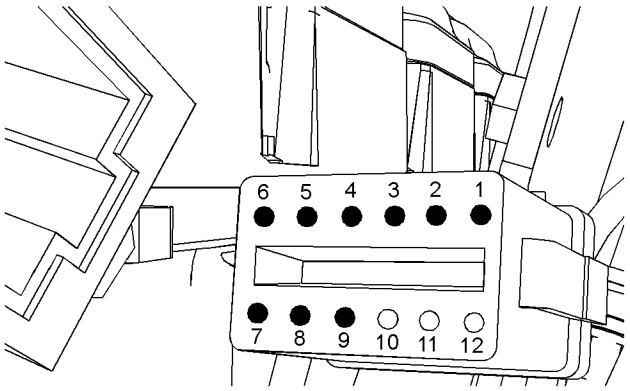


Illustration 95 g01161304

J300A terminals that are associated with the injector solenoids (harness side of connector)

(J300A-1) Injector 1 return
(J300A-2) Injector 3 return
(J300A-3) Injector 5 return
(J300A-4) Injector 7 return
(J300A-5) Injector 9 return
(J300A-6) Injector 11 return
(J300A-7) Injectors 1 & 3 supply
(J300A-8) Injectors 5 & 7 supply
(J300A-9) Injectors 9 & 11 supply

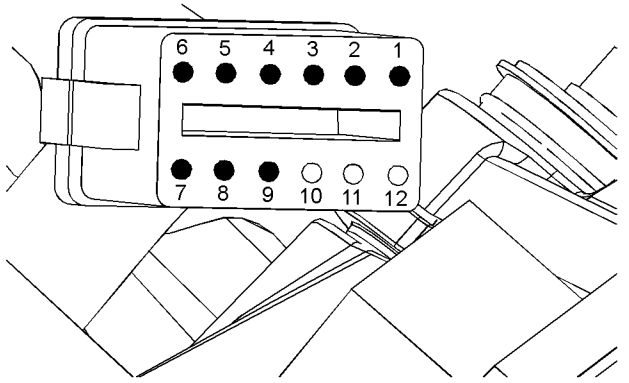


Illustration 96 g01203187

J300B terminals that are associated with the injector solenoids (harness side of connector)

(J300B-1) Injector 12 return
(J300B-2) Injector 10 return
(J300B-3) Injector 8 return
(J300B-4) Injector 6 return
(J300B-5) Injector 4 return
(J300B-6) Injector 2 return
(J300B-7) Injectors 10 & 12 supply
(J300B-8) Injectors 6 & 8 supply
(J300B-9) Injectors 2 & 4 supply

E. Insert one end of the jumper wire into the P300 connector socket for the suspect injector's supply wire. Insert the other end of the jumper wire into the P300 connector socket for the suspect injector's return wire. This will replace the injector solenoid with a short circuit.

F. Perform the “Injector Solenoid Test” at least two times.

G. Repeat this test for each suspect circuit. Stop the “Injector Solenoid Test” before handling the jumper wire.

Restore the wiring to the original configuration.

Expected Result:

Cat ET displays “Short” for each circuits that was jumpered.

Results:

- OK – Cat ET displays “Short” for each circuit that was jumpered. The harness between the ECM and the P300 connector does not have an open circuit.Proceed to Test Step 7.
- Not OK – Cat ET displays “Open” for the cylinder with the jumper wire. There is a problem in the wiring between the ECM and the P300 connector. There may be a problem with the ECM. Proceed to Test Step 8.

Test Step 6. Check the Harness between the ECM and the Valve Cover Base for a Short Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

B. Disconnect the appropriate P300 connector.

C. Restore the electrical power to the ECM.

D. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

All of the cylinders in the appropriate bank indicate “Open” on Cat ET.

Results:

- OK – All cylinders indicate “Open” on Cat ET.The ECM and the engine harness are OK. Proceed to Test Step 7.
- Not OK – One or more cylinders indicate “Short” on Cat ET. Note the cylinders that indicate “Short” .Proceed to Test Step 8.

Test Step 7. Check the Injector Harness Under the Valve Cover for an Open Circuit or a Short Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

B. Remove the valve cover in order to gain access to the suspect injector.

C. Disconnect the harness connector from the suspect injector.

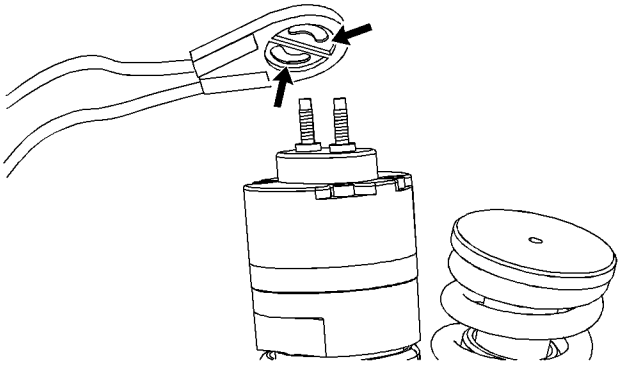


Illustration 97 g01147088

Connector terminals for the injector solenoid

D. Thoroughly clean the terminals on the injector solenoid and on the harness connector.

E. Use a jumper wire to short circuit the connector terminals for the suspect injector. This will effectively replace the injector solenoid with a short circuit.

F. Restore the electrical power to the ECM.

G. Perform the “Injector Solenoid Test” at least two times.

Note: The injector solenoid that shares the supply wire of the injector that is short circuited may indicate a false test result. Disregard this test result.

H. Remove the electrical power from the ECM.

I. Remove the jumper wire from the injector connector. This will effectively replace the injector solenoid with an open circuit.

J. Restore the electrical power to the ECM.

K. Perform the “Injector Solenoid Test” at least two times.

L. Remove the electrical power from the ECM.

Expected Result:

Cat ET displays “Short” for the cylinder with the jumper wire and “Open” when the jumper wire is removed.

Results:

- OK – Cat ET displays the correct status during the test.

  Repair: The harness wiring is OK. There may be a problem with the injector. Use a multimeter to check the resistance of the suspect injector solenoid.

The correct resistance of each injector solenoid is 1.06 ± 0.05 Ohms at 25 °C (77 °F).

If the resistance of the solenoid is not within specifications replace the faulty injector. Verify that the problem is resolved.

If the resistance of the solenoid is within specifications the problem may be intermittent. If the problem is intermittent, refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

STOP. STOP

- Not OK – Cat ET did not display the correct status during the test.

  Repair: There is a problem with the injector harness under the valve cover. There may be a problem with a connector. Repair the wiring and/or the connector, when possible. Replace parts, if necessary.

  STOP. STOP

Test Step 8. Check the ECM for Proper Operation

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

B. Fabricate a jumper that is long enough to reach from the P2 ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.

C. Disconnect the P2 connector.

D. Remove the supply wire from the terminal location for the suspect injector at the ECM connector. Install the jumper wire into this socket.

E. Connect the J2/P2 ECM connectors.

F. Verify that the ECM will detect an open circuit for the suspect injector:

a. Ensure that the jumper wire is not in contact with a ground source or another circuit. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.

b. Restore the electrical power to the ECM.

c. Perform the “Injector Solenoid Test” at least two times.

d. Remove the electrical power from the ECM.

Cat ET displays “Open” for the two injectors that share the supply wire.

G. Verify that the ECM detects a short circuit for the suspect injector:

a. Connect the jumper wire to the engine ground stud. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.

b. Restore the electrical power to the ECM.

c. Perform the “Injector Solenoid Test” at least two times.

d. Remove the electrical power from the ECM.

Cat ET displays “Short” for the two injectors that share the supply wire.

Expected Result:

Cat ET displays the correct status for each test circuit.

Results:

- OK – The ECM detects the correct status of the circuit.

  Repair: The ECM is OK. The problem is in the engine harness or in a connector. Inspect the connectors for moisture and for corrosion. Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Clear all diagnostic codes after you complete this test step.

  STOP. STOP

- Not OK – The ECM does not detect the correct status of the circuit.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP. STOP

i05239429

Sensor Signal (PWM) - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the sensor or if any one of the diagnostic codes in Table 45 is active or easily repeated.

Table 45

Diagnostic Codes Table			
Code and Description	**Conditions which Generate this Code**	**System Response**	**Label on Sensor**
827-3 Left Exhaust Temperature Sensor voltage above normal	The Electronic Control Module (ECM) detects a signal voltage that is above normal.	The code is logged. The ECM flags the exhaust temperature as invalid data.	“FRONT LEFT EXHAUST TC” Located in the exhaust manifold below the turbocharger
827-4 Left Exhaust Temperature Sensor voltage below normal	The Electronic Control Module (ECM) detects a signal voltage that is below normal.		
827-8 Left Exhaust Temperature Sensor abnormal frequency, pulse width, or period	The Electronic Control Module (ECM) detects a sensor frequency that is greater than 600 Hz or less than 400 Hz. The ECM detects a duty cycle that is greater than 88 percent or a duty cycle that is less than 22 percent.		
828-3 Right Exhaust Temperature Sensor voltage above normal	The Electronic Control Module (ECM) detects a signal voltage that is above normal.	The code is logged. The ECM flags the exhaust temperature as invalid data.	“FRONT RIGHT EXHAUST TC” Located in the exhaust manifold below the turbocharger
828-4 Right Exhaust Temperature Sensor voltage below normal	The Electronic Control Module (ECM) detects a signal voltage that is below normal.		
828-8 Right Exhaust Temperature Sensor abnormal frequency, pulse width, or period	The Electronic Control Module (ECM) detects a sensor frequency that is greater than 600 Hz or less than 400 Hz. The ECM detects a duty cycle that is greater than 88 percent or a duty cycle that is less than 22 percent.		
2350-3 Left Exhaust #2 Temperature Sensor voltage above normal	The Electronic Control Module (ECM) detects a signal voltage that is above normal.	The code is logged. The ECM flags the exhaust temperature as invalid data.	“REAR LEFT EXHAUST TC” Located in the exhaust manifold below the turbocharger
2350-4 Left Exhaust #2 Temperature Sensor voltage below normal	The Electronic Control Module (ECM) detects a signal voltage that is below normal.		
2350-8 Left Exhaust #2 Temperature Sensor abnormal frequency, pulse width, or period	The Electronic Control Module (ECM) detects a sensor frequency that is greater than 600 Hz or less than 400 Hz. The ECM detects a duty cycle that is greater than 88 percent or a duty cycle that is less than 22 percent.		

(continued)

(Table 45, contd)

Diagnostic Codes Table			
Code and Description	**Conditions which Generate this Code**	**System Response**	**Label on Sensor**
2351-3 Right Exhaust #2 Temperature Sensor voltage above normal	The Electronic Control Module (ECM) detects a signal voltage that is above normal.	The code is logged. The ECM flags the exhaust temperature as invalid data.	“REAR RIGHT EXHAUST TC” Located in the exhaust manifold below the turbocharger
2351-4 Right Exhaust #2 Temperature Sensor voltage below normal	The Electronic Control Module (ECM) detects a signal voltage that is below normal.		
2351-8 Right Exhaust #2 Temperature Sensor abnormal frequency, pulse width, or period	The Electronic Control Module (ECM) detects a sensor frequency that is greater than 600 Hz or less than 400 Hz. The ECM detects a duty cycle that is greater than 88 percent or a duty cycle that is less than 22 percent.		

System Operation

A Pulse Width Modulated Sensor (PWM) provides a signal to the Electronic Control Module (ECM) from the exhaust temperature sensor. The sensor receives a 8.0 ± 0.4 VDC regulated voltage from the ECM.

The sensor generates a PWM signal that is in a specific range of duty cycle that is sent to the ECM. This range is directly related to the temperature that is sampled by the temperature probe. When the temperature of the sensor probe is 50 °C (122 °F) the duty cycle output of the sensor is 22 percent. When the temperature of the sensor probe is 850 °C (1550 °F) the duty cycle output of the sensor is 88 percent. As the temperature of the probe fluctuates between the minimum and the maximum temperatures, the duty cycle fluctuates on a scale that is directly related to the temperature of the temperature probe.

The ECM performs an automatic calibration of this sensor whenever the ECM is powered and the engine has been off for at least five seconds.

The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply of the ECM.

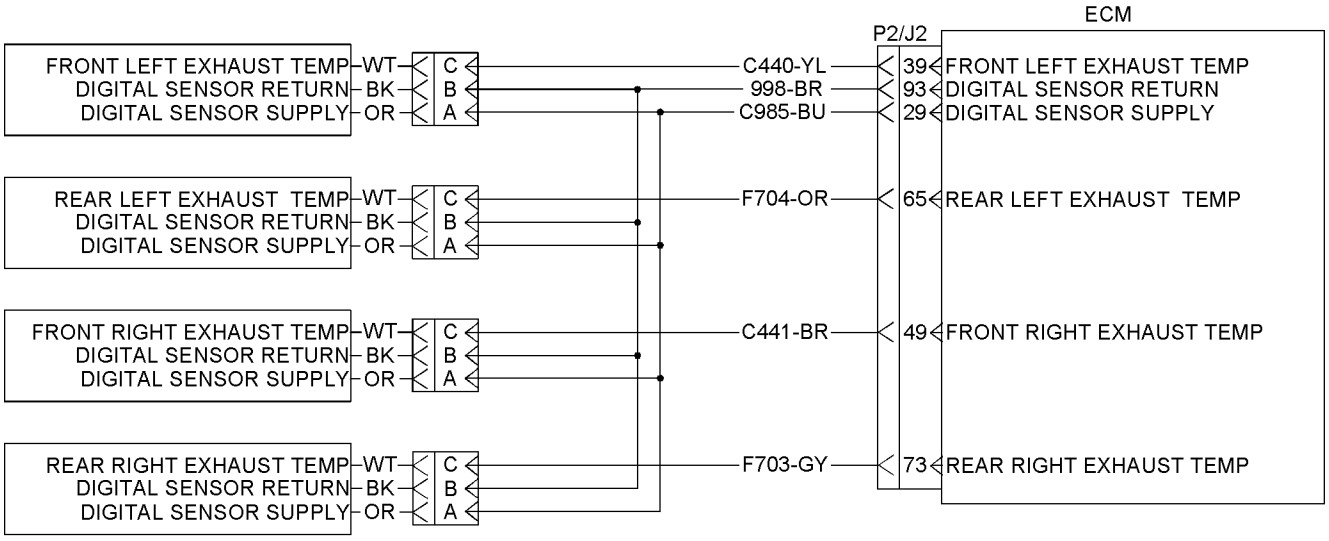


Illustration 98 g01405556

Schematic of the sensor circuit for the PWM sensors

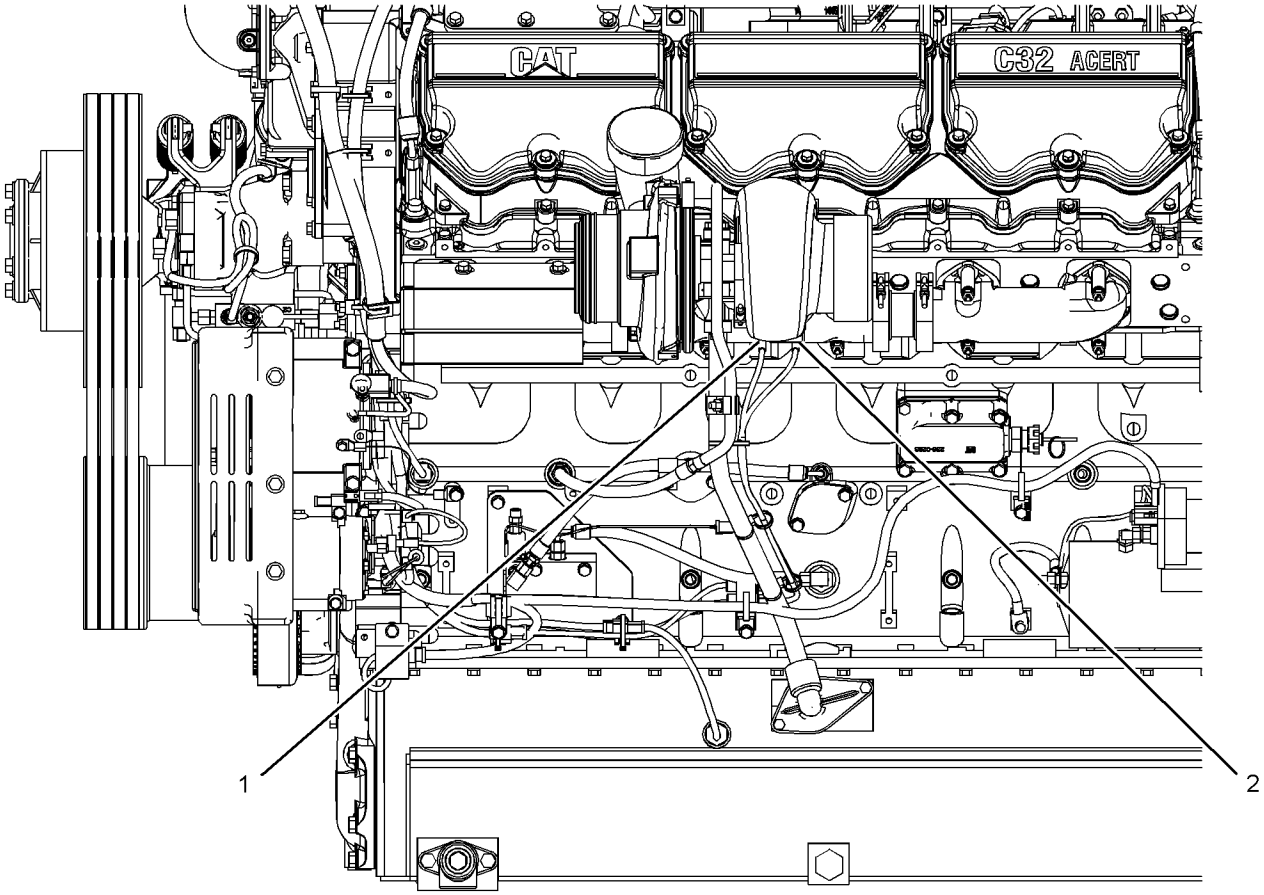


Illustration 99 g01406331

Locations of the left side exhaust temperature sensors

(1) “FRONT LEFT EXHAUST TC” (2) “REAR LEFT EXHAUST TC”

Test Step 1. Inspect the Electrical Connectors and the Wiring

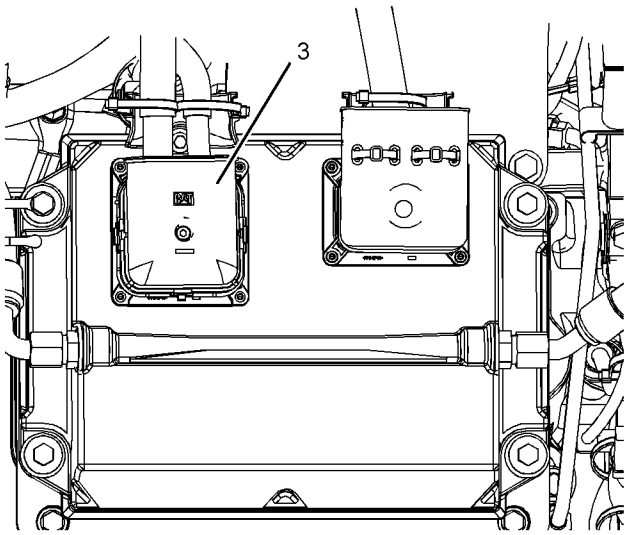


Illustration 100 g01406077

Location of the ECM connector that is for the exhaust temperature sensors

(3) J2/P2 ECM connectors

A. Thoroughly inspect connectors (1),(2) and (3). Refer to Troubleshooting, “Electrical Connectors - Inspect” for details that are related to inspection of the electrical connectors.

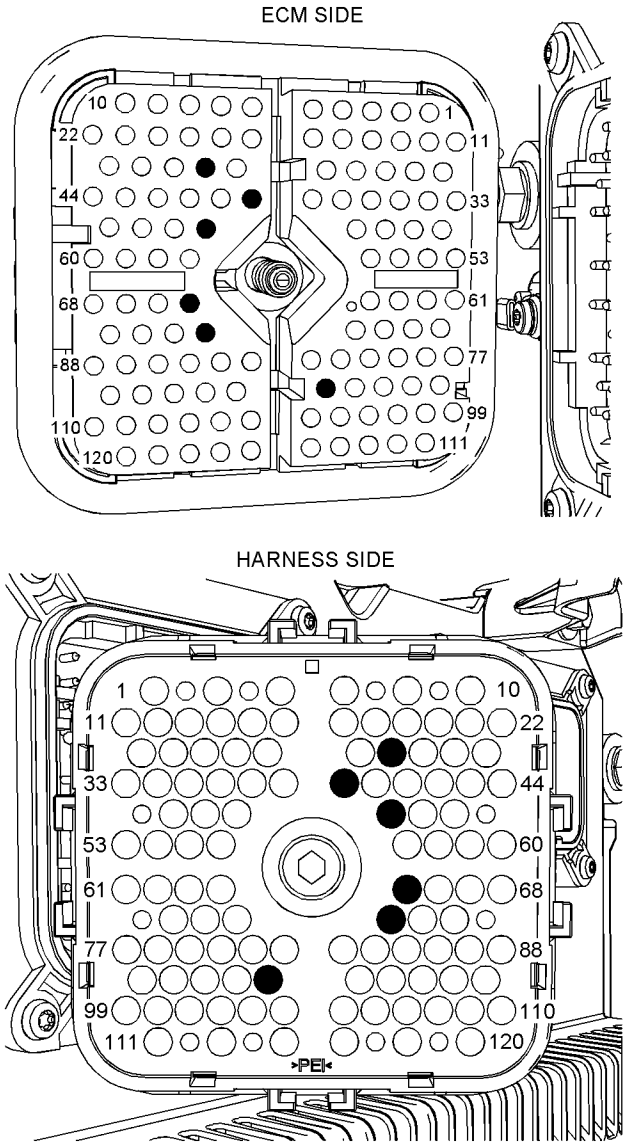


Illustration 101 g01406078

Terminal locations at the P2 ECM connector that are for the exhaust temperature sensor

(P2-29) Digital sensor supply
(P2-39) Front left exhaust temperature
(P2-49) Front right exhaust temperature
(P2-65) Rear left exhaust temperature
(P2-73) Rear right exhaust temperature
(P2-93) Digital return

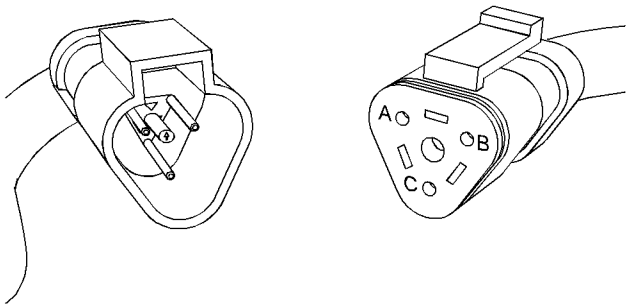


Illustration 102 g01159881

Terminal locations at the connectors for the exhaust temperature sensor

(Terminal A) Digital sensor supply
(Terminal B) Digital return
(Terminal C) Exhaust temperature

B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the customer connector that are associated with the circuit.

C. Check the allen head screw on each ECM connector for the proper torque. refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

D. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP. Repair Complete

Test Step 2. Check the Supply Voltage at the Sensor

A. Disconnect the exhaust temperature sensor at the harness connector.

B. Restore electrical power to the ECM. Turn the keyswitch to the ON position.

C. Measure the voltage across terminal A (digital sensor supply) and terminal B (digital return) on the harness side of the connector.

D. Remove electrical power from the ECM. Turn the keyswitch to the OFF position.

E. Restore the wiring to the original configuration.

Expected Result:

The supply voltage measures 8.0 ± 0.4 VDC at the sensor connector.

Results:

- OK – The correct supply voltage is measured at the sensor connector.The sensor is receiving the correct supply voltage. Proceed to Test Step 3.
- Not OK – The voltage is not correct at the sensor connector.

  Repair: There is a problem in the circuit for the digital sensor supply that is between the ECM and the exhaust temperature sensor. Repair the circuit. Refer to Troubleshooting, “Digital Sensor Supply Circuit - Test” for details that are related to troubleshooting a problem with the circuit.

  STOP. STOP

Test Step 3. Check the Signal Frequency and the Duty Cycle at the Sensor

A. Disconnect the sensor connector from the exhaust temperature sensor.

B. Remove the signal wire from terminal C of the harness side of the connector for the exhaust temperature sensor.

C. Install a 7X-6370 Adapter Cable As (3-PIN BREAKOUT) at the sensor connector.

D. Connect the sensor to the breakout harness.

E. Restore electrical power to the ECM. Turn the keyswitch to the ON position.

F. Measure the frequency and the duty cycle between terminal B (digital return) and terminal C (exhaust temperature) at the 7X-6370 Adapter Cable As (3-PIN BREAKOUT).

G. Remove electrical power from the ECM. Turn the keyswitch to the OFF position.

H. Remove the breakout harness. Restore the wiring to the original configuration.

Expected Result:

The frequency is between 400 and 600 Hz. The duty cycle is between 22 and 88 percent.

Note: When the temperature of the sensor probe is 50 °C (122 °F) the duty cycle output of the sensor is 22 percent. When the temperature of the sensor probe is 850 °C (1550 °F) the duty cycle output of the sensor is 88 percent.

Results:

- OK – The frequency and the duty cycle are within specifications.The sensor is producing a valid signal. Proceed to Test Step 4.
- Not OK – The frequency and the duty cycle are not within specifications.

  Repair: The sensor is not producing a valid signal. Replace the exhaust temperature sensor. Verify that the repair eliminates the problem.

  STOP. STOP

Test Step 4. Check the Signal Frequency and the Duty Cycle at the ECM

A. Remove the signal wire of the suspect sensor from the P2 ECM connector in order to isolate the circuit. Refer to illustration 98 for the number of the P2 terminal of the suspect sensor.

B. Restore electrical power to the ECM. Turn the keyswitch to the ON position.

C. Install a 7X-1709 Multimeter Probe (BLACK) into terminal location P2-14 (digital return) at the ECM connector.

Note: Ensure that the multimeter probe is in good repair. A bent probe may contact other terminals inside the connector.

D. Measure the duty cycle and the frequency between the loose wire and the multimeter probe at the ECM connector.

E. Remove electrical power from the ECM. Turn the keyswitch to the OFF position.

Expected Result:

The frequency is between 400 and 600 Hz. The duty cycle is between 22 and 88 percent.

Note: When the temperature of the sensor probe is 50 °C (122 °F) the duty cycle output of the sensor is 22 percent. When the temperature of the sensor probe is 850 °C (1550 °F) the duty cycle output of the sensor is 88 percent.

Results:

- OK – The frequency and the duty cycle are within specifications.

  Repair: A valid signal appears at the ECM, but the ECM is not detecting the signal properly. There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “ECM - Replace” for details.

  STOP. STOP

- Not OK – The frequency and the duty cycle are not within specifications.

  Repair: There is not a valid signal at the ECM connector. Repair the signal wire in the harness that is between the ECM connector and the harness connector for the suspect exhaust temperature sensor. Verify that the repair eliminates the problem.

  STOP. STOP

i06930559

Switch Circuits - Test

SMCS Code: 1435-038

System Operation Description:

This procedure covers the following diagnostic codes.

- 2354-3 Engine Compression Brake Pedal Switch : Voltage Above Normal
- 2354-4 Engine Compression Brake Pedal Switch : Voltage Below Normal

Operation of the engine retarder switch

The engine retarder switch is a momentary push button switch. This switch is used to select the operating mode of the engine retarders by the operator. There are two control modes for the engine retarder that are available to the operator, auto mode and manual mode.

The auto mode is selected when the engine retarder switch is in the released position. In auto mode, the retarder will be activated only when the engine speed is above the “Auto Mode Trip Point” . The retarder will remain on until the engine reaches the engine speed of the “Auto Mode Kickout” .

The manual mode is selected when the engine retarder switch is actuated continuously by the operator. In the manual mode, the engine retarder will be activated only when the engine speed is above the “Manual Mode Trip Point” . The retarder will remain on until the engine reaches the engine speed of the “Manual Mode Kickout” , or the engine retarder switch is released.

Operation of the right brake pedal switch

The right brake pedal switch is a momentary contact switch. The Electronic Control Module (ECM) uses the switch inputs for the right brake pedal switch in order to detect the status of the right brake pedal switch. The ECM uses this status information in order to disengage the throttle lock control when the brake is depressed. The throttle lock feature is used by the operator in order to maintain a desired engine speed.

Both of these switches are momentary switches that provide two switch inputs to the ECM. One of these inputs is normally open and the other input is normally closed.

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the engine ECM.

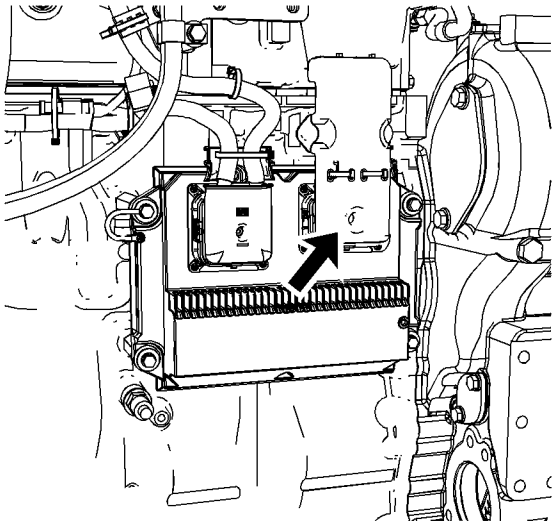


Illustration 103 g01186024

Location of the J1/P1 ECM connectors (typical left side engine view)

B. Thoroughly inspect the J1/P1 ECM connectors and the connectors for each switch. Also inspect each of the machine connectors that are in the circuit. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

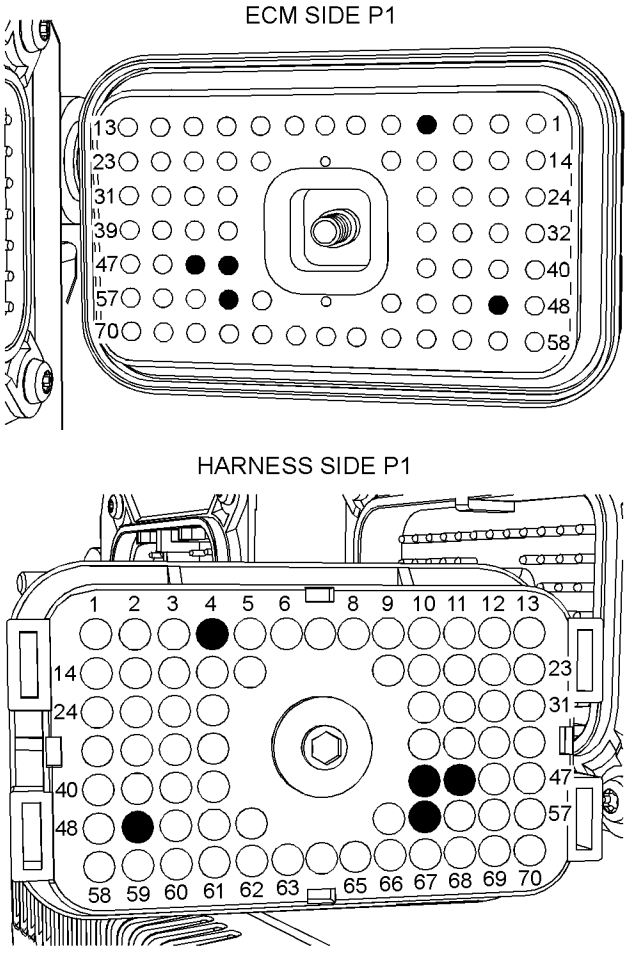


Illustration 104 g01243962

Terminal locations at the P1 ECM connector for the switch circuits

(P1-5) Digital return
(P1-49) Retarder switch (N/C)
(P1-54) Retarder switch (N/O)

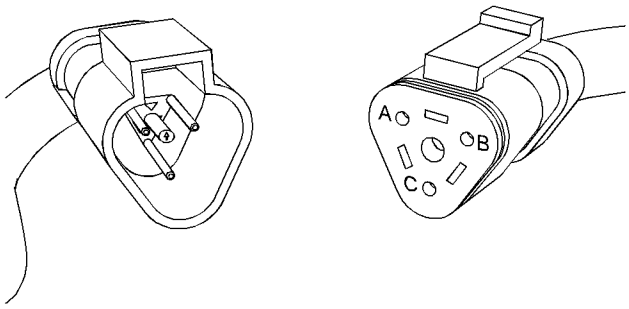


Illustration 105 g01195660

Connector for the retarder switch

(A) Retarder switch (N/C)
(B) Digital return
(C) Retarder switch (N/O)

C. Perform a 45 N (10 lb) pull test on each of the wires for the suspect switch.

D. Check the torque of the allen head screw on each of the ECM connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points from the switch back to the ECM.

Expected Result:

Allof the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and the connectors appear to be OK.Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or wiring.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore the electrical power to the engine ECM.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

C. Check the “Active Diagnostic Codes” screen for an active code that relates to one of the switches. Toggle the suspect switch as you monitor Cat ET for the active diagnostic code.

D. Remove electrical power from the engine ECM.

Expected Result:

A diagnostic code that is related to one of the switches is not active.

Results:

- OK – A diagnostic code that is related to one of the switches does not become active.

  Repair: The switches are operating normally. There may be an intermittent problem in the wiring harness or in a connector. Check the wiring harness and the connectors for an intermittent electrical problem. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – A diagnostic code that is related to one of the switches is active.Proceed to Test Step 3.

Test Step 3. Create a short at the Connector for the Suspect Switch and Check for Diagnostic Codes

A. Disconnect the connectors for the suspect switch.

B. Fabricate a jumper wire that is long enough to connect two terminals at the connector for the suspect switch. Crimp a connector pin to both ends of the jumper wire.

C. Install the jumper wire between the terminals for switch (N/C) and digital return on the harness side of the connector for the suspect switch.

D. Restore the electrical power to the engine ECM.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

E. Check the “Active Diagnostic Codes” screen on Cat ET for an active code that relates to the suspect switch.

Also use Cat ET to check the status of the switch. The correct switch status will be “Released” .

F. Remove electrical power from the engine ECM.

G. Install the jumper wire between the terminal for switch (N/O) and digital return on the harness side of the connector for the suspect switch.

H. Restore the electrical power to the engine ECM.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

I. Check the “Active Diagnostic Codes” screen on Cat ET for an active code that relates to the suspect switch.

Also use Cat ET to check the status of the switch. The correct switch status will be “Depressed” .

J. Remove electrical power from the engine ECM.

Expected Result:

There are no active diagnostic codes and the switch status is correct.

Results:

- OK – There are no active diagnostic codes and the switch status is correct.

  Repair: There is a problem with the switch. Replace the switch. Verify that the problem is resolved.

  STOP.

- Not OK – There is either an active diagnostic code or the switch status is incorrect.The switch is OK. There is a problem in the harness between the connector for the suspect switch and the ECM. There may be a problem with the ECM. Proceed to Test Step 4.

Test Step 4. Check the ECM for Proper Operation

A. Disconnect the J1/P1 ECM connectors.

B. Fabricate a jumper wire that is long enough to connect two terminals locations at the ECM connector. Crimp a connector socket to both ends of the jumper wire.

C. Remove the wires from the terminal locations that are for switch (N/C), switch (N/O), and digital return at the P1 ECM connector. Install the jumper wire between the terminal locations for switch (N/C) and digital return at the P1 ECM connector.

D. Connect the J1/P1 ECM connectors.

E. Restore the electrical power to the engine ECM.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

F. Check the “Active Diagnostic Codes” screen on Cat ET for an active code that relates to the suspect switch.

Also use Cat ET to check the status of the switch. The correct switch status will be “Released” .

G. Remove electrical power from the engine ECM.

H. Disconnect the J1/P1 ECM connectors.

I. Remove the jumper wire from the terminal location for switch (N/C) at the P1 ECM connector.

J. Install the loose end of the jumper wire into the terminal location for switch (N/O) at the P1 ECM connector.

K. Connect the J1/P1 ECM connectors.

L. Restore the electrical power to the engine ECM.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

M. Check the “Active Diagnostic Codes” screen on Cat ET for an active code that relates to the suspect switch.

Also use Cat ET to check the status of the switch. The correct switch status will be “Depressed” .

N. Remove electrical power from the engine ECM.

Expected Result:

There are no active diagnostic codes and the switch status is correct.

Results:

- OK – There are no active diagnostic codes and the switch status is correct.

  Repair: There is a problem in the wiring harness between the connector for the suspect switch and the ECM connector. Check the machine wiring harnesses and the connectors for an open circuit or a short circuit. Repair the wiring and/or the connectors. Replace parts, if necessary. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – There is either an active diagnostic code or the switch status is incorrect.

  Repair: The ECM is not detecting the switch inputs correctly. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02430749

Throttle Position Sensor Circuit - Test

SMCS Code: 1439-038; 1913-038

System Operation Description:

Use this procedure to troubleshoot the system when a 91-08 Throttle Position Signal abnormal is active.

The throttle position sensor provides the throttle signal to the Electronic Control Module (ECM).

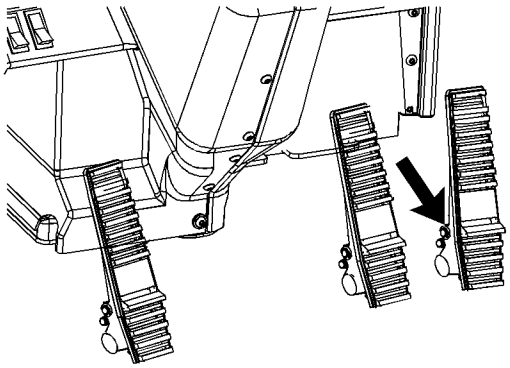


Illustration 106 g01193730

Mounting location of the throttle position sensor on the throttle pedal (typical example)

The throttle position sensor is mounted to a pedal assembly that allows the operator to control the speed of the engine. The geometry of the pedal assembly controls both the travel of the sensor and the range of the output signal. The throttle position sensor cannot be adjusted.

The output from the throttle position sensor is a PWM signal that varies with the position of the throttle pedal. The throttle position sensor produces a minimum duty cycle in the released position and a maximum duty cycle in the fully depressed position. When the pedal is released, the ECM translates the sensor's output signal to a throttle position of 0 percent. When the pedal is fully depressed, the ECM translates the output signal to a throttle position of 100 percent.

The throttle position sensor is powered by 8.0 ± 0.4 VDC that is provided by the ECM. A digital return for the sensor is also provided by the ECM.

The ECM uses an automatic calibration function that allows the ECM to minimize the deadband of the sensor. The automatic calibration function assumes a range of PWM duty cycle at powerup. If the duty cycle of the sensor exceeds this initial range, the automatic calibration function adjusts the limits of the duty cycle in order to adjust for the new range.

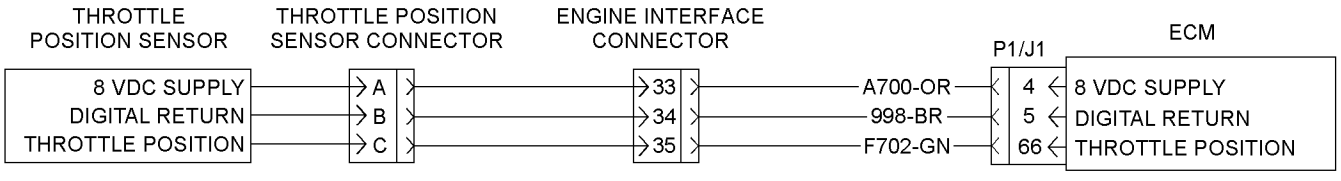


Illustration 107 g01214470

Schematic for throttle position sensor

A. Turn the keyswitch to the OFF position.

Test Step 1. Inspect the Electrical Connectors and the Wiring

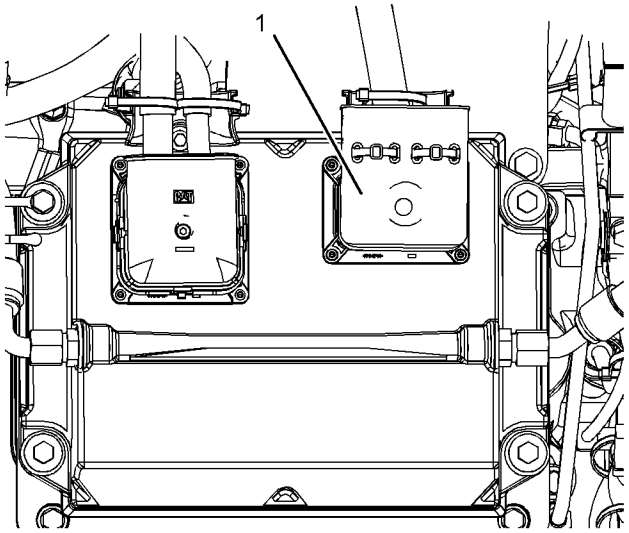


Illustration 108 g01167488

Location of the J1/P1 ECM connectors (typical engine view)

(1) J1/P1 ECM connectors

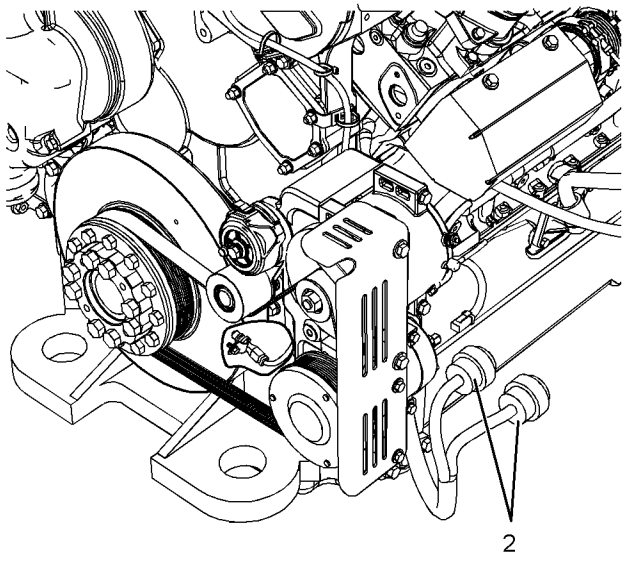


Illustration 109 g01213916

Location of the engine interface connectors (typical left side engine view)

(2) engine interface connectors

B. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect the connector for the throttle position sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

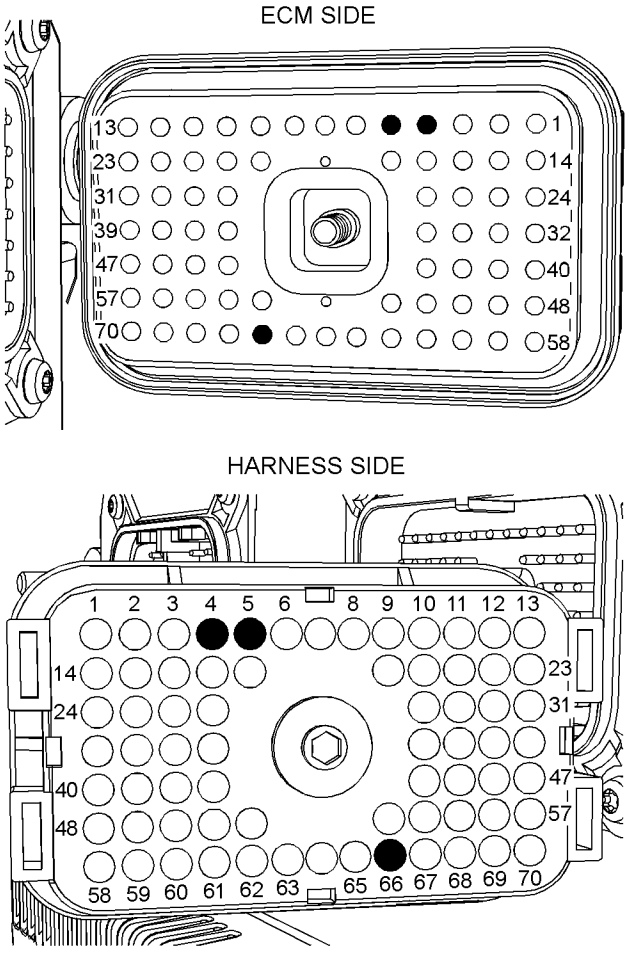


Illustration 110 g01214474

P1 ECM connector

(P1-4) 8 VDC supply
(P1-5) Digital return
(P1-66) Throttle position

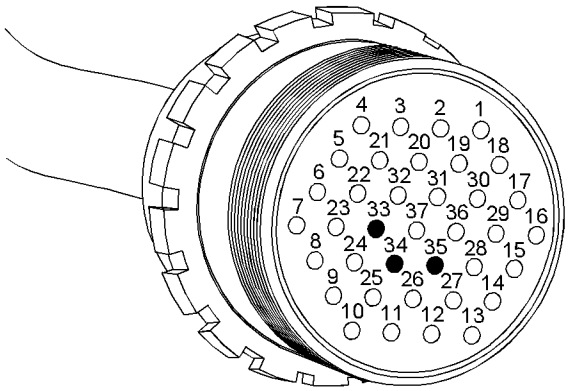


Illustration 111 g01214475

Terminal locations at the engine interface connector for the throttle position sensor

(Terminal 33) 8 VDC supply
(Terminal 34) Digital return
(Terminal 35) Throttle position

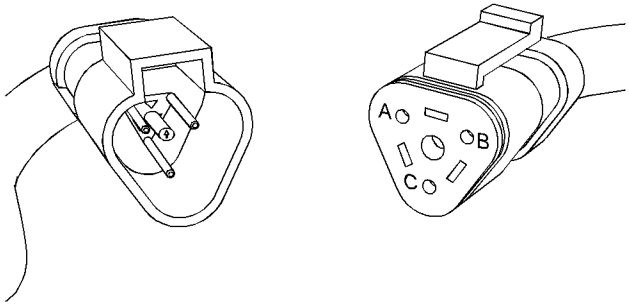


Illustration 112 g01159881

Terminal locations for the throttle position sensor

(Terminal A) 8 V supply
(Terminal B) Digital return
(Terminal C) Throttle position

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the connector for the throttle position sensor.

D. Check the allen head screw from each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All of the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and connectors appear to be OK.Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP. STOP

Test Step 2. Inspect the Throttle Pedal Assembly

A. Inspect the throttle pedal assembly for components that are loose, bent, missing, or worn.

B. Slowly depress the pedal and release the pedal.

Expected Result:

The throttle pedal assembly operates smoothly without excessive drag. The pedal springs back smoothly to the LOW IDLE position without assistance.

Results:

- OK – The throttle pedal assembly functions properly.The throttle pedal assembly is OK. Proceed to Test Step 3.
- Not OK – The throttle pedal assembly is in poor repair.

  Repair: There is excessive drag or improper operation of the throttle pedal assembly. Repair the throttle pedal assembly or replace the throttle pedal assembly, as required.

  STOP.

Test Step 3. Check the Status for “Throttle Position” on Cat ET

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Observe the status for “Throttle Position” on Cat ET while you operate the throttle pedal through the entire range of travel.

Expected Result:

The status is zero percent when the throttle pedal is released. The status progressively increases to 100 percent when the throttle pedal is fully depressed.

Results:

- OK – The throttle position sensor is working properly.

  Repair: The original problem seems to be resolved. There may be an intermittent electrical problem with the harness or the connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” if the problem is intermittent.

  STOP.

- Not OK – The throttle position that is displayed on Cat ET is questionable.Proceed to Test Step 4.

Test Step 4. Check the Supply Voltage at the Sensor

A. Turn the keyswitch to the OFF position.

B. Disconnect the harness connector for the throttle position sensor.

C. Turn the keyswitch to the ON position.

D. Measure the voltage across terminal A (8 V supply) and terminal B (digital return) on the harness side of the connector.

E. Turn the keyswitch to the OFF position.

Expected Result:

The supply voltage measures 8.0 ± 0.4 VDC at the sensor connector.

Results:

- OK – The correct voltage is measured at the sensor connector.The sensor is receiving the correct supply voltage. Proceed to Test Step 5.

- Not OK – The voltage is not correct at the sensor connector.

  Repair: There may be a problem with the digital sensor supply. Refer to Troubleshooting, “Digital Sensor Supply Circuit - Test” for information that is related to troubleshooting the digital supply circuit.

  STOP.

Test Step 5. Check the Signal Frequency and the Duty Cycle at the Sensor

A. Remove the wire from terminal location C (throttle position) on the harness side of the connector for the throttle position sensor.

B. Install a 7X-6370 Adapter Cable As (3-PIN BREAKOUT) at the connector for the throttle position sensor.

C. Connect the connector for the throttle position sensor.

D. Turn the keyswitch to the ON position.

E. Measure the frequency and the duty cycle between terminal B (digital return) and terminal C (throttle position) at the 7X-6370 Adapter Cable As (3-PIN BREAKOUT) while you operate the throttle pedal.

F. Turn the keyswitch to the OFF position.

G. Remove the breakout harness. Restore the wiring for the harness connector to the original configuration.

Expected Result:

The frequency is between 150 and 1000 Hz. The duty cycle is between 7 and 95 percent.

Results:

- OK – The frequency and the duty cycle are within specifications for the entire range of the pedal.The sensor is producing a valid signal. Proceed to Test Step 6.

- Not OK – The frequency and the duty cycle are not within specifications.

  Repair: The sensor is not producing a valid signal. Replace the throttle position sensor. Verify that the repair eliminates the problem.

  STOP.

Test Step 6. Check the Signal Frequency and the Duty Cycle at the ECM

A. Disconnect the J1/P1 ECM connectors.

B. Remove the wire from terminal location P1-66 (throttle position) at the ECM connector.

C. Install a 208-0059 Adapter Cable As (70-PIN BREAKOUT) between the J1 and the P1 ECM connectors.

D. Connect the J1/P1 ECM connectors.

E. Turn the keyswitch to the ON position.

F. Measure the frequency between the loose signal wire (throttle position) and P1-5 (digital return) on the breakout harness while you operate the throttle pedal.

G. Set the multimeter to read the duty cycle of the sensor. Measure the duty cycle between the loose signal wire (throttle position) and P1-5 (digital return) on the breakout harness while you operate the throttle pedal.

H. Turn the keyswitch to the OFF position.

Expected Result:

The frequency is between 150 and 1000 Hz. The duty cycle is between 7 percent and 95 percent.

Results:

- OK – The frequency and the duty cycle are within specifications for the entire range of the pedal.

  Repair: A valid signal appears at the ECM, but the ECM is not reading the signal properly. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM” for complete instructions. Verify that the repair eliminates the problem.

  STOP.

- Not OK – The frequency and the duty cycle are not within specifications.

  Repair: There is a valid signal in the isolated circuit between the sensor and the sensor connector, but there is not a valid signal at the ECM connector. The problem is in the harness wiring or in a connector between the ECM and the harness connector for the throttle position sensor. Repair the harness and/or the connectors. Replace parts, if necessary. Verify that the repair eliminates the problem.

  STOP.

Calibration Procedures

i02940248

Engine Cooling Fan - Calibrate

SMCS Code: 1386-524

System Operation Description:

Use this procedure if a 1551-13 Engine Demand Fan System : Calibration Required is active.

This code indicates that the cooling fan system has not been calibrated.

The wiring from the Electronic Control Module (ECM) to the engine cooling fan does not include a feedback circuit in order to detect the speed of the cooling fan. For this reason, the speed of the engine cooling fan needs to be calibrated. The following procedure is performed in order to calibrate the current that is sent to the solenoid for the engine cooling fan from the ECM.

During the calibration, a 1U-6602 Photo-Tachometer is used in order to determine the actual speed of the fan. The current to the solenoid is adjusted using Caterpillar Electronic Technician (ET). The ECM uses a min/max setting to provide the correct offset for the entire speed range of the cooling fan.

Ensure that the following conditions are met before the calibration procedure is performed:

- The parking brake is engaged.
- The engine speed is set to high idle.
- The engine coolant temperature is at least 75 °C (167 °F).
- No diagnostic codes are active.

Use Cat ET to Calibrate the Fan Speed

A. Ensure that the keyswitch is in the OFF position.

B. Secure a strip of reflective tape to the fan in a place that is convenient for use of the photo-tachometer.

C. Connect the 1U-6602 Photo-Tachometer. Refer to Tool Operating Manual, NEHS0554 for information that is related to the operation of the photo-tachometer.

D. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

E. Turn the keyswitch to the ON position.

F. Start the engine. Set the engine speed to high idle.

G. Select the following menu options on Cat ET:

- “Service”
- “Calibration”
- “Engine Cooling Fan Calibration”

H. Follow the instructions that are provided:

a. Ensure that both of the min/max settings for the desired fan speed in Cat ET match the reading that is provided by the photo-tachometer.

Expected Result:

The desired fan speed in Cat ET matches the speed that is reported by the photo-tachometer. The engine cooling fan speed is calibrated.

Results:

- OK – The engine cooling fan speed is calibrated.

  STOP. STOP

- Not OK – The engine cooling fan speed is not calibrated. Perform the calibration procedure again.

  Repair: If Cat ET is not communicating with the ECM refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

  STOP. STOP

i02348860

Engine Speed/Timing Sensor - Calibrate

SMCS Code: 1439-524; 1912-524

System Operation Description:

Use this procedure if a 261-13 Engine Timing Calibration required is active.

Also use this procedure if any of the following conditions exist:

- The Electronic Control Module (ECM) has been replaced.
- The ECM software has been updated.
- The front gear group has been serviced.

The ECM has the ability to calibrate the mechanical differences between the Top Center (TC) of the No. 1 piston and the orientation of the camshaft. The ECM uses the signal from the primary engine speed/timing sensor as a control reference that identifies the exact orientation of the crankshaft. The ECM uses the signal that is detected from the secondary engine speed/timing sensor to identify the exact orientation of the camshaft.

The two signals are then used by the ECM to calculate a timing offset. The offset is used by the ECM to calibrate the signal from the secondary engine speed/timing sensor.

Note: A timing calibration will not increase the available engine power.

Test Step 1. Check for Active Diagnostic Codes

A. Turn the keyswitch to the OFF position.

B. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

C. Turn the keyswitch to the ON position.

D. Check for any active diagnostic codes.

Expected Result:

No active diagnostic codes are present.

Results:

- OK – No active diagnostic codes are present.If a timing calibration is necessary due to service to the ECM or to the front gear train, proceed to Test Step 2.
- Not OK – 261-13 Engine Timing Calibration required is the only active diagnostic code that is present.Proceed to Test Step 2.
- Not OK – There are active diagnostic codes. A 261-13 is not one of the active diagnostic codes.

  Repair: Troubleshoot the active diagnostic codes. Make the necessary repairs.

  STOP.

- Not OK – A 261-13 and other active diagnostic codes are present.

  Repair: Make the necessary repairs in order to resolve the active diagnostic codes. The 261-13 Engine Timing Calibration required may remain active while the repairs are made.
  Repeat Test Step 1.

Test Step 2. Calibrate the Engine Speed/ Timing Sensor

A. Start the engine. Run the engine until the engine has exited cold mode operation.

B. After the engine has warmed up, access the “Timing Calibration” screen on Cat ET. Access the following display screens in order:

- “Service”
- “Calibrations”
- “Timing Calibration”

C. To calibrate the timing to the correct setting, set the engine speed to 1100 ± 50 rpm and select “Continue” on Cat ET. Wait until Cat ET indicates that the timing is calibrated.

D. Press the “Continue” button on Cat ET. Wait until Cat ET indicates that the ECM has calculated the timing reference.

Note: If Cat ET displays “Calibration Unsuccessful” , the electronic injection timing has not been calibrated.

Expected Result:

The timing calibration was successful.

Results:

- OK – The timing calibration was successful.

  Repair: Return the engine to service.

  STOP.

- Not OK – The timing calibration was unsuccessful.

  Repair: The following conditions can cause the timing calibration to fail:

  - If the crankshaft and camshaft gears have been reassembled incorrectly, the timing will not calibrate.
  - Verify that the engine speed/timing sensors are installed correctly.
  - Verify that the engine speed is correct and that the engine speed is stable. If the engine speed is unstable, refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable”.

  If a problem with the engine speed/timing sensors is suspected, refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

STOP.

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RENR9317
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RENR9217-55 (en-us)
January 2021

Disassembly and Assembly

C27 and C32 Engines for Caterpillar Built Machines

HPE 1-UP (Engine)
LJW 1-UP (Engine)
EHX 1-UP (Engine)
MZM 1-UP (Engine)
LJX 1-UP (Engine)
PZB 1-UP (Engine)
NZG 1-UP (Engine)
FZS 1-UP (Engine)
NZT 1-UP (Engine)
MJX 1-UP (Engine)
JA4 1-UP (Engine)
TC9 1-UP (Engine)
DLT 1-UP (Engine)
NZK 1-UP (Engine)
WZH 1-UP (Engine)
JHM 1-UP (Engine)
TZC 1-UP (Engine)
TZD 1-UP (Engine)
TZB 1-UP (Engine)
TZR 1-UP (Engine)
TZR 1-UP (Engine)
JZP 1-UP (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

NOTICE

When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

Disassembly and Assembly Section

i03569298

Fuel Filter Base - Remove (C27)

SMCS Code: 1262-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply to the OFF position.

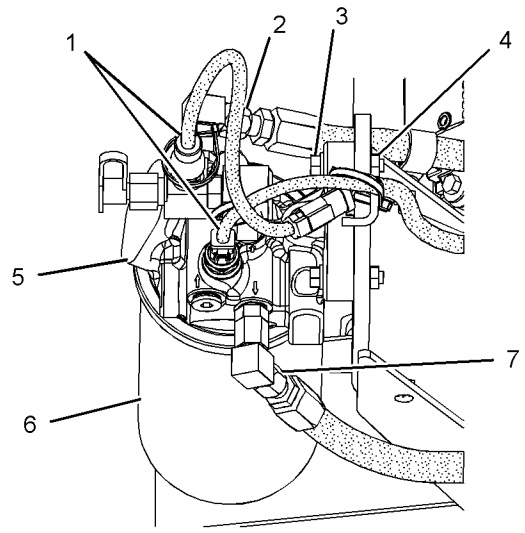


Illustration 1 g01265878

2. Disconnect harness assemblies (1).

3. Disconnect hose assemblies (2) and (7).

4. Use Tooling (A) to remove fuel filter (6) from fuel filter base (5).

5. Remove bolts (3), the washers, and nuts (4). Remove fuel filter base (5).

i03569300

Fuel Filter Base - Remove (C32)

SMCS Code: 1262-011

S/N: NZK1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply to the “OFF” position.

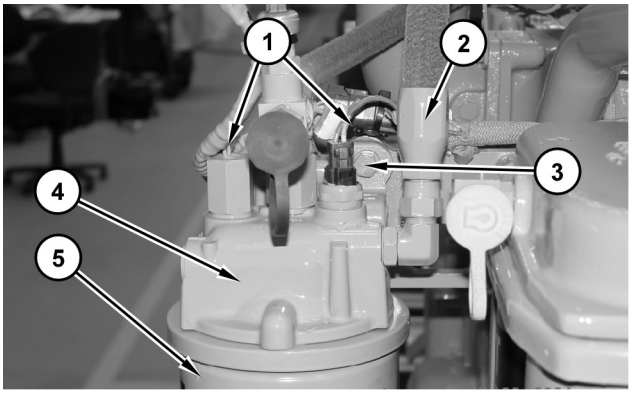


Illustration 2 g01143681

2. Disconnect harness assemblies (1).

3. Disconnect hose assemblies (2).

4. Use Tooling (A) to remove fuel filter (5) from fuel filter base (4).

5. Remove bolts (3). Remove fuel filter base (4).

i03569309

Fuel Filter Base - Install (C27)

SMCS Code: 1262-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

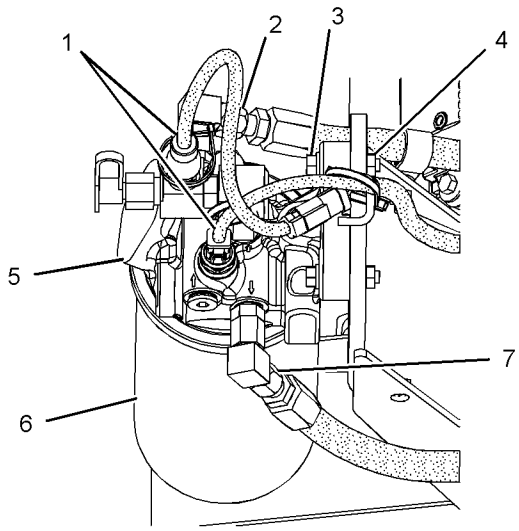


Illustration 3 g01265878

1. Position fuel filter base (5) on the engine.

2. Install bolts (3), the washers, and nuts (4).

3. Install fuel filter (6) on fuel filter base (5).

4. Connect hose assemblies (2) and (7).

5. Connect harness assemblies (1).

6. Turn the fuel supply to the “ON” position.

i03569319

Fuel Filter Base - Install (C32)

SMCS Code: 1262-012

S/N: NZK1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

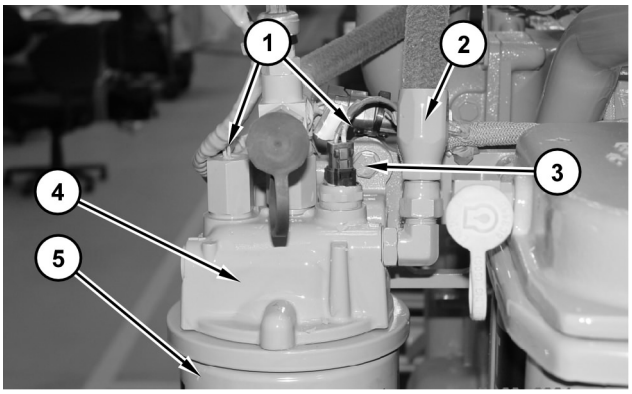


Illustration 4 g01143681

1. Position fuel filter base (4) on the engine.

2. Install bolts (3).

3. Install fuel filter (5) on the fuel filter base.

4. Connect hose assemblies (2).

5. Connect harness assemblies (1).

6. Turn the fuel supply to the “ON” position.

i05768549

Fuel Lines - Remove and Install

SMCS Code: 1250-010; 1252-010; 1274-010

Remove Nonmetallic Fuel Lines

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

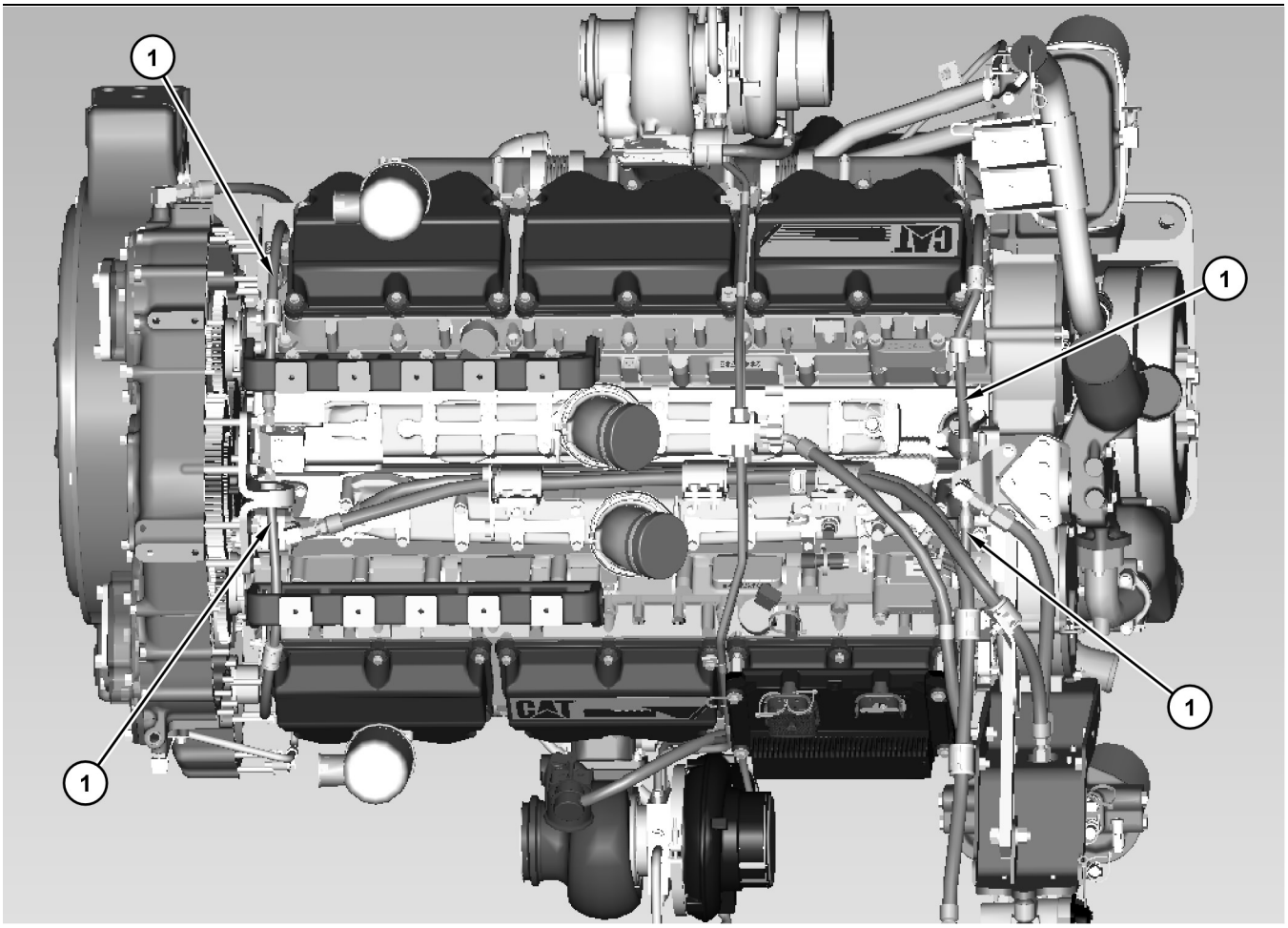


Illustration 5 g02257273

1. Mark fuel lines (1) for reinstallation purposes. Remove fuel lines (1).

2. If any hoses are worn or damaged, replace with new parts.

Reference: Refer to the Operation and Maintenance Manual for information on when to replace the fuel lines.

Install Nonmetallic Fuel Lines

Note: During installation, ensure that the hoses do not contact nearby parts. Pressure pulsations in these hoses cause the hoses to flex. Inadvertent contact with nearby surfaces will produce chafing/ abrasion damage that could eventually lead to a leak. A properly installed hose will contact only the hose clips.

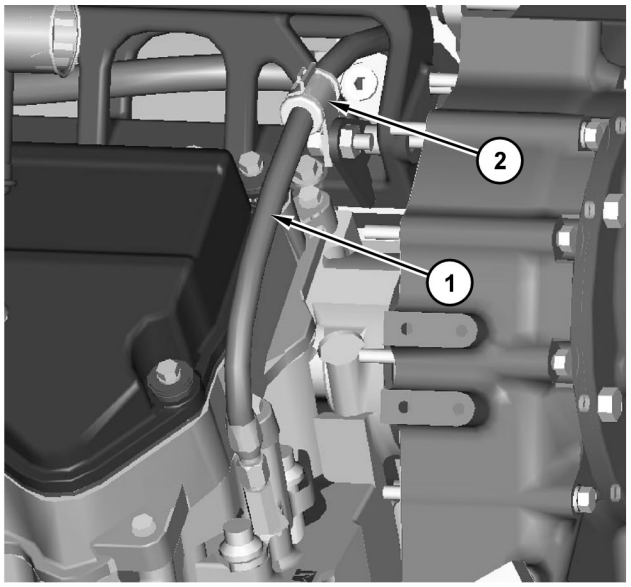


Illustration 6 g02233899

Rear Left Side View - Hose Length = 475 mm (18.7 inch)

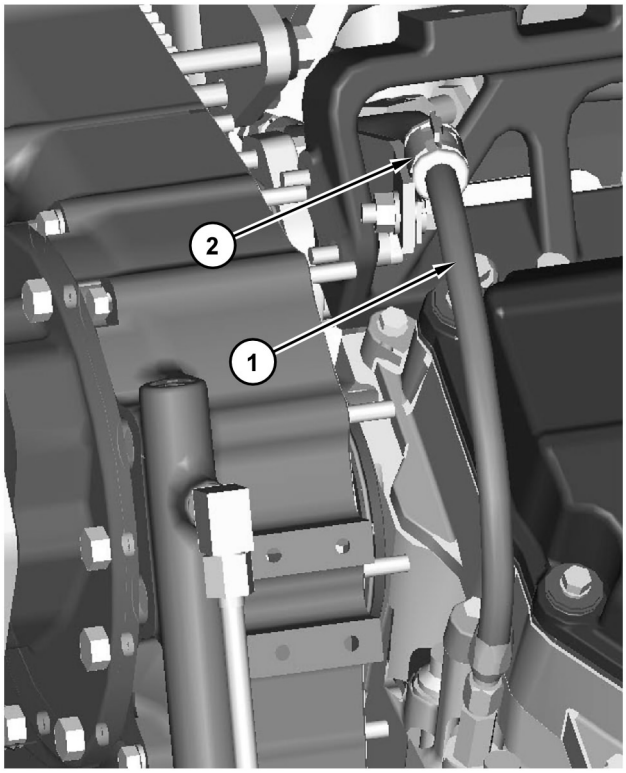


Illustration 7 g02233901

Rear Right Side View - Hose Length = 620 mm (24.4 inch)

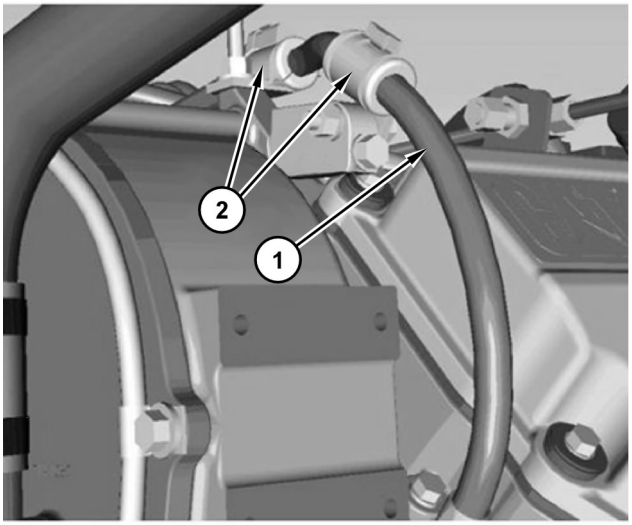


Illustration 8 g02233898

Front Left Side View - Hose Length = 581 mm (22.9 inch)

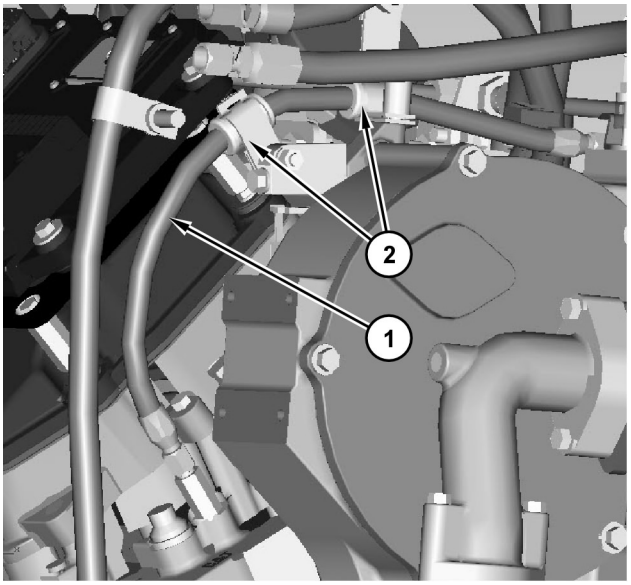


Illustration 9 g02257014

Front Right Side View - Hose Length = 581 mm (22.9 inch)

1. Install fuel lines (1).

2. Loosely install clips (2). Position fuel lines (1) so that there is no contact with any other surfaces. Tighten clips (2). Tighten fuel lines using standard torque.

Best Practices for Installing Nonmetallic Fuel Lines

Use the following best practices for proper fuel line installation and maintenance.

1. Do not twist the hose when installing, allow the hose to find the natural position.

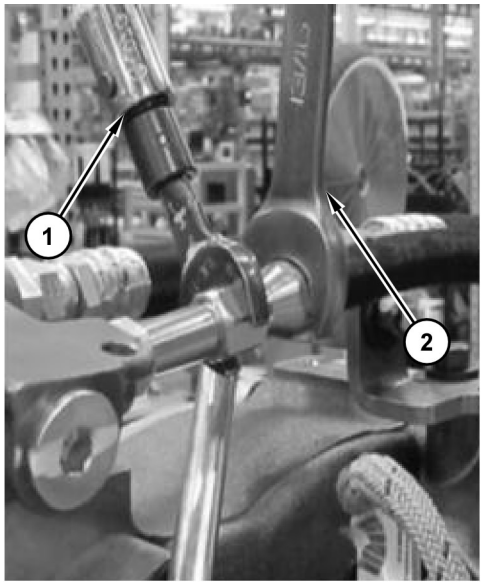


Illustration 10 g03659618

(1) Torque wrench
(2) Back-up wrench

2. When torquing hose fittings, use a back-up wrench to prevent twisting as in Illustration 10 .

3. Use the proper length of hose to prevent the hose being too tight or slack.

4. Keep the bending radius of the hose as large as possible to prevent kinking.

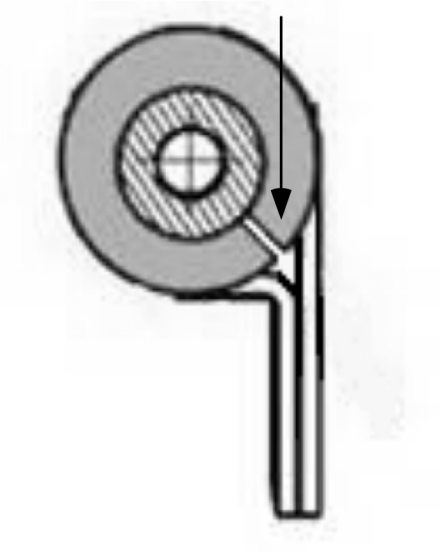


Illustration 11 g03659622



Illustration 12 g03659636

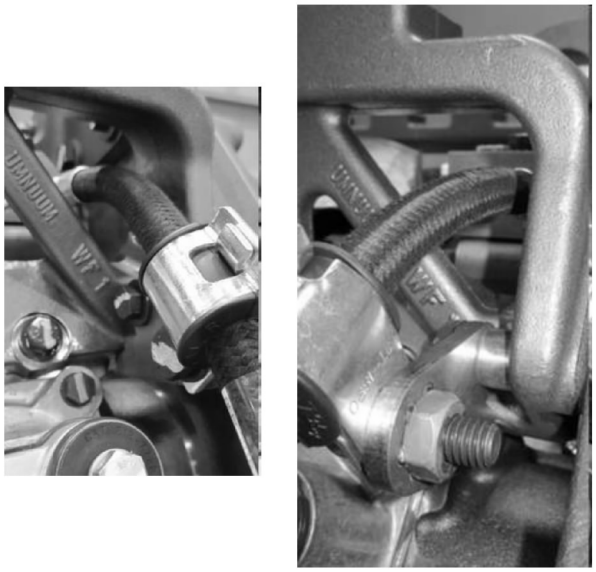


Illustration 13 g03659640

5. Ensure proper alignment of the grommets when installed in the fuel line clips as shown in Illustration 12 . Proper alignment of the opening of the grommet with the mating faces of the clips ensures proper clamp load.

6. Clips should support the natural position of the fuel line and guide routing as in Illustration 13 . Clips should not create strain on the fuel hoses.

7. Use the proper torque to all line fasteners and connectors.

8. Recheck all fuel lines after completing installation to look for contact with surrounding components. Fuel lines should only be in contact with rubber grommets and at the termination points.

Note: All third-party installations must meet prescribed installation guidelines. Third-party components must not come in contact with Caterpillar components.

9. Inspect fuel lines, grommets, and mounting hardware every 500 hours. Refer to the Operation and Maintenance Manual maintenance schedule for replacement intervals of fuel system lines and components.

Note: Certain components such as the side covers will need to be removed to conduct a proper inspection of fuel lines and components.

The following illustrations below show proper line, clip, and grommet alignment to allow for sufficient clearance from other components. Proper alignment creates gentle bends that guide fuel lines to the termination points.



Illustration 14 g03659643



Illustration 15 g03659647



Illustration 16 g03659650



Illustration 17 g03659652

i02285574

Fuel Transfer Pump - Remove

SMCS Code: 1256-011

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply to the “OFF” position.

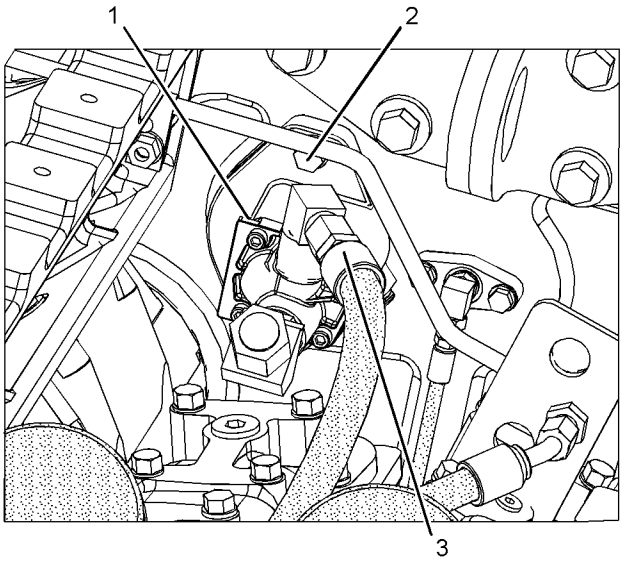


Illustration 18 g01143748

2. Disconnect hose assemblies (3).

3. Remove bolts (2).

4. Remove fuel transfer pump (1) and the O-ring seal.

i02287501

Fuel Transfer Pump - Install

SMCS Code: 1256-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

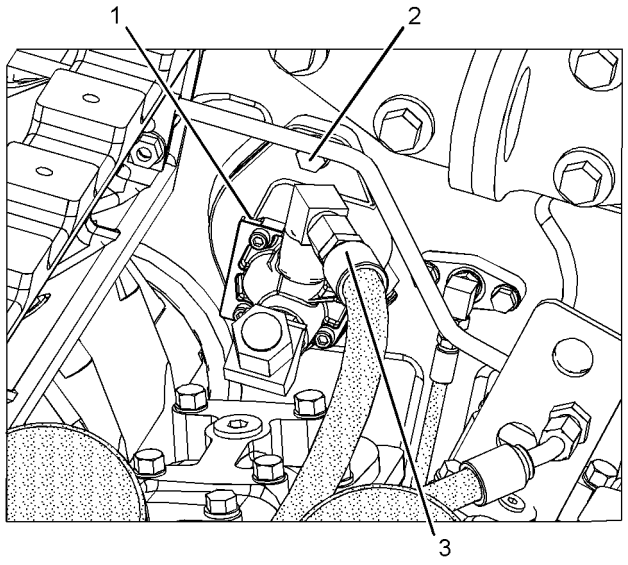


Illustration 19 g01143748

1. Install the O-ring seal on fuel transfer pump (1). Lubricate the O-ring seal with clean engine oil.

2. Position fuel transfer pump (1) on the engine. Install bolts (2).

3. Connect hose assemblies (3).

4. Turn the fuel supply to the “ON” position.

i07773530

Fuel Pressure Regulator - Remove and Install

SMCS Code: 1715-010

S/N: FZS1–Up

Removal Procedure

Start By:

a. Remove the fuel transfer pump.

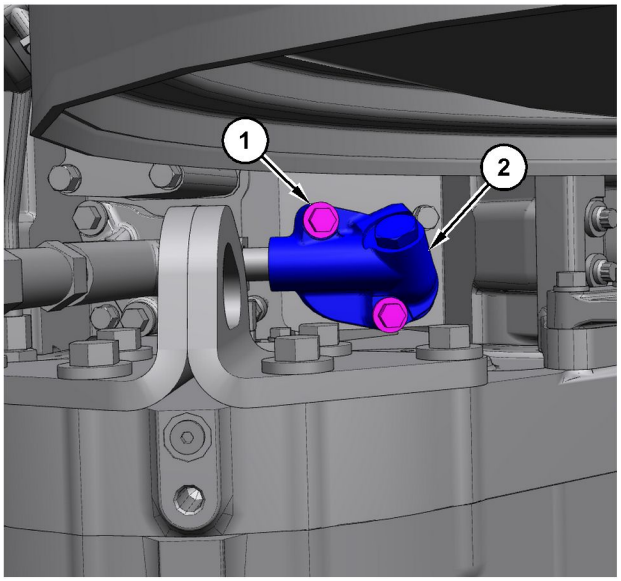


Illustration 20 g06430914

1. Remove bolts (1) and manifold (2).

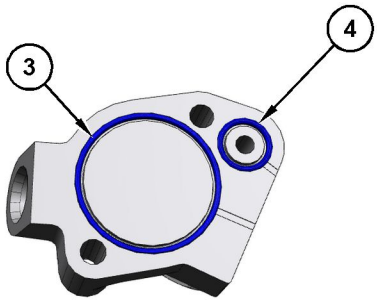


Illustration 21 g06430920

2. Remove O-rings (3) and (4).

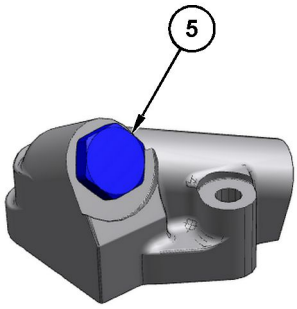


Illustration 22 g06430922

3. Remove check valve (5).

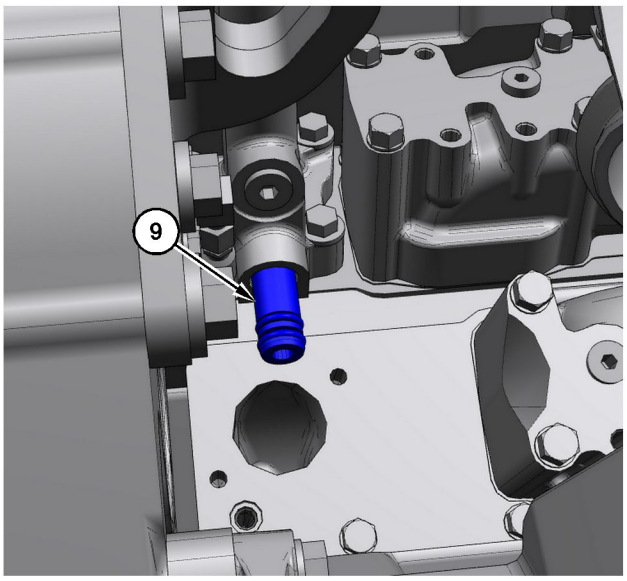


Illustration 24 g06430931

5. Remove tube (9).

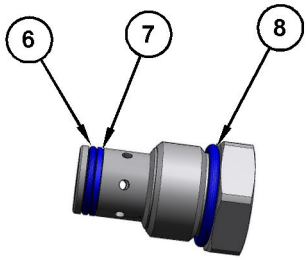


Illustration 23 g06430924

4. Remove O-ring seal (6), backup ring (7), and O-ring seal (8).

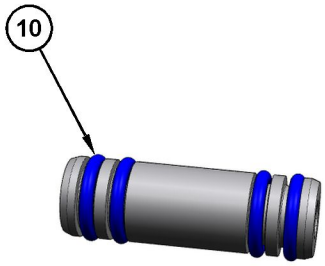


Illustration 25 g06430933

6. Remove O-ring seals (10).

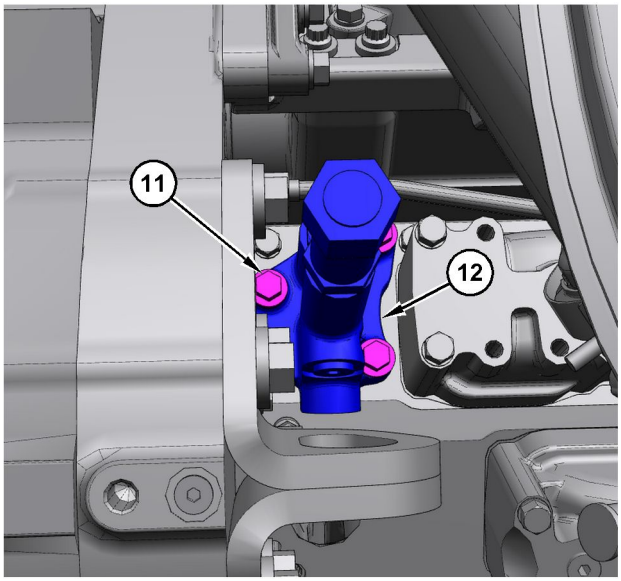


Illustration 26 g06430938

7. Remove bolts (11) and manifold (12).

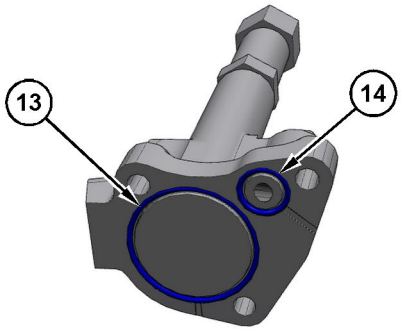


Illustration 27 g06430944

8. Remove O-ring seals (13) and (14).

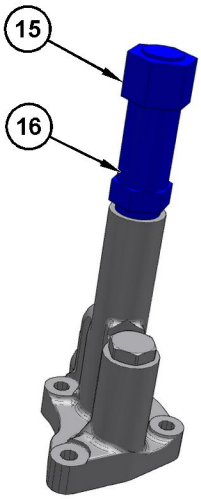


Illustration 28 g06430952

9. Remove cap assembly (15) and connector (16).

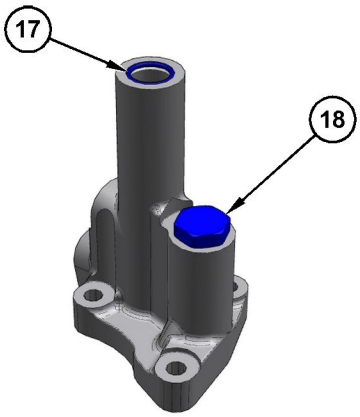


Illustration 29 g06430955

10. Remove O-ring seal (17) and check valve (18).

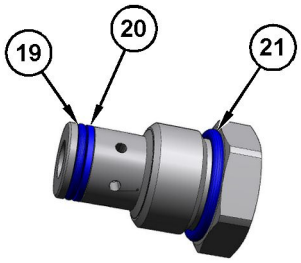


Illustration 30 g06430961

11. Remove O-ring seal (19), backup ring (20), and O-ring seal (21).

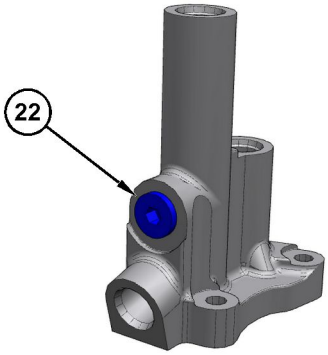


Illustration 31 g06430965

12. Remove plug (22).

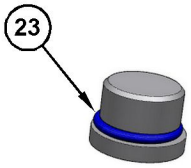


Illustration 32 g06430971

13. Remove O-ring seal (23).

Installation Procedure

1. Install manifolds (2) and (12) in the reverse order of removal.

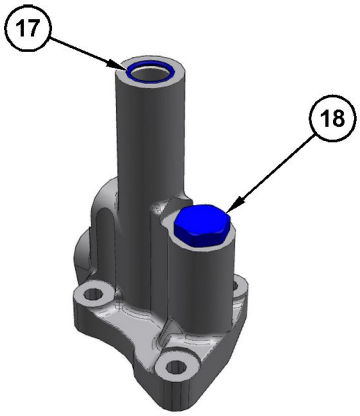


Illustration 33 g06430955

Note: Lubricate bore lighting with fluid being sealed.

2. Install new O-ring seal (17) and check valve (18). Tighten check valve (18) to a torque of 28 ± 3 N·m (21 ± 2 lb ft).

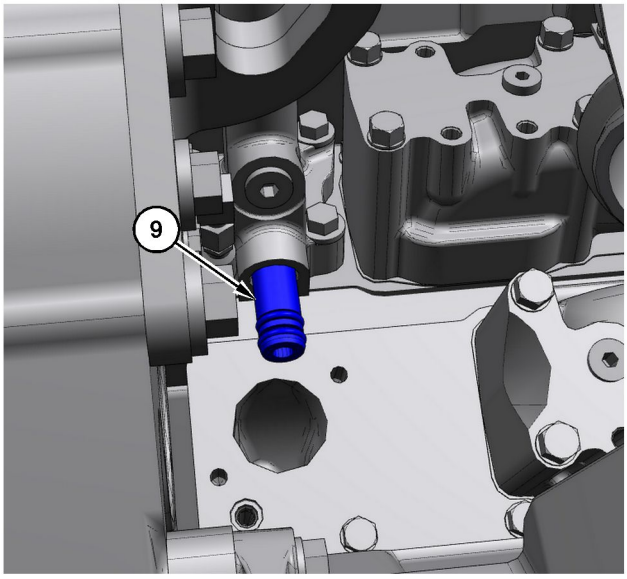


Illustration 34 g06430931

Note: Lubricate bore lighting with fluid being sealed.

3. Install tube (9).

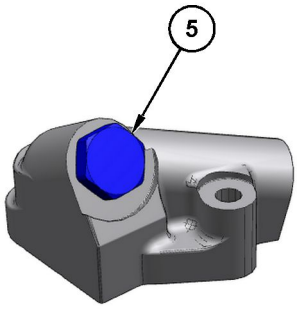


Illustration 35 g06430922

Note: Lubricate bore lighting with fluid being sealed.

4. Install check valve (5). Tighten check valve (5) to a torque of 28 ± 3 N·m (21 ± 2 lb ft).

End By:

a. Install the fuel transfer pump.

i04164632

Electronic Unit Injector - Remove

SMCS Code: 1290-011

Removal Procedure

Table 3

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5F-4764	Pry Bar	1

Start By:

a. Remove the rocker arms and the rocker arm shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

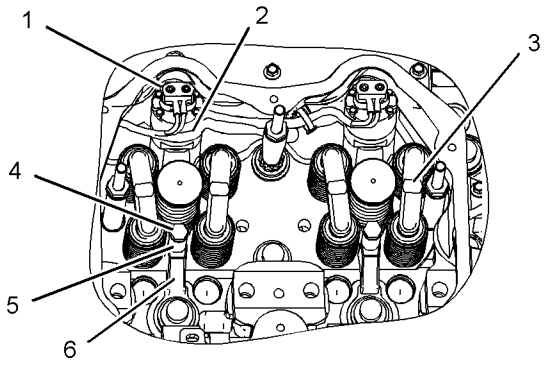


Illustration 36 g01114892

1. Disconnect harness assembly (1).

2. Remove bridge assemblies (3).

NOTICE
Do not reuse the injector hold down bolts. New injector hold down bolts must be used.

NOTICE
If the injector hold down bolt is loose during the removal procedure, inspect the injector bore for wear and debris. Replace the clamp and spacer.

3. Remove bolt (4), spacer (5), and clamp (6). Discard bolt (4).

4. Place an identification mark on electronic unit injectors (2) for installation purposes. Each electronic unit injector must be reinstalled in the original location in the cylinder head.

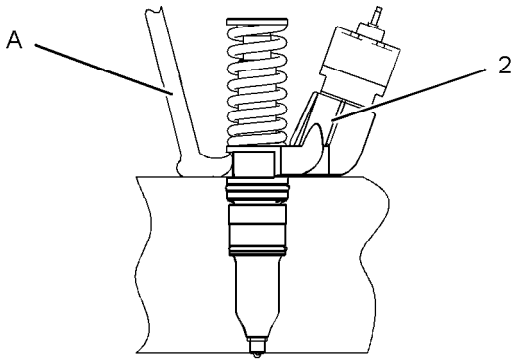


Illustration 37 g01073439

5. Use Tooling (A) to pry beneath the base and free electronic unit injector (2).

6. Remove electronic unit injector (2) from the cylinder head.

i08192796

Electronic Unit Injector - Install

SMCS Code: 1290-012

Installation Procedure

Table 4

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Clean Engine Oil	1
C	1U-5718	Vacuum Pump	1
	169-7372	Fluid Sampling Bottle	1
	4C-4057	Tube 7.9 mm (0.31 inch) OD	1
D	4C-5552	Large Bore Brush	1
E	4C-6774	Vacuum Gun Kit	1

(continued)

(Table 4, contd)

F	8T-7765	Surface Reconditioning Pad	1
G	9U-6862	Tapered Brush	
	9U-7237	Brush Extension	

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (C) to remove the fuel and oil from the cylinder. Evacuate as much fuel and oil as possible from the cylinder before installing the electronic unit injector. Several evacuations may be necessary.

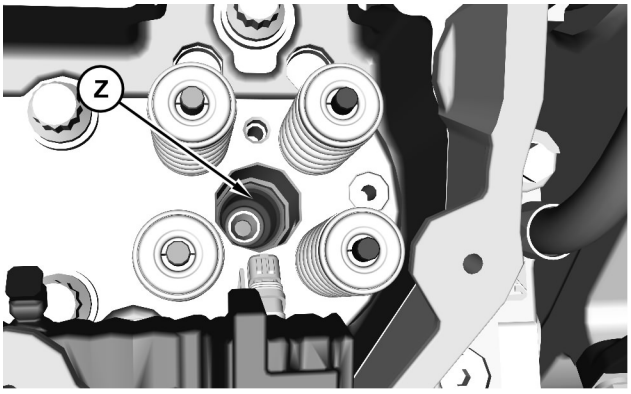


Illustration 38 g03718000

2. Use Tooling (D) to clean the carbon deposit from the inside the electronic unit injector sleeve at Location (Z). Tooling (E) is available to clean loose material from the bore of the electronic unit injector sleeve and the cylinder.

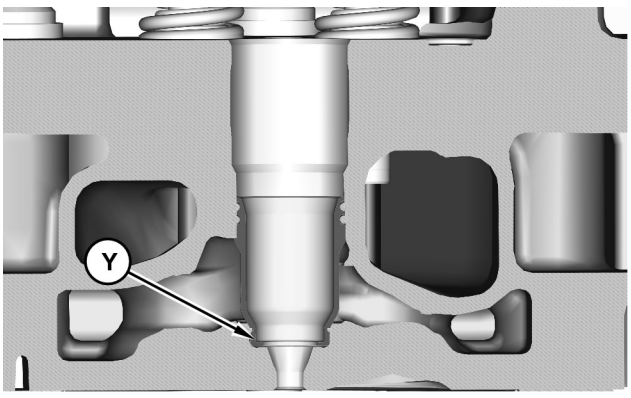


Illustration 39 g03722826

Section view.

3. Use Tooling (F) to clean the carbon from the seat area at location (Y) that is inside the electronic unit injector sleeve.

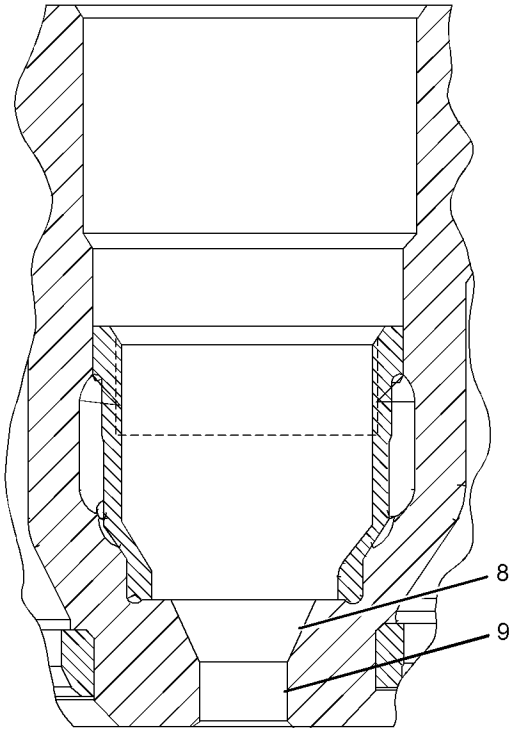


Illustration 40 g03722522

4. Use Tooling (G) to clean injector seating area (8) and injector tip bore (9).

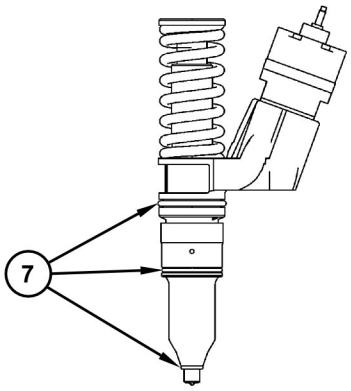


Illustration 41 g03718585

5. Use a lint free material to clean O-ring seals (7) and electronic unit injector (2).

6. Lubricate the top two O-ring seals (7) with Tooling (A). Do not use any other lubricant.

Note: Once O-ring seals (7) are lubricated, install immediately.

Note: Do not reuse O-ring seals (7).

Note: O-ring seals (7) must be stored properly to prevent contamination.

7. Install O-ring seals (7) on the electronic unit injector.

Note: Caution must be taken to avoid overstretching the O-ring seals (7).

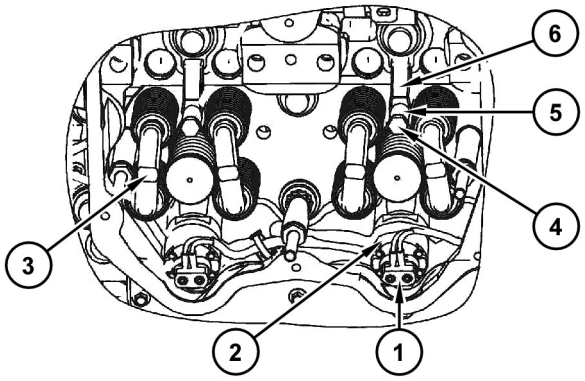


Illustration 42 g03729389

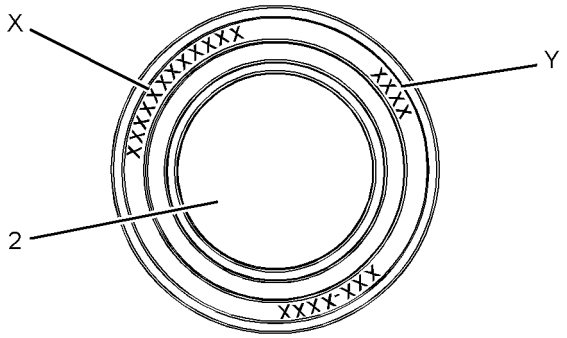


Illustration 43 g01135876

8. When you install a new injector, the E-Trim value must be programmed into the engine control module. The injector confirmation code may need to be programmed into the engine control module. E-Trim Value (X) is a 12-digit alphanumeric code that is supplied with the data sheet that comes with the new injectors. Injector Confirmation Code (Y) is a four-digit numeric code. Both of the codes are on the top of electronic unit injector (2). Use the following menu to program the E-Trim value.

- ECM Summary Screen
- Service Menu
- Calibration
- Injector Code Calibration

NOTICE
When an electronic unit injector is replaced, the new electronic injector code must be programmed into the engine's personality module software by using the calibration menu on the Electronic Service Tool. If the new electronic injector code is not entered, the characteristics of the previous electronic unit injector is assumed.

If it is not possible to immediately reprogram the electronic injector code into the personality module software, the engine will not be severely harmed. The new electronic injector code should be reprogrammed as quickly as possible in order to optimize engine performance.

9. Assemble electronic unit injector (2) with the clamp (6), spacer (5), and new bolt (4). Position electronic unit injector (2) in the injector bore.

Note: Caution must be used to avoid damaging O-ring seals (7) are not damaged when positioning electronic unit injector (2) in the injector bore.

Note: Do not push or manually force electronic unit injector into the bore.

10. Tighten bolt (4) to a torque of 55 ± 10 N·m (41 ± 7 lb ft). Ensure that electronic unit injector (2) is aligned in the bore while tightening bolt (4).

Note: Tighten bolt (4) at a slow and uniform rate. If a pneumatic or electric tool is used, care must be taken to avoid damage to the O-ring due to quickly seating the injector.

Note: Tightening bolt (4) to correct torque will properly seat electronic unit injector (2).

11. Inspect area around the bore for electronic unit injector (2) to ensure that O-ring seals (7) were not damaged or extruded.

12. Install bridge assemblies (3).

13. Connect harness assembly (1). Tighten the nuts to a torque of 2.5 ± 0.25 N·m (22 ± 2 lb in).

End By:

a. Install the rocker arms and the rocker arm shaft.

i06729616

Electronic Unit Injector Sleeve - Remove

SMCS Code: 1713-011

Removal Procedure

Table 5

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6891	Injector Tool Group	1

Start By:

a. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

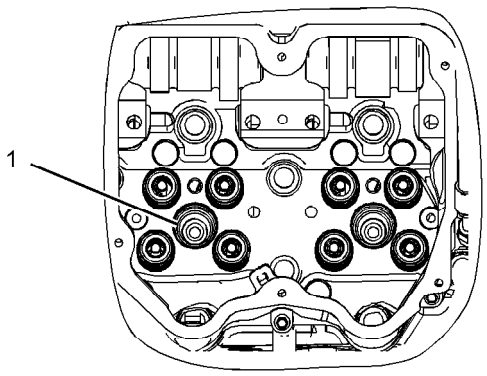


Illustration 44 g01043124

2. Install Tooling (A) in electronic unit injector sleeve (1).

3. Tighten the nut on Tooling (A) until the electronic unit injector sleeve is pulled free of the cylinder head.

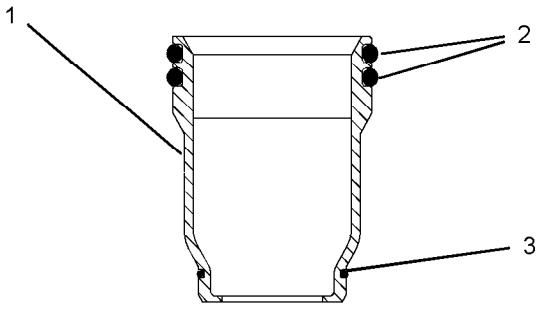


Illustration 45 g01073635

4. Remove O-ring seals (2) and O-ring seal (3) from electronic unit injector sleeve (1).

i06745960

Electronic Unit Injector Sleeve - Install

SMCS Code: 1713-012

Installation Procedure

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6891	Injector Tool Group	1
B	9U-6862	Tapered Brush	1
	9U-6863	Small Bore Brush	1
	9U-7244	End Brush	1
	9U-7237	Brush Extension	1
	4C-5552	Large Bore Brush	1
C		Loctite 620 Retaining Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (B) to clean the bore in the cylinder head for the electronic unit injector sleeve.

NOTICE
Ensure that the electronic unit injector sleeve and the cylinder head bore are completely free of oil, dirt, and sealant debris.

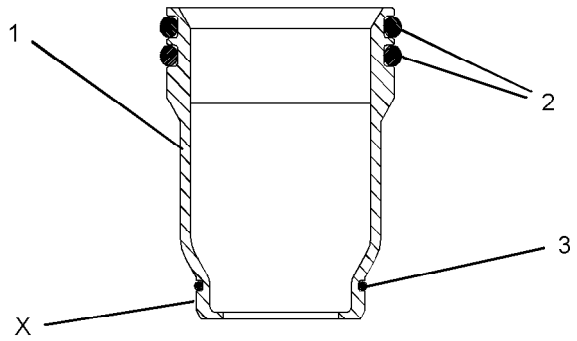


Illustration 46 g01043165

2. Install new O-ring seals (2) and O-ring seal (3) on electronic unit injector sleeve (1).

3. Apply Tooling (C) to the contact surface of electronic unit injector sleeve (1) on the surface that is Marked “X” .

Note: Do not apply Tooling (C) to the cylinder head surfaces. Apply Tooling (C) on the electronic unit injector sleeve only.

4. Lubricate O-ring seals (2) with clean engine oil.

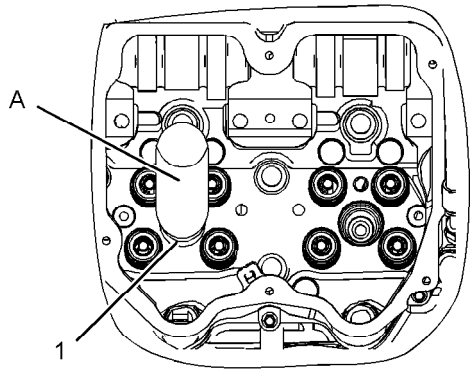


Illustration 47 g01099549

5. Install electronic unit injector sleeve (1) on Tooling (A). Position the electronic unit injector sleeve in the cylinder head. Use care not to damage the O-ring seals on the electronic unit injector sleeve. Use Tooling (A) and a hammer to install the electronic unit injector sleeve in the cylinder head.

NOTICE
Ensure that the electronic unit injector sleeve is properly seated in the cylinder head. The Tooling will "RING" when the electronic unit injector sleeve is fully seated in the bore of the cylinder head.

6. Remove Tooling (A). Remove excess Tooling (C).

7. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.

i05806728

Turbocharger - Remove

SMCS Code: 1052-011

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

Note: Cleanliness is an important factor. Before the removal procedure, thoroughly clean the exterior of the component. Cleaning the exterior of the component will prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes to prevent fluid loss and to keep contaminants from entering the system.

⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant from the cooling system into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change”.

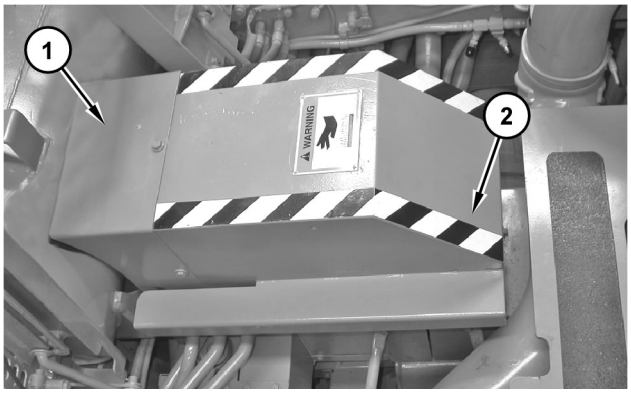


Illustration 48 g02567456

2. Move cover (1) aside.

3. Remove four bolts (2).

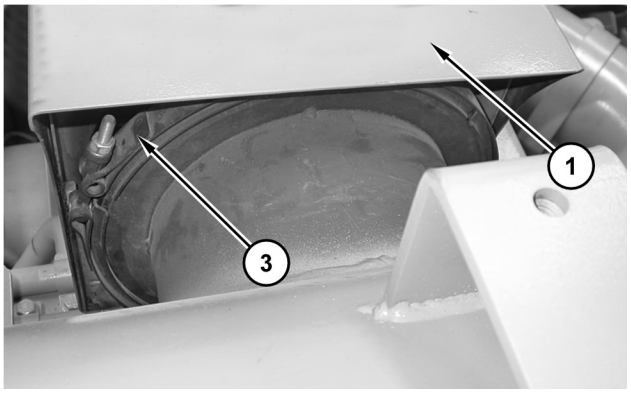


Illustration 49 g02567457

4. Remove clamp (3) below cover (1).

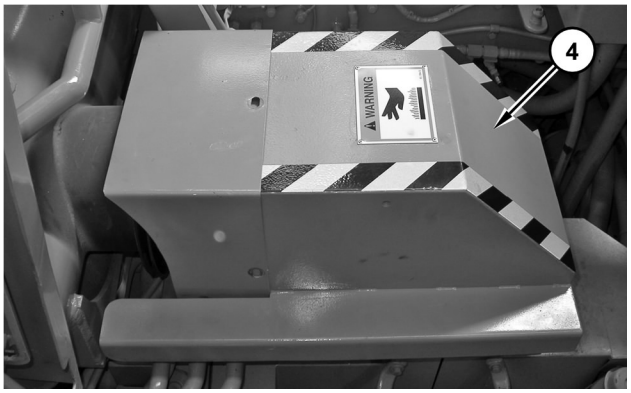


Illustration 50 g02567476

5. Using two people, remove tube assembly (4). The weight of tube assembly (4) is approximately 27 kg (60 lb).



Illustration 51 g02567477

6. Remove cover (5).

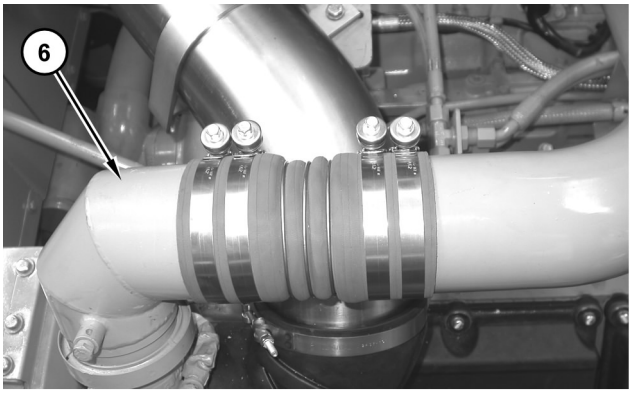


Illustration 52 g02592358

7. Disconnect elbow (6) from the turbocharger.

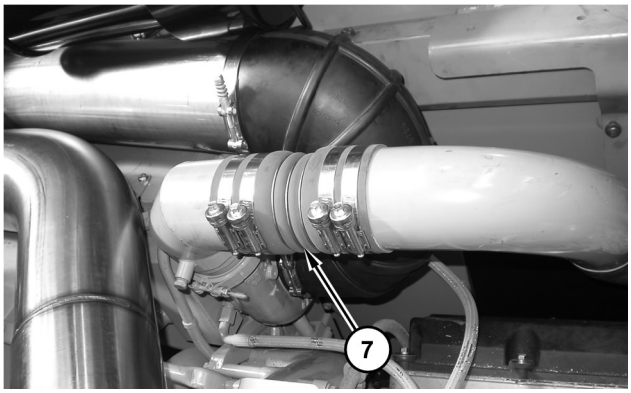


Illustration 53 g02592359

8. Loosen the clamps and disconnect hose (7) from the elbow.

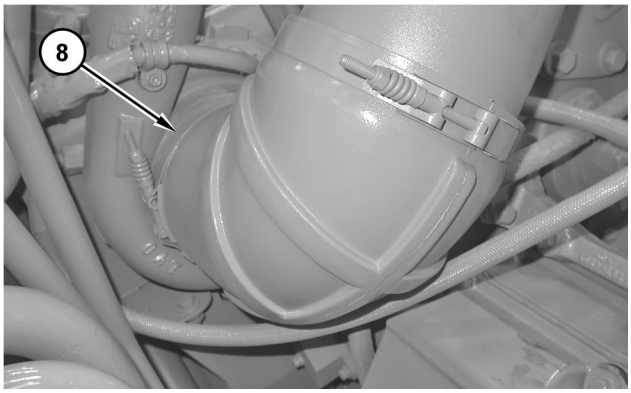


Illustration 54 g02567478

9. Loosen clamp (8).

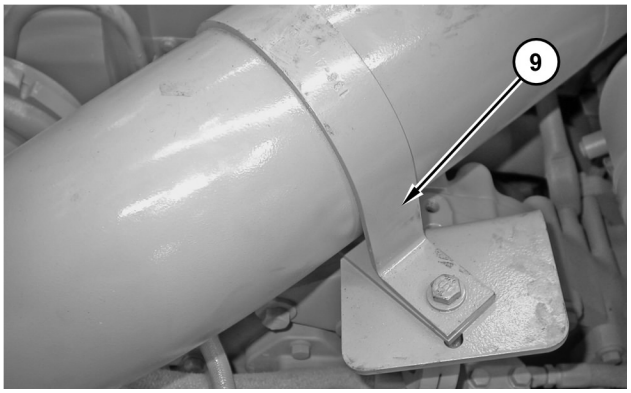


Illustration 55 g02567479

10. Remove clamp assembly (9).

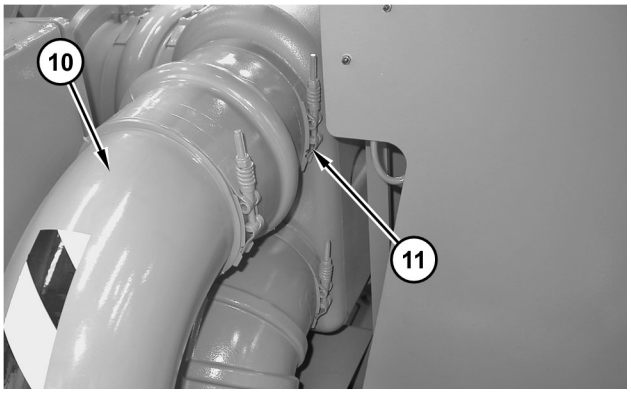


Illustration 56 g02567480

11. Loosen clamp (11) and remove tube assembly (10).

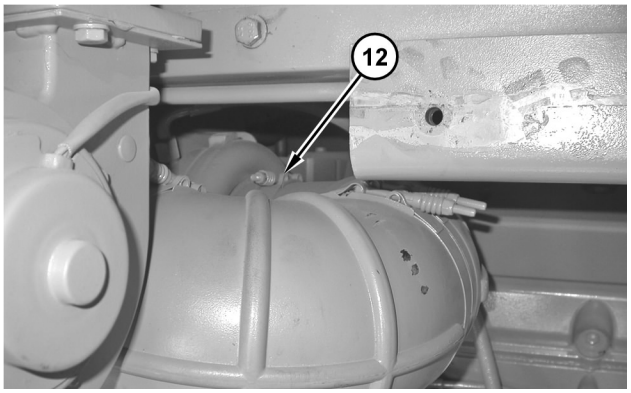


Illustration 57 g02567481
Typical example

12. Loosen clamp (12).



Illustration 58 g02567482

13. Loosen clamp (13) and remove tube assembly (14).

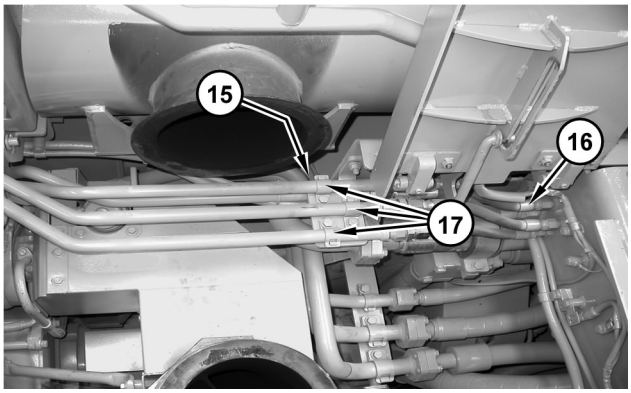


Illustration 59 g02569976
Typical example

14. Disconnect four hose assemblies (16). Remove three clamp assemblies (17) and clamp assembly (15) (not shown).

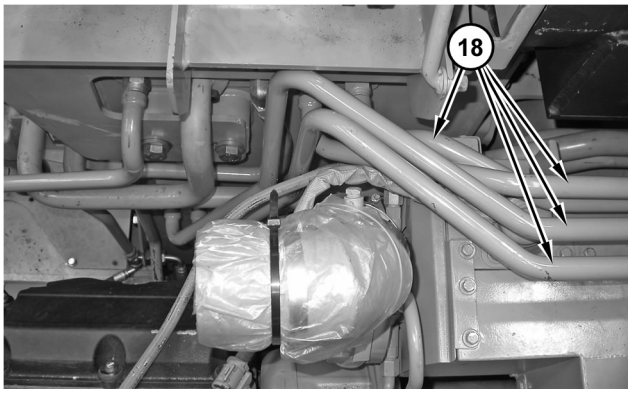


Illustration 60 g02569977
Typical example

15. Remove four tube assemblies (18).

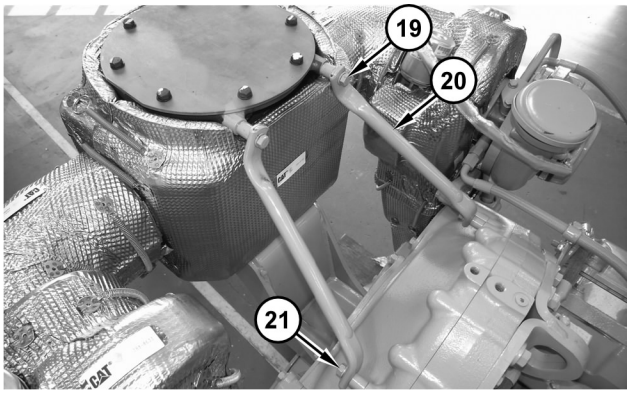


Illustration 61 g03293957

16. Remove two bolts (19) and the spacers.

17. Loosen two bolts (21) and move support brackets (20) out the way.

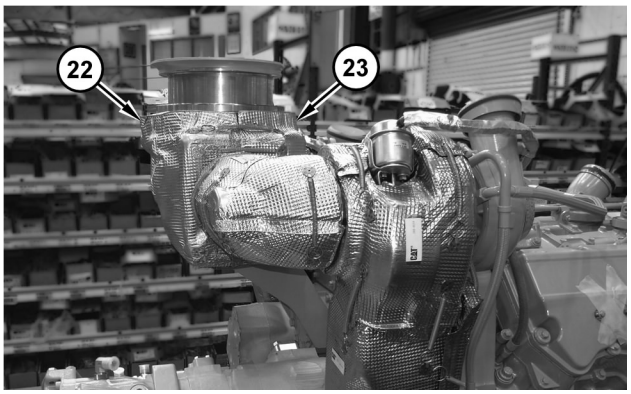


Illustration 62 g03293976

18. Remove cover (22) and cover (23).

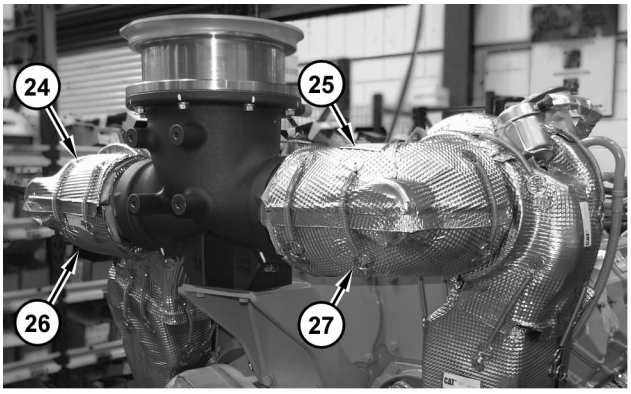


Illustration 63 g03293979

19. Remove cover (24), cover (25), cover (26) and cover (27).

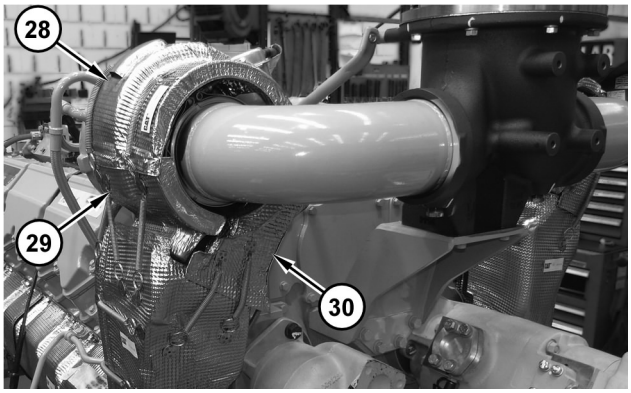


Illustration 64 g03293981
View of the left side turbocharger

20. Remove cover (28), cover (29), and cover (30).

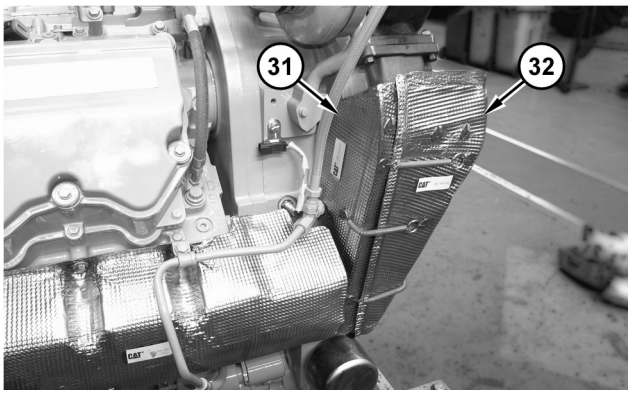


Illustration 65 g03293997
View of the left side turbocharger

21. Remove cover (31) and cover (32).

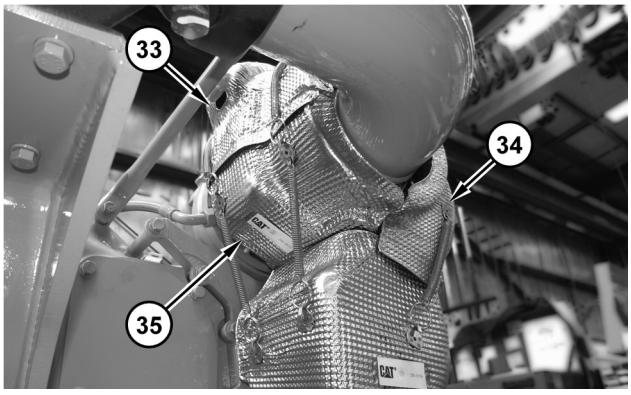


Illustration 66 g03294016
View of the right side turbocharger

22. Remove cover (33), cover (34), and cover (35).

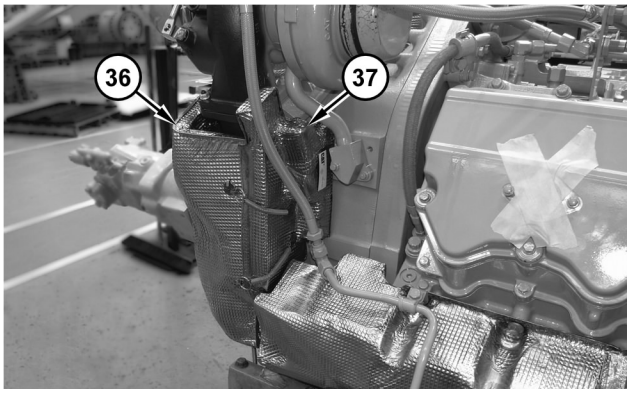


Illustration 67 g03294036
View of the right side turbocharger

23. Remove cover (36) and cover (37).

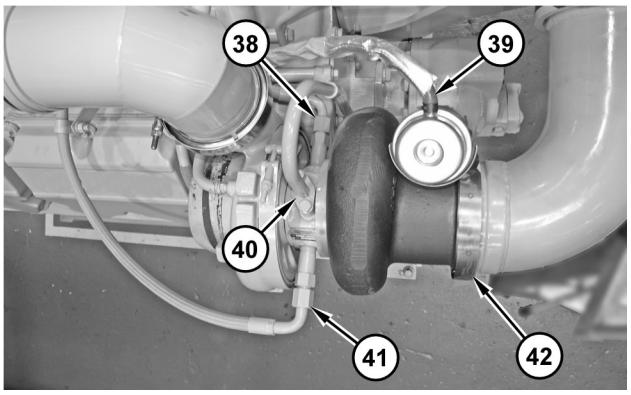


Illustration 68 g03294077
View of the left side turbocharger

24. Disconnect hose assembly (38), hose (39), and hose assembly (41).

25. Disconnect tube assembly (40).

26. Loosen clamp (42).

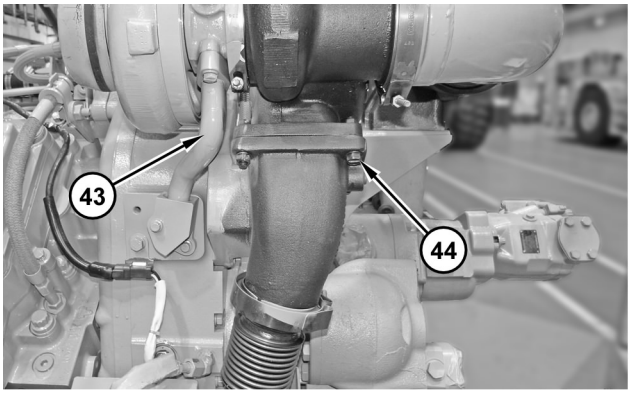


Illustration 69 g02592339
View of the left side turbocharger

27. Remove tube (43).

28. Remove four bolts (44) and the nuts.

Note: Before you remove the two turbochargers, mark the location of the turbochargers and the orientation of the turbochargers for installation purposes.

29. Using two people, remove the turbocharger. The weight of the turbocharger is approximately 24 kg (53 lb).

30. Repeat Step 24 through 29 for the right side turbocharger.

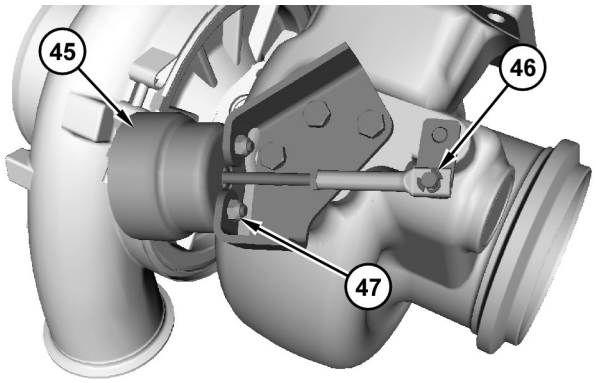


Illustration 70 g03401977

Typical Example

31. Remove clip (46) and actuator nuts (47). Remove actuator can (45).

i05807235

Turbocharger - Remove

SMCS Code: 1052-011

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

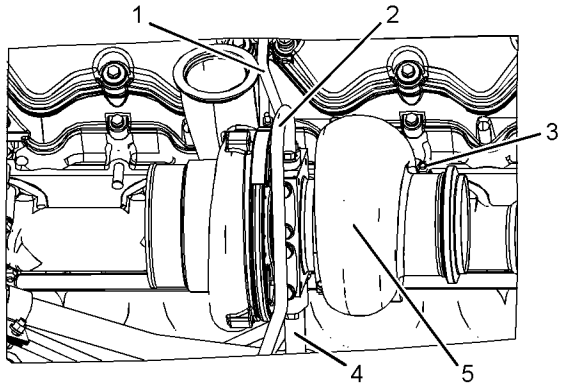


Illustration 71 g01145002

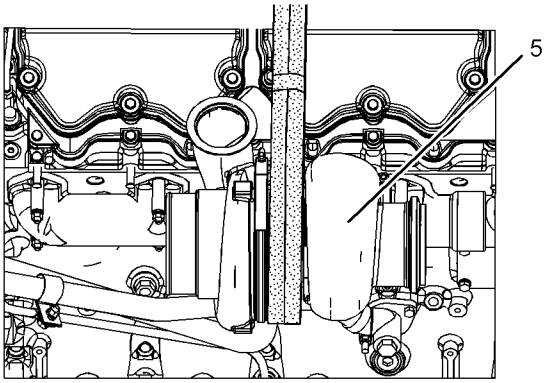


Illustration 72 g01148173

2. Remove tube assembly (2).

3. Disconnect tube assemblies (1) and tube assembly (4).

Note: Before you remove the turbocharger, mark the location and the orientation of the turbocharger for installation purposes.

4. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 45 kg (100 lb).

5. Remove nuts (3). Remove turbocharger (5) and the gasket.

i02287870

Turbocharger - Disassemble

SMCS Code: 1052-015

Disassembly Procedure

Start By:

a. Remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

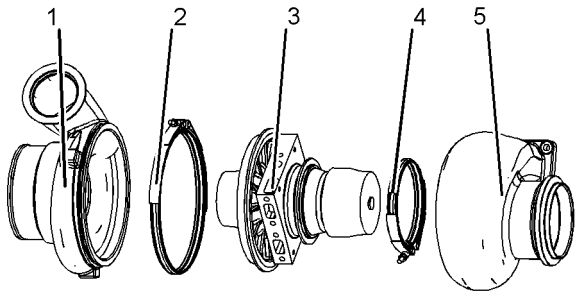


Illustration 73 g01145263

1. Loosen V-band clamp (2) and V-band clamp (4).

2. Separate compressor housing (1) from turbocharger cartridge (3).

3. Separate turbine housing (5) from turbocharger cartridge (3).

i05826359

Turbocharger - Disassemble

SMCS Code: 1052-015

S/N: TZC1–Up

S/N: HPE1–Up

S/N: JHM1–Up

S/N: TZR1–Up

Disassembly Procedure

Start By:

a. Remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

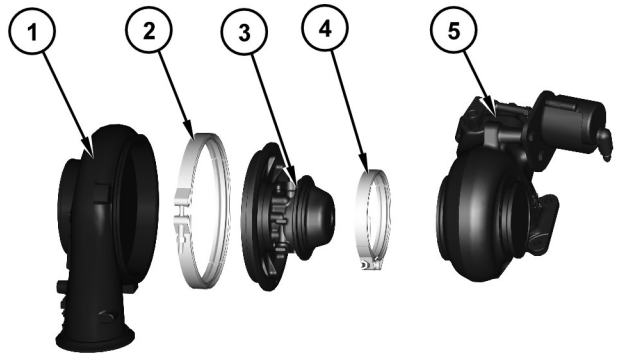


Illustration 74 g03686981

1. Loosen V-band clamp (2) and V-band clamp (4).

2. Separate compressor housing (1) from turbocharger cartridge (3).

3. Separate turbine housing (5) from turbocharger cartridge (3).

i02451256

Turbocharger - Assemble

SMCS Code: 1052-016

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
The compressor housing must remain straight with the turbocharger cartridge during disassembly and assembly. Tilting may cause damage to the tips of the compressor wheel and the compressor shaft.

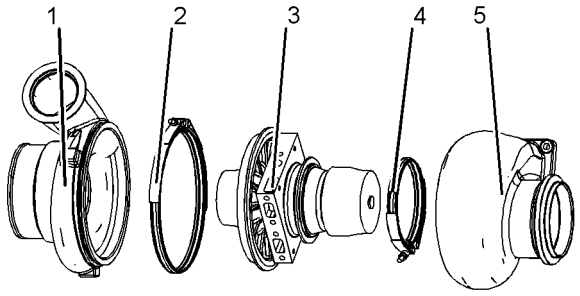


Illustration 75 g01145263

1. Position compressor housing (1) and turbine housing (5) on turbocharger cartridge (3).

Note: Ensure that the mating surfaces are flush.

2. Tighten the nuts on V-band clamp (2) to a torque of 14 ± 1 N·m (10 ± 1 lb ft). Use a soft hammer to lightly hit around the diameter of the band clamp. Tighten the nuts again to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

3. Tighten the nuts on V-band clamp (4) to a torque of 14 ± 1 N·m (10 ± 1 lb ft). Use a soft hammer to lightly hit around the diameter of the band clamp. Tighten the nuts again to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

4. Ensure that the impeller spins freely.

End By:

a. Install the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Install”.

i05826371

Turbocharger - Assemble

SMCS Code: 1052-016

S/N: TZC1–Up

S/N: HPE1–Up

S/N: JHM1–Up

S/N: TZR1–Up

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
The compressor housing must remain straight with the turbocharger cartridge during disassembly and assembly. Tilting may cause damage to the tips of the compressor wheel and the compressor shaft.

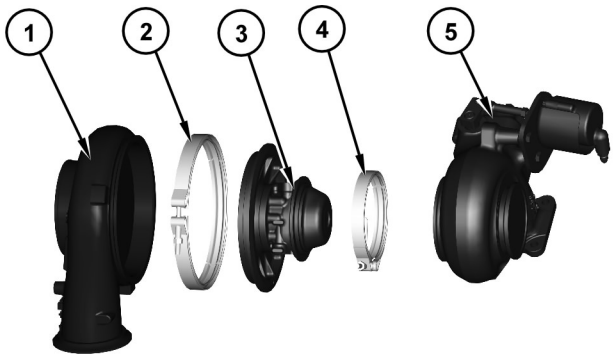


Illustration 76 g03686981

1. Position compressor housing (1) and turbine housing (5) on turbocharger cartridge (3).

Note: Ensure that the mating surfaces are flush.

2. Tighten the nuts on V-band clamp (2) to a torque of 14 ± 1 N·m (123 ± 8 lb in). Use a soft hammer to lightly hit around the diameter of the band clamp. Tighten the nuts again to a torque of 14 ± 1 N·m (123 ± 8 lb in).

3. Tighten the nuts on V-band clamp (4) to a torque of 14 ± 1 N·m (123 ± 8 lb in). Use a soft hammer to lightly hit around the diameter of the band clamp. Tighten the nuts again to a torque of 14 ± 1 N·m (123 ± 8 lb in).

4. Ensure that the impeller spins freely.

End By:

a. Install the turbocharger.

i05806855

Turbocharger - Install

SMCS Code: 1052-012

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Installation Procedure

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

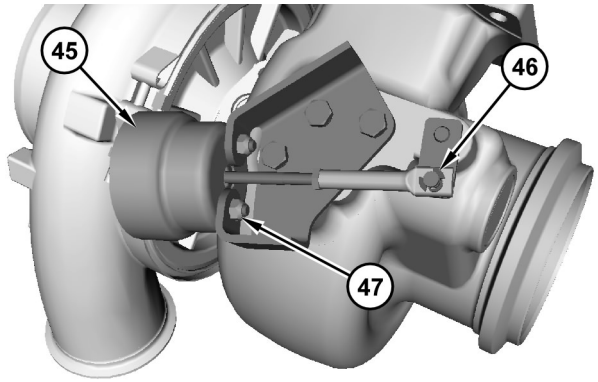


Illustration 77 g03401977
Typical Example

Note: After actuator can (45) has been installed on the turbocharger, actuator can (45) will need to be calibrated. Refer to Special Instruction, REHS5721.

1. Position actuator can (45) on the turbocharger. Install nuts (47) and clip (46).

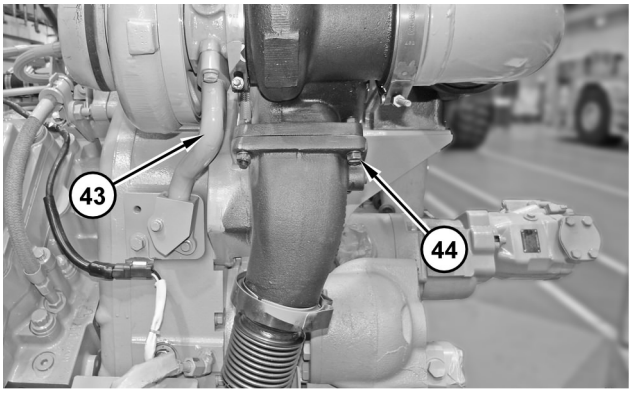


Illustration 78 g02592339
View of the left side turbocharger

Note: Install the turbocharger in the original location and at the original orientation that was marked during the removal procedure.

2. Using two people, install the turbocharger. The weight of the turbocharger is approximately 24 kg (53 lb).

3. Install the gasket, four bolts (44) and the nuts.

4. Install two gaskets and tube (43).

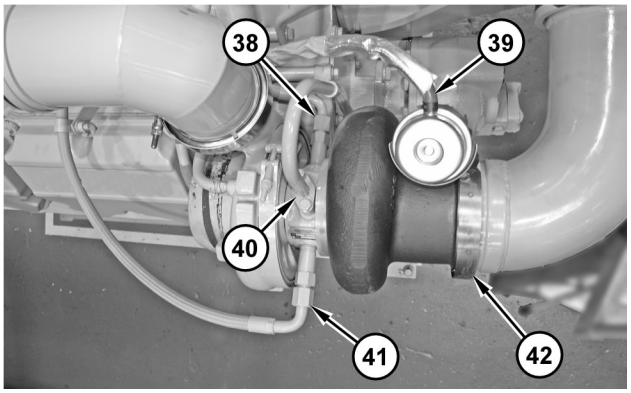


Illustration 79 g03294077
View of the left side turbocharger

5. Tighten clamp (42).

6. Install the gasket and connect tube assembly (40).

7. Connect hose assembly (38), hose (39), and hose assembly (41).

8. Repeat Step 2 through 7 for the right side turbocharger.

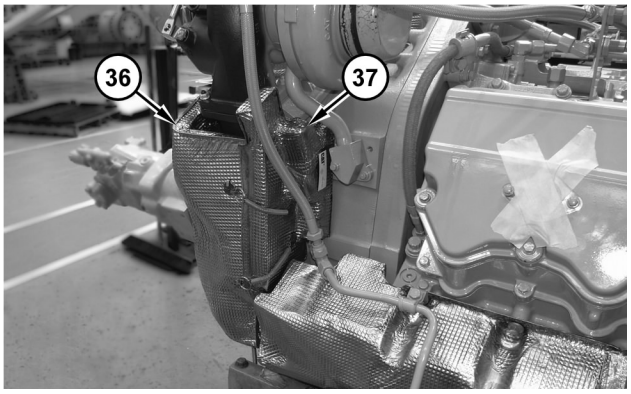


Illustration 80 g03294036
View of the right side turbocharger

9. Install cover (36) and cover (37).

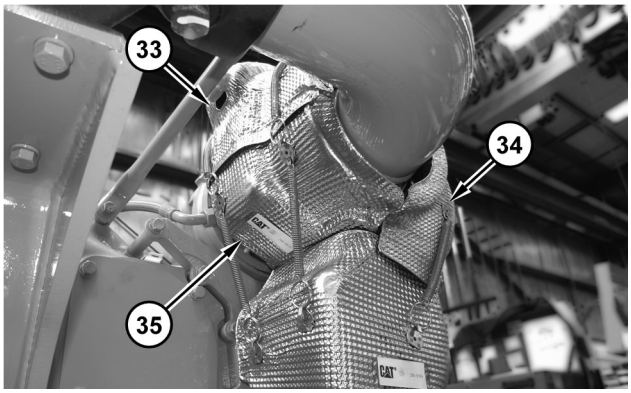


Illustration 81 g03294016
View of the right side turbocharger

10. Install cover (33), cover (34), and cover (35).

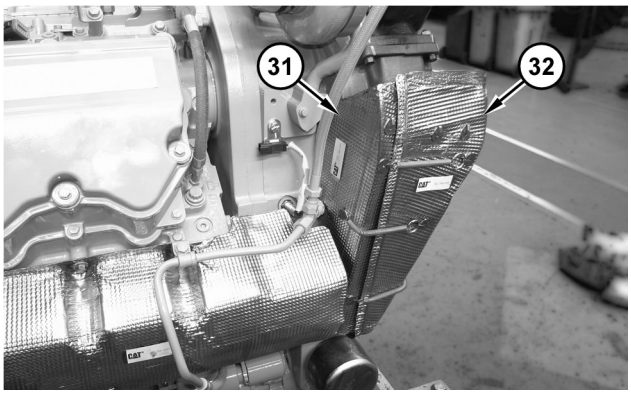


Illustration 82 g03293997
View of the left side turbocharger

11. Install cover (31) and cover (32).

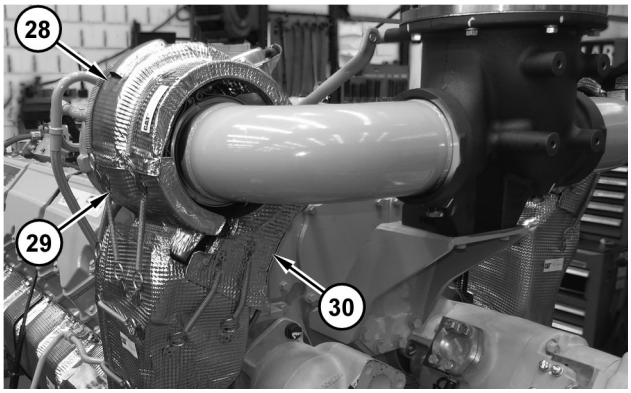


Illustration 83 g03293981
View of the left side turbocharger

12. Install cover (28), cover (29), and cover (30).

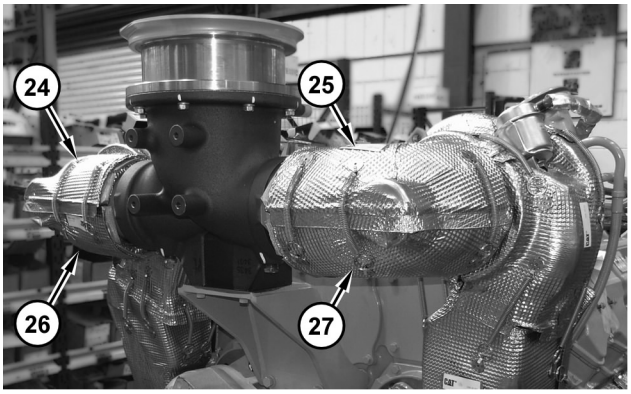


Illustration 84 g03293979

13. Install cover (24), cover (25), cover (26) and cover (27).

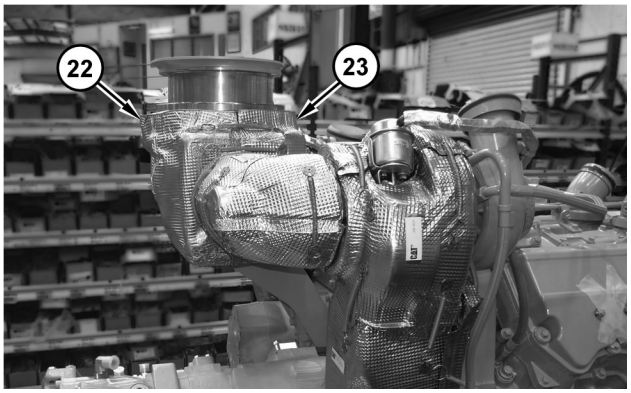


Illustration 85 g03293976

14. Install cover (22) and cover (23).

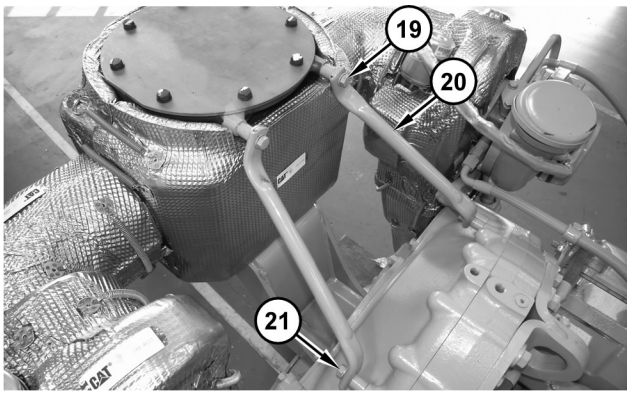


Illustration 86 g03293957

15. Install two support brackets (20), two bolts (19) and the spacers

16. Tighten two bolts (21).

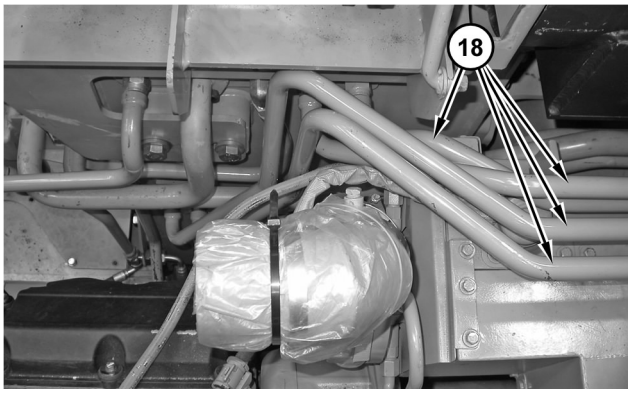


Illustration 87 g02569977

Typical example

17. Install four tube assemblies (18).

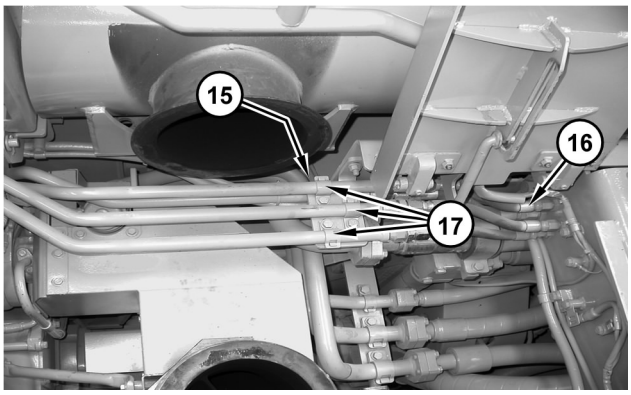


Illustration 88 g02569976

Typical example

18. Connect four hose assemblies (16). Install three clamp assemblies (17) and clamp assembly (15) (not shown).



Illustration 89 g02567482

19. Install tube assembly (14) and tighten clamp (13).

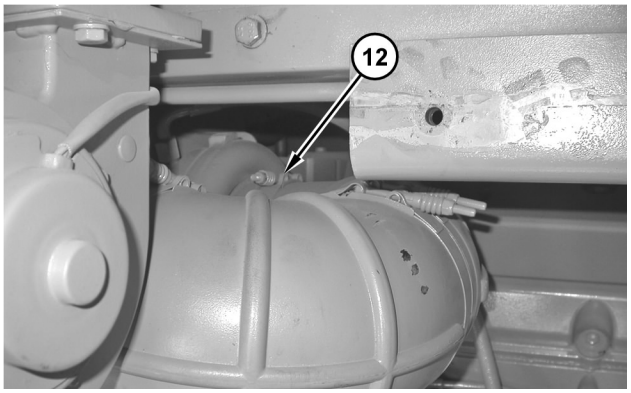


Illustration 90 g02567481

20. Tighten clamp (12).

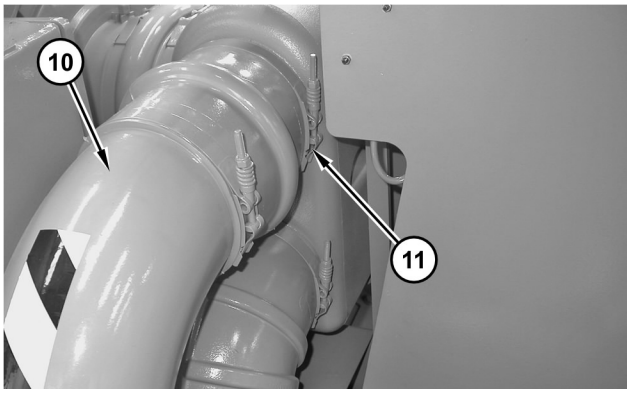


Illustration 91 g02567480

21. Install tube assembly (10) and tighten clamp (11).

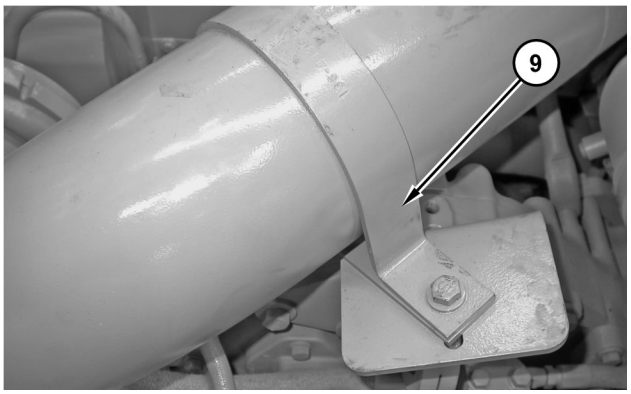


Illustration 92 g02567479

22. Install clamp assembly (9).

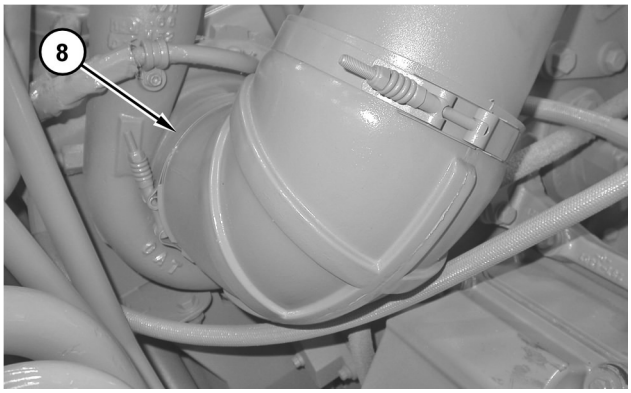


Illustration 93 g02567478

23. Tighten clamp (8).

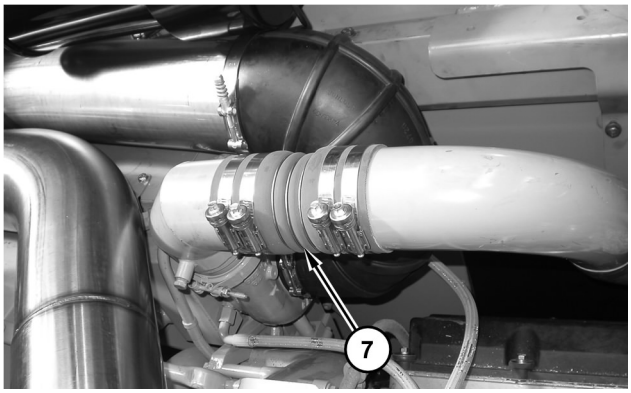


Illustration 94 g02592359

View of the left side turbocharger

24. Connect hose (7) to the elbow and tighten the clamps.

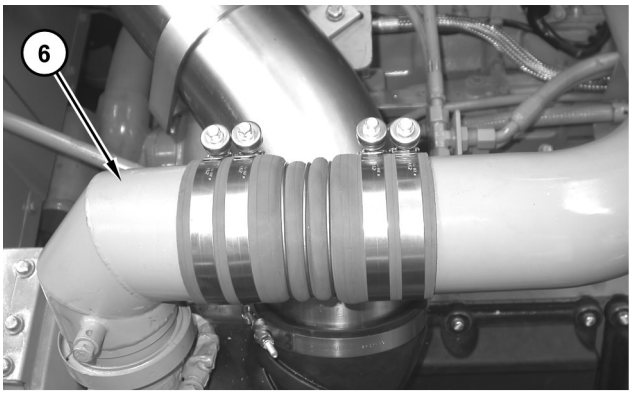


Illustration 95 g02592358

View of the right side of the engine

25. Connect elbow (6) to the turbocharger.



Illustration 96 g02567477

26. Install cover (5).

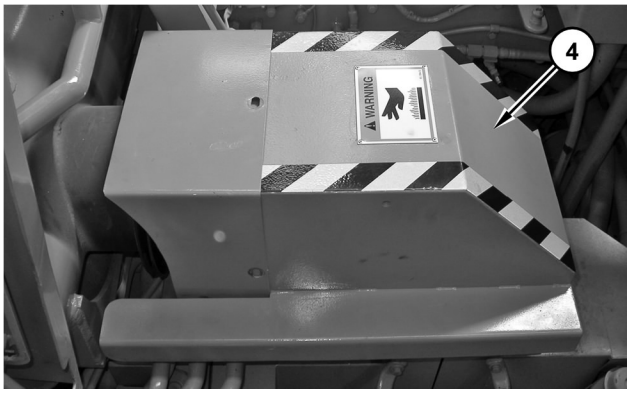


Illustration 97 g02567476

27. Using two people, install tube assembly (4). The weight of tube assembly (4) is approximately 27 kg (60 lb).

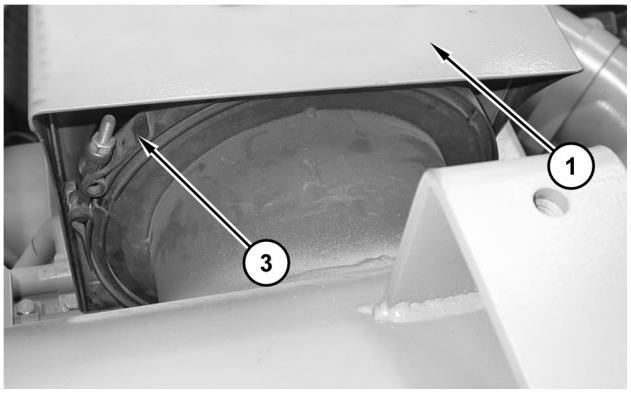


Illustration 98 g02567457

28. Install clamp (3) below cover (1).

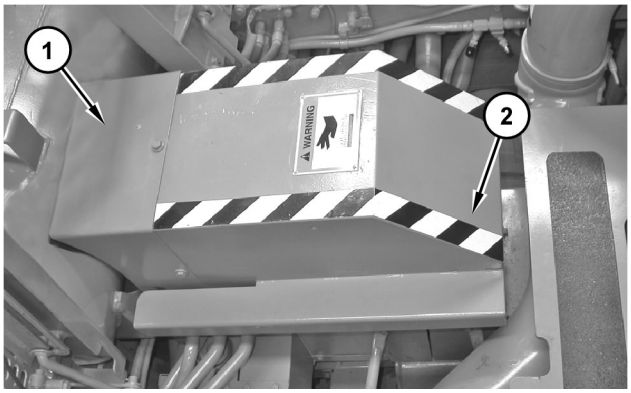


Illustration 99 g02567456

29. Install four bolts (2). Position cover (1) (as shown).

End By:

a. Fill the cooling system. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change”.

b. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i05807185

Turbocharger - Install

SMCS Code: 1052-012

Installation Procedure

Table 7

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

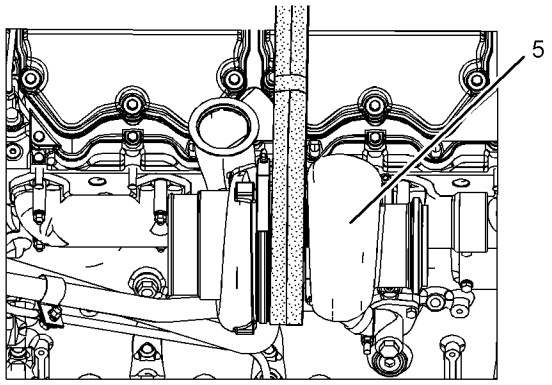


Illustration 100 g01148173

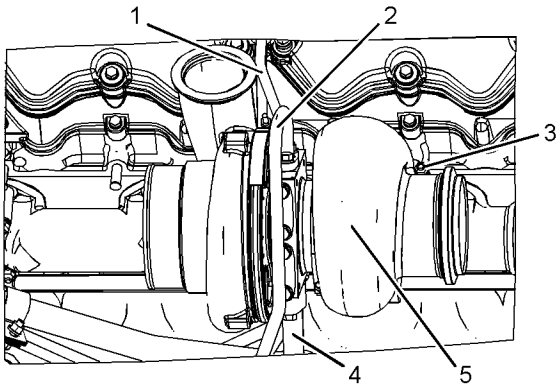


Illustration 101 g01145002

1. Position the gasket on the exhaust manifold.

2. Apply Tooling (A) to the threads of the exhaust manifold studs.

Note: Install turbocharger (5) in the original location and the original orientation that was noted in the removal procedure.

3. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 45 kg (100 lb). Position turbocharger (5) on the exhaust manifold.

4. Install nuts (3) and tighten to a torque of 55 ± 9 N·m (41 ± 7 lb ft).

5. Connect tube assemblies (1) and tube assembly (4).

6. Install tube assembly (2).

7. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i02617133

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

S/N: JA41–Up

S/N: TC91–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

Start By:

a. Remove the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

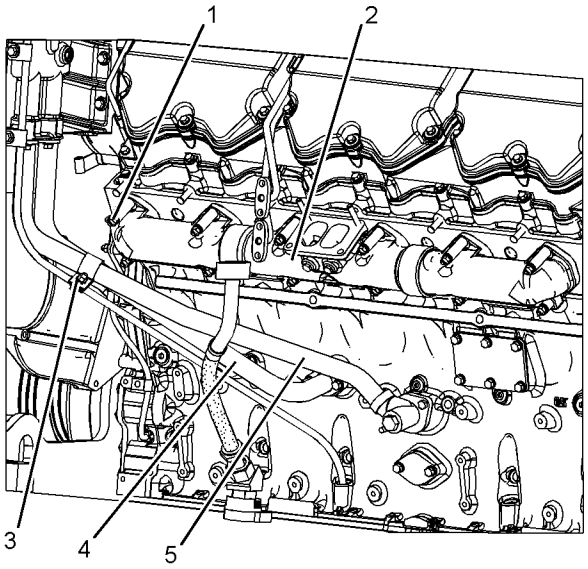


Illustration 102 g01145325

1. Disconnect clamp (3).

2. Disconnect tube assembly (4) and tube assembly (5). Position tube assembly (4) and tube assembly (5) out of the way of exhaust manifold (2).

3. Remove locknuts (1), the washers, and the spacers.

4. Remove exhaust manifold (2).

Installation Procedure

Table 8

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	-
B	2P-2333	High Temperature Sealer	-
C	165-4638	Guide	3

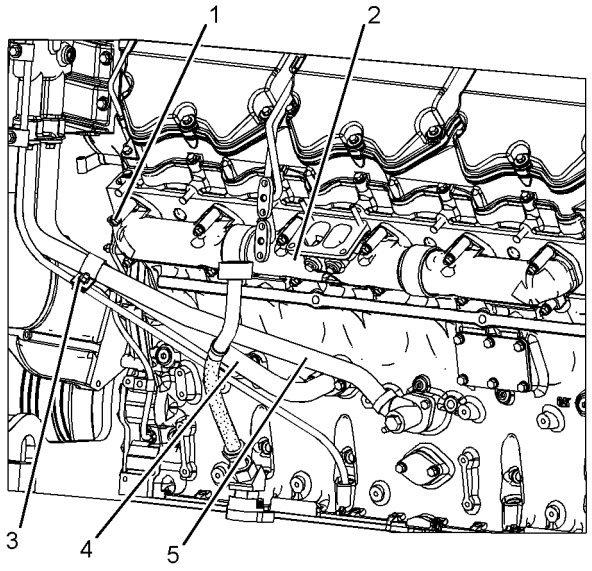


Illustration 103 g01145325

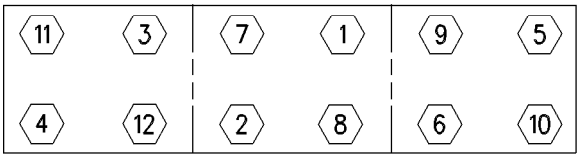


Illustration 104 g00566145

1. Apply clean engine oil to the female ends of exhaust manifold (2) before assembly. Apply Tooling (B) to the male ends of exhaust manifold (2) before assembly. Remove excess sealer from the assembled joint.

2. Apply Tooling (A) to the studs prior to assembly. If necessary, install the studs and tighten to a torque of 35 ± 5 N·m (26 ± 4 lb ft).

3. Position exhaust manifold (2) on the engine.

Note: Use Tooling (C) in at least one oversize hole per manifold section in order to align the exhaust manifolds. Do not remove Tooling (C) until removal is required to tighten the locknuts.

4. Install the spacers, the washers, and locknuts (1). Tighten locknuts (1) in a numerical sequence to a torque of 20 ± 3 N·m (15 ± 2 lb ft). Tighten locknuts (1) again in a numerical sequence to a torque of 38 ± 5 N·m (28 ± 4 lb ft).

5. Connect tube assembly (4) and tube assembly (5).

6. Connect clamp (3).

End By:

a. Install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

i05441240

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

S/N: JA41–Up

S/N: TC91–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

Table 9

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	165-4638	Guide	3
B	5P-3931	Anti-Seize Compound	1

Start By:

a. Remove the turbocharger.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

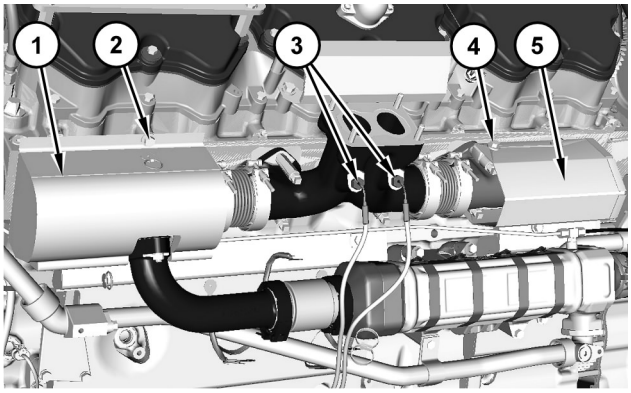


Illustration 105 g03434048

1. Remove bolts (2), heat shield (1), bolts (4), and heat shield (5).

2. Disconnect tube assemblies (3).

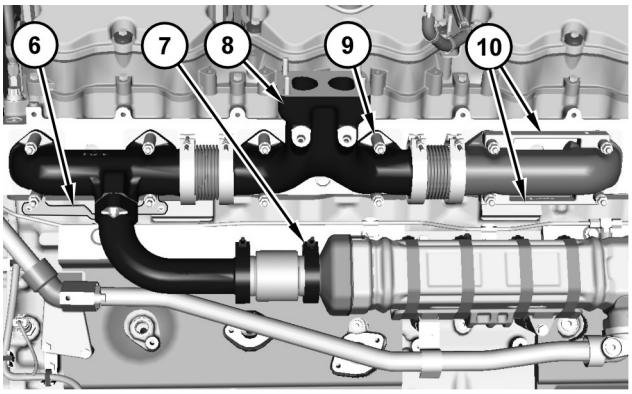


Illustration 106 g03434269

3. Remove brackets (6) and (10).

4. Remove clamp assembly (7).

5. Remove and discard nuts (9). Remove the spacers and remove the exhaust manifold assembly (8).

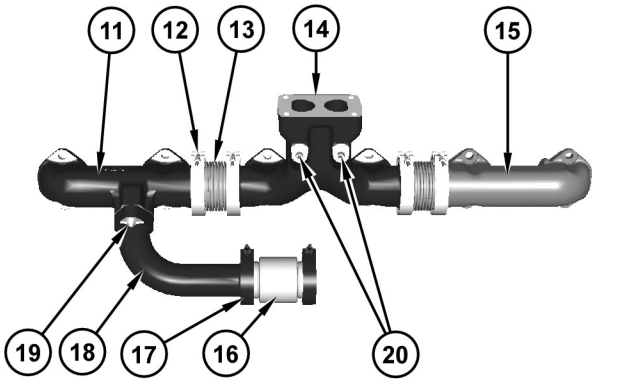


Illustration 107 g03434276

6. Remove and discard clamp assemblies (17) and bellows (16).

7. Remove and discard nuts (19). Remove elbow (18) and remove the gasket (not shown).

8. Remove and discard clamp assemblies (12) and bellows (13). Separate the exhaust manifold sections (11), (14), and (15).

9. Remove temperature sensors (20).

Installation Procedure

1. Install exhaust manifold assembly (8) in reverse order of removal.

a. Install new clamp assemblies (12) and new bellows (13).

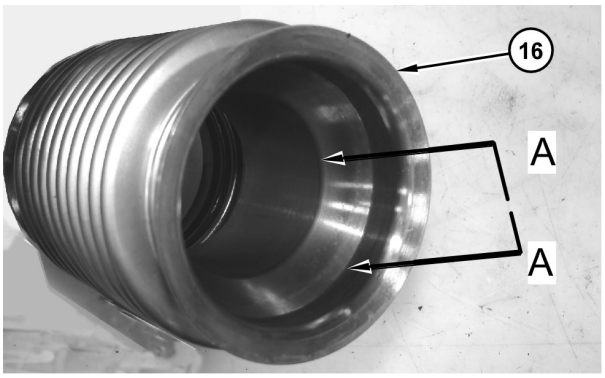


Illustration 108 g03435357

b. Position the new bellows (16) and install new clamp assemblies (17) (not shown). Ensure that the end of the bellows with the taper (A-A) is facing the exhaust manifold.

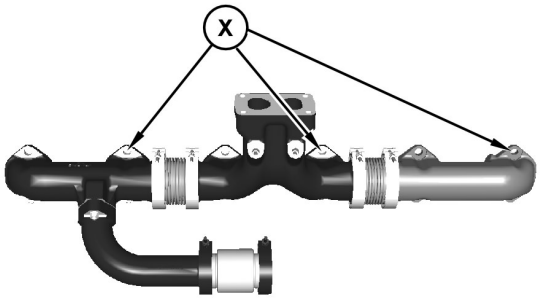


Illustration 109 g02256033

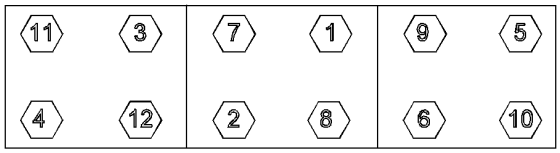


Illustration 110 g02256453

Torque Sequence

c. Position the exhaust manifold into place and install Tooling (A) at Location (X).

d. Apply Tooling (B) on the threads of the new nuts (9). Tighten nuts (9) in the above sequence to a torque of 20 ± 3 N·m (15 ± 2 lb ft). Tighten nuts (9) again in the above sequence to a torque of 38 ± 5 N·m (28 ± 4 lb ft).

e. Apply Tooling (B) on the threads of the new nuts (19). Tighten nuts (19) to a torque of 35 ± 2 N·m (26 ± 2 lb ft).

i05622429

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

Table 10

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	165-4638	Guide	3
B	-	Loctite C5-A Copper Anti-Seize	1

Start By:

a. Remove the turbocharger.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

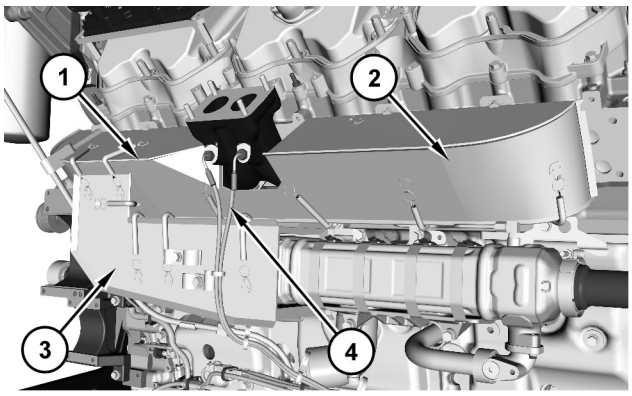


Illustration 111 g03570496

1. Remove heat shield (1), heat shield (2), heat shield (3), and temperature sensors (4).

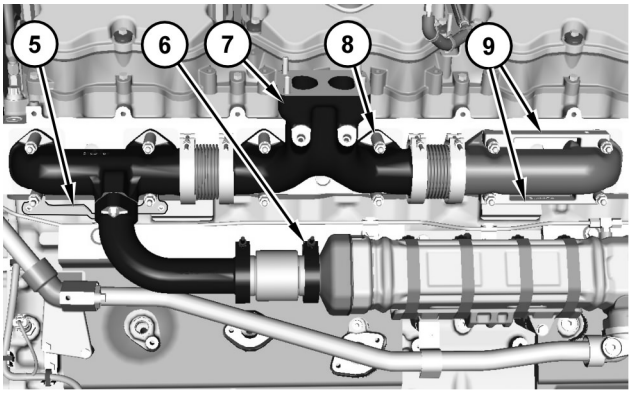


Illustration 112 g03571596

2. Remove brackets (5) and (9).

3. Remove clamp assembly (6).

4. Remove and discard nuts (8). Remove the spacers and remove the exhaust manifold assembly (7).

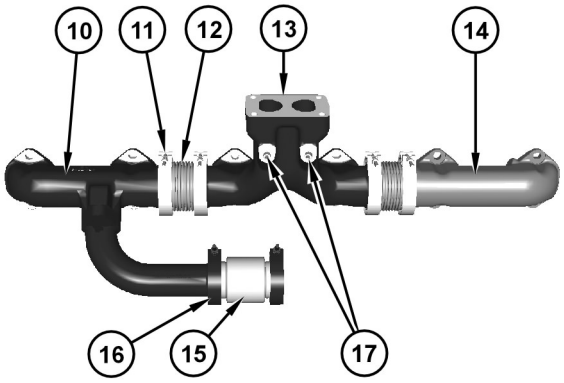


Illustration 113 g03573919

5. Remove and discard clamp assemblies (16) and bellows (15).

6. Remove and discard clamp assemblies (11) and bellows (12). Separate the exhaust manifold sections (10), (13), and (14).

7. Remove temperature sensors (17).

Installation Procedure

Table 11

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	165-4638	Guide	3
B	-	Loctite C5-A Copper Anti-Seize	1
C	-	Loctite Nickel Anti-Seize	1

1. Install exhaust manifold assembly (7) in the reverse order of removal.

a. Install new clamp assemblies (11) and new bellows (12).

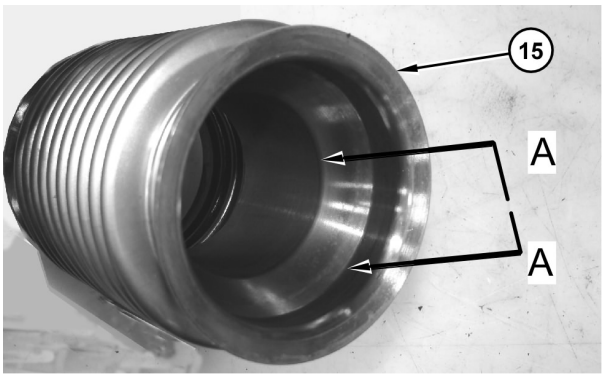


Illustration 114 g03573997

b. Position the new bellows (15) and install new clamp assemblies (16) (not shown). Ensure that the end of the bellows with the taper (A-A) is facing the exhaust manifold.

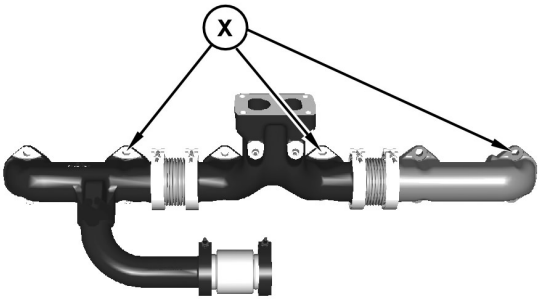


Illustration 115 g03640862

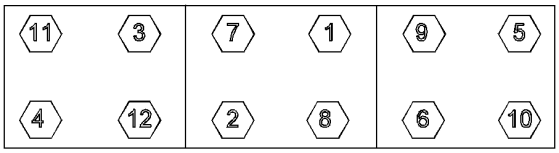


Illustration 116 g02256453

Torque Sequence

c. Position the exhaust manifold into place and install Tooling (A) at Location (X).

d. Apply Tooling (B) on the threads of the new nuts (8). Tighten nuts (8) in the above sequence to a torque of 20 ± 3 N·m (15 ± 2 lb ft). Tighten nuts (8) again in the above sequence to a torque of 38 ± 5 N·m (28 ± 4 lb ft).

e. Apply Tooling (C) on the threads of temperature sensors (4). Tighten temperature sensors (4) to a torque of 45 ± 5 N·m (33 ± 4 lb ft).

i05826385

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

Table 12

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	165-4638	Guide	3
B	-	Loctite C5-A Copper Anti-Seize	1

Start By:

a. Remove the turbocharger.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

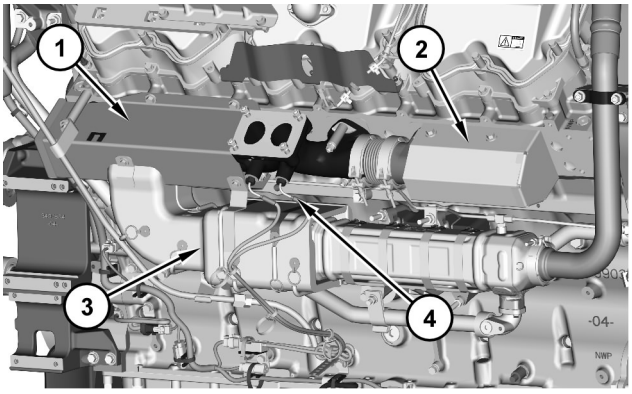


Illustration 117 g03687001

1. Remove heat shield (1), heat shield (2), heat shield (3), and temperature sensors (4).

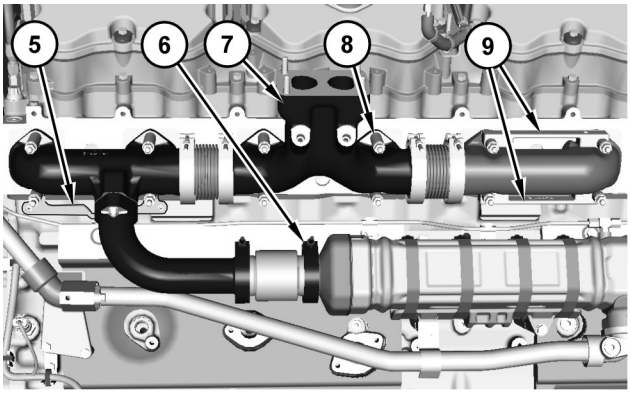


Illustration 118 g03571596

2. Remove brackets (5) and (9).

3. Remove clamp assembly (6).

4. Remove and discard nuts (8). Remove the spacers and remove the exhaust manifold assembly (7).

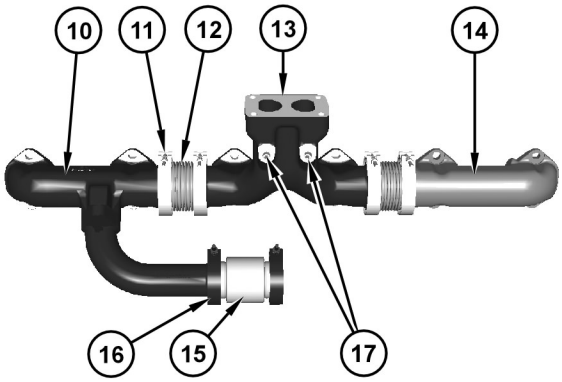


Illustration 119 g03573919

5. Remove and discard clamp assemblies (16) and bellows (15).

6. Remove and discard clamp assemblies (11) and bellows (12). Separate the exhaust manifold sections (10), (13), and (14).

7. Remove temperature sensors (17).

Installation Procedure

Table 13

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	165-4638	Guide	3
B	-	Loctite C5-A Copper Anti-Seize	1
C	-	Loctite Nickel Anti-Seize	1

1. Install exhaust manifold assembly (7) in the reverse order of removal.

a. Install new clamp assemblies (11) and new bellows (12).

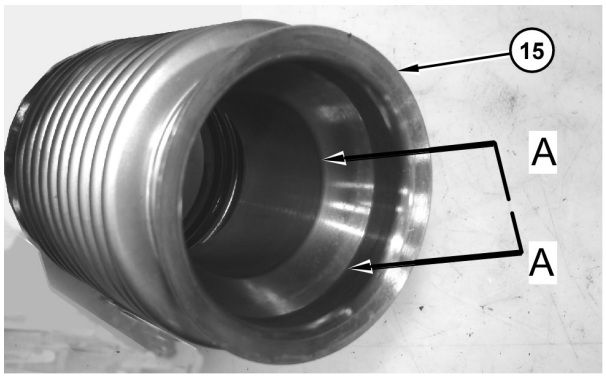


Illustration 120 g03573997

b. Position the new bellows (15) and install new clamp assemblies (16) (not shown). Ensure that the end of the bellows with the taper (A-A) is facing the exhaust manifold.

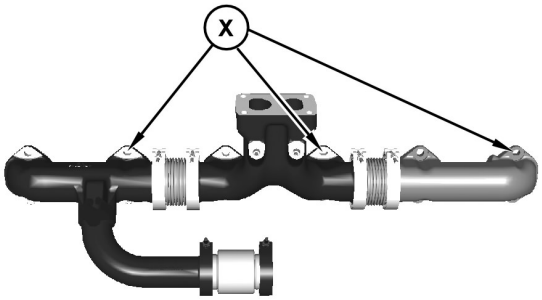


Illustration 121 g03640862

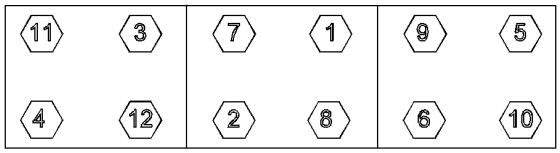


Illustration 122 g02256453

Torque Sequence

c. Position the exhaust manifold into place and install Tooling (A) at Location (X).

d. Apply Tooling (B) on the threads of the new nuts (8). Tighten nuts (8) in the above sequence to a torque of 20 ± 3 N·m (15 ± 2 lb ft). Tighten nuts (8) again in the above sequence to a torque of 38 ± 5 N·m (28 ± 4 lb ft).

e. Apply Tooling (C) on the threads of temperature sensors (4). Tighten temperature sensors (4) to a torque of 45 ± 5 N·m (33 ± 4 lb ft).

i06750397

Inlet and Exhaust Valve Springs - Remove and Install

SMCS Code: 1108-010

Removal Procedure

Table 14

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7241	Valve Spring Compressor	1
B	441-0714	Tool As	1

Start By:

a. Remove the electronic unit injectors.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Place the piston at the top of the compression stroke (TC). Remove the valve springs for that cylinder. If the valves fall into the cylinder liner, then the cylinder head must be removed.

1. Position the No. 1 piston at the top center of the compression stroke. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

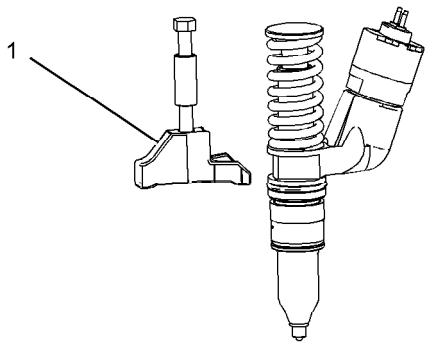


Illustration 123 g01073852

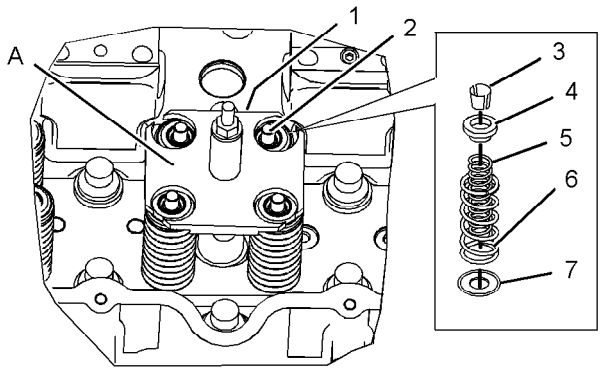


Illustration 124 g01043625

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

2. Install Tooling (A) in the electronic unit injector sleeve. Secure Tooling (A) with unit injector clamp (1).

3. Tighten the full nut until valve spring keepers (3) are loose on valve (2).

4. Remove valve spring keepers (3) from the valve.

5. Carefully remove Tooling (A).

6. Remove valve rotator (4).

7. Remove outer valve spring (6) and inner valve spring (5) from the valve.

8. Remove washer (7) from the valve guide.

9. Use Tooling (B) to check the valve springs (spring force). Refer to Specifications, “Cylinder Head Valves” for additional information on the valve springs.

Installation Procedure

Table 15

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7241	Valve Spring Compressor	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Lubricate the valve stems with clean engine oil.

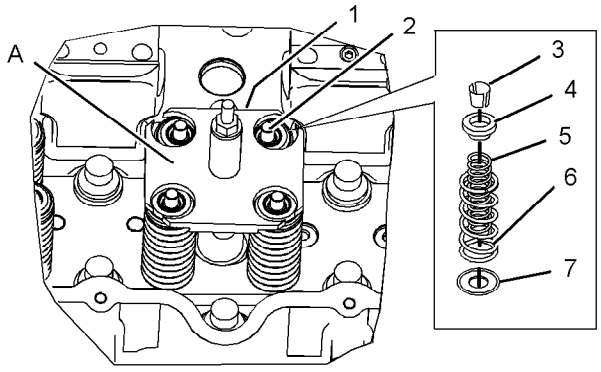


Illustration 125 g01043625

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

2. Ensure that washer (7) is installed on the valve guide.

3. Install inner valve spring (5) and outer valve spring (6) on valve (2).

4. Install valve rotator (4) on valve (2).

⚠ WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

5. Use Tooling (A) to compress inner valve spring (5) and outer valve spring (6). Install valve spring keepers (3) on valve (2). Remove unit injector clamp (1) and Tooling (A).

End By:

a. Install the electronic unit injectors.

i06750410

Inlet and Exhaust Valves - Remove and Install

SMCS Code: 1105-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 16

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5S-1330	Valve Spring Compressor	1
B	441-0714	Tool As	1

Start By:

a. Remove the cylinder head.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

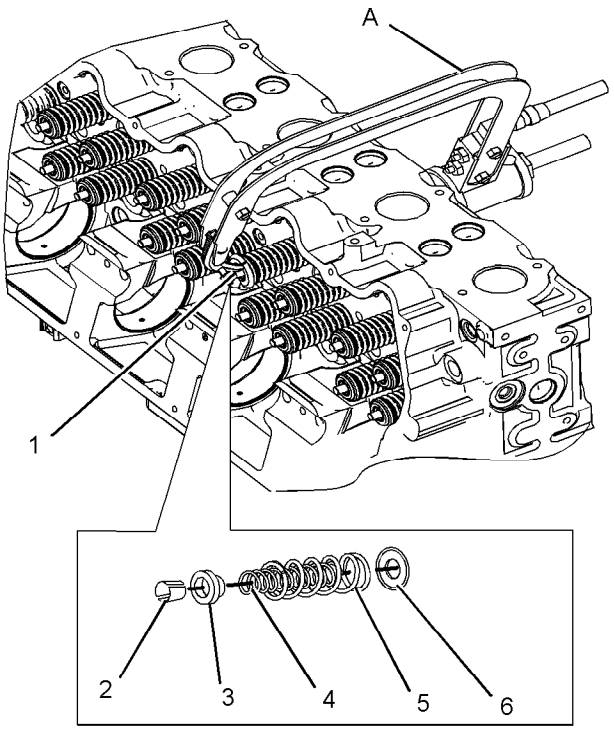


Illustration 126 g01015263

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Install Tooling (A) and compress the valve springs. Remove valve spring keepers (2) from valve (1).

2. Carefully remove Tooling (A) from valve (1).

3. Remove valve rotator (3).

4. Remove outer valve spring (5) and inner valve spring (4) from valve (1).

5. Remove washer (6) and valve (1) from the valve guide.

6. Use Tooling (B) to check the valve springs (spring force). Refer to Specifications, “Cylinder Head Valves” for additional information on the valve springs.

7. Inspect the valves. Refer to Specifications, “Cylinder Head Valves” for additional information on the inlet and exhaust valves.

Installation Procedure

Table 17

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5S-1330	Valve Spring Compressor	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: A small amount of grease can be used to hold the retainer locks in position during installation.

1. Lubricate the valves with clean engine oil. Install the valves in the cylinder head.

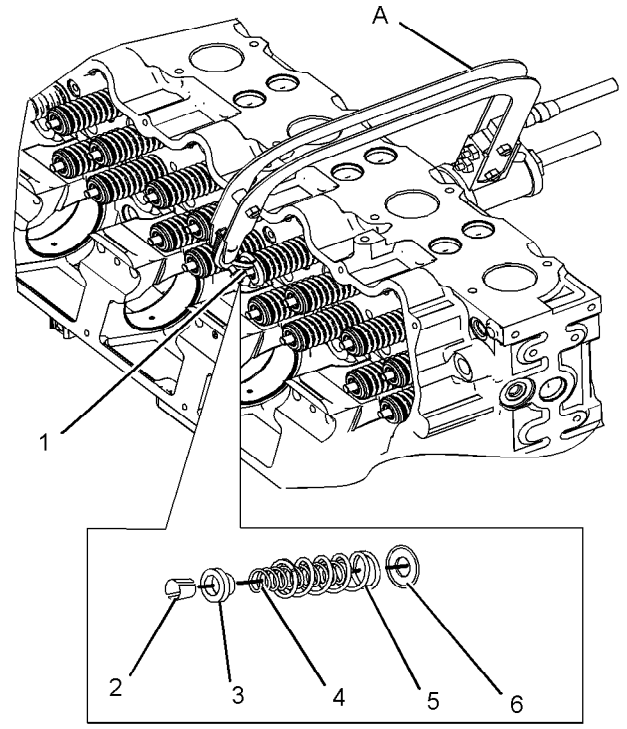


Illustration 127 g01015263

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

2. Install washer (6) on the valve guide.

3. Install inner valve spring (4) and outer valve spring (5) on valve (1).

4. Install valve rotator (3) on valve (1).

5. Use Tooling (A) to compress inner valve spring (4) and outer valve spring (5). Install valve spring keepers (2) on valve (1).

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

6. Carefully remove Tooling (A).

End By:

a. Install the cylinder head.

i05887270

Inlet and Exhaust Valve Guides - Remove and Install

SMCS Code: 1104-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 18

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	9U-6895	Valve Guide Driver	1

(1) Part of 9U-7530 Engine Tool Group

Start By:

a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, “Inlet and Exhaust Valves - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

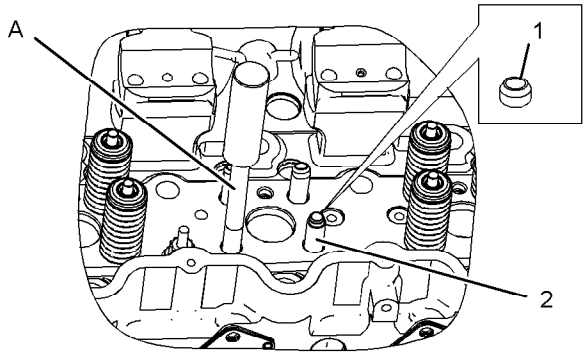


Illustration 128 g01073841

1. Remove valve stem seal (1) from valve guide (2).

2. Use Tooling (A) and a hammer to remove the valve guide from the cylinder head.

Installation Procedure

Table 19

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	9U-6895	Valve Guide Driver	1
B(1)	9U-6894	Guide Collar	1
C(2)	455-0128	Seal Installer	1
	375-2773	Seal Installer	1

(1) Part of 9U-7530 Engine Tool Group
(2) Use Seal Installer 455-0128 with Seal 163-2478. Use Seal Installer 375-2773 with Seal 361-3926

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

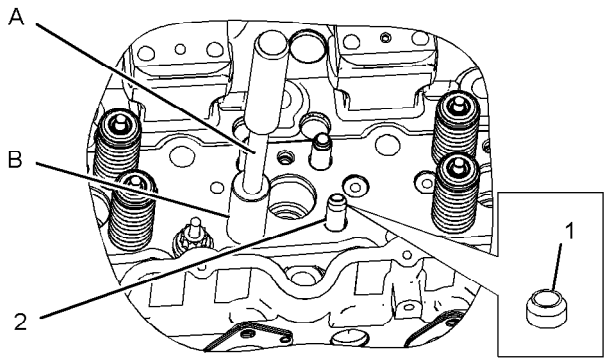


Illustration 129 g01073842

1. Lubricate the bores for the valve guides with clean engine oil.

2. Install valve guide (2) in the cylinder head with Tooling (A) and Tooling (B).

Note: Tooling (B) must be used in order to install the valve guide to the correct height.

Height to top of valve guide from cylinder head surface . . . . . 35.00 ± 0.50 mm ((1.378 ± 0.020 inch))

Note: For more information, refer to Specifications, “Cylinder Head Valves”.

3. Use Tooling (C) to install valve stem seal (1) on the valve guide.

End By:

a. Install the inlet and exhaust valves. Refer to Disassembly and Assembly, “Inlet and Exhaust Valves - Remove and Install”.

i04947937

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS Code: 1103-010

Removal Procedure

Table 20

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	166-7441	Valve Seat Extractor Tool Group	1

Start By:

a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, “Inlet and Exhaust Valves - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

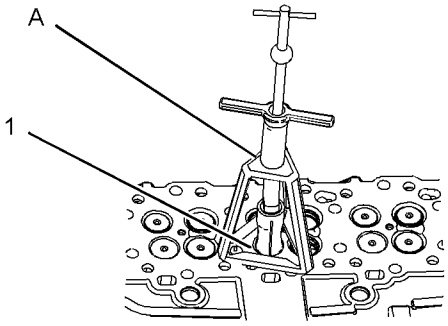


Illustration 130 g01145463

1. Use Tooling (A) to remove valve seat insert (1) from the cylinder head.

2. Clean the bores in the cylinder head for the valve seat inserts. Remove any rough areas from the bores.

Installation Procedure

Table 21

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B(1)	9U-6898	Valve Seat Driver (Exhaust)	1
	9U-6897	Valve Seat Driver (Inlet)	1

(1) Part of 9U-7530 Engine Tool Group

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

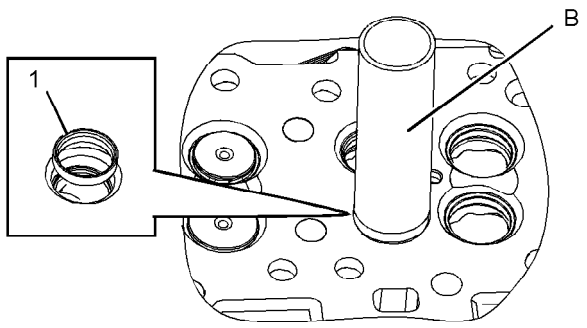


Illustration 131 g01079028

1. Lower the temperature of new valve seat insert (1).

2. Use Tooling (B) to install the new valve seat insert in the cylinder head.

Note: Do not machine the prefinished valve seat inserts in order to correct the valve stem projection. An excessive valve stem projection indicates that the valve seat insert is not seated or material was not cleaned from the bottom of the counterbore.

End By:

a. Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

i02288520

Engine Oil Filter Base - Remove

SMCS Code: 1306-011

Removal Procedure

Table 22

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (A) to remove the engine oil filters.

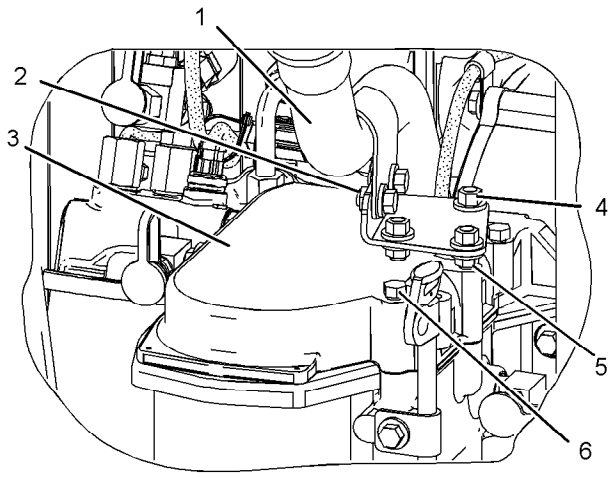


Illustration 132 g01096521

2. Remove bolts (2) and nuts (4). Remove tube assembly (1).

3. Remove nuts (5) and bolts (6). Remove engine oil filter base (3).

i02288537

Engine Oil Filter Base - Install

SMCS Code: 1306-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

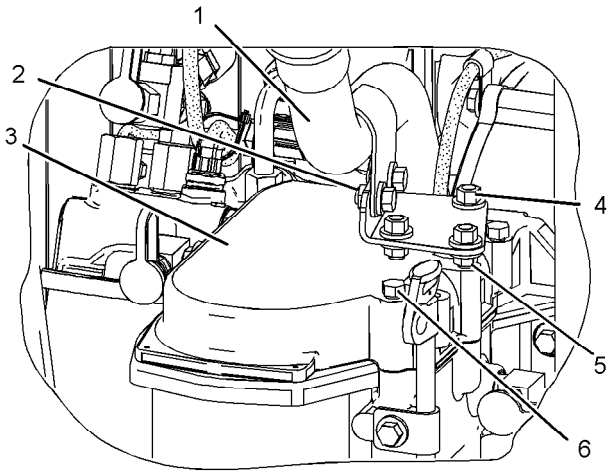


Illustration 133 g01096521

1. Position engine oil filter base (3) on the engine. Install nuts (5) and bolts (6).

2. Install tube assembly (1). Install bolts (2) and nuts (4).

3. Install the engine oil filters.

4. Fill the lubrication system with engine oil. Refer to Operation and Maintenance Manual, “Refill Capacities”.

i05599870

Engine Oil Filter Base - Remove and Install

SMCS Code: 1306-010

Removal Procedure

Table 23

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

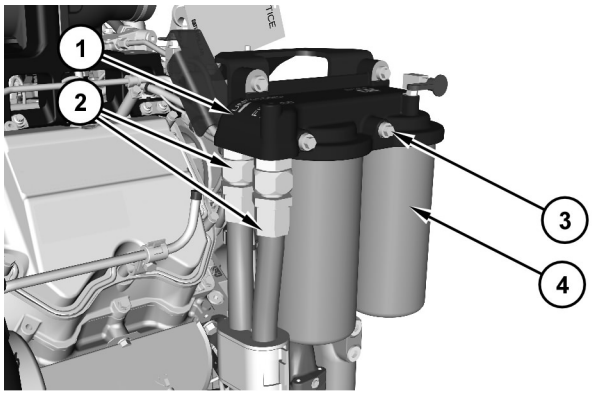


Illustration 134 g03557137

1. Disconnect hose assemblies (2).

2. Use Tooling (A) to remove engine oil filter (4) from engine oil filter base (1).

3. Remove bolts (3). Remove engine oil filter (4).

Installation Procedure

1. Install engine oil filter base (1) in the reverse order of removal.

i02288684

Engine Oil Cooler - Remove

SMCS Code: 1378-011

S/N: JA41–Up

S/N: TC91–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

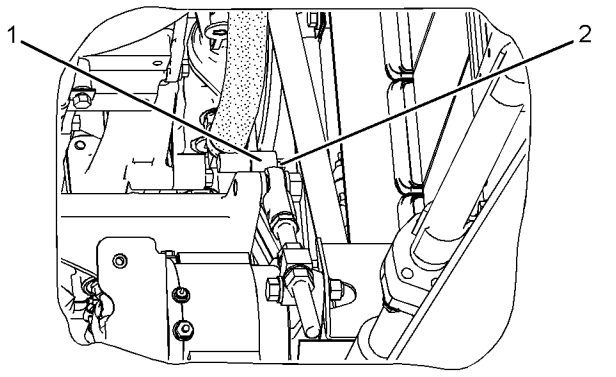


Illustration 135 g01145663

2. Remove bolts (2) and bonnet (1).

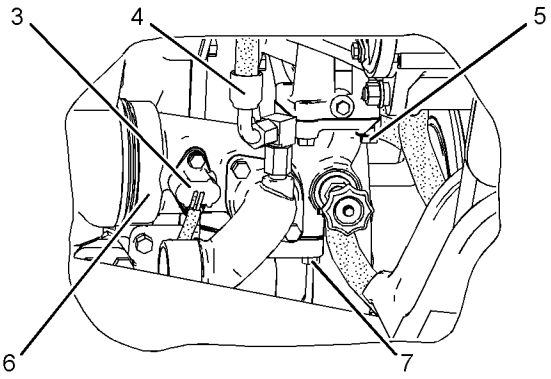


Illustration 136 g01145699

3. Disconnect harness assembly (3).

4. Disconnect hose assembly (4).

5. Remove bolts (5) and bolts (7). Remove bonnet (6).

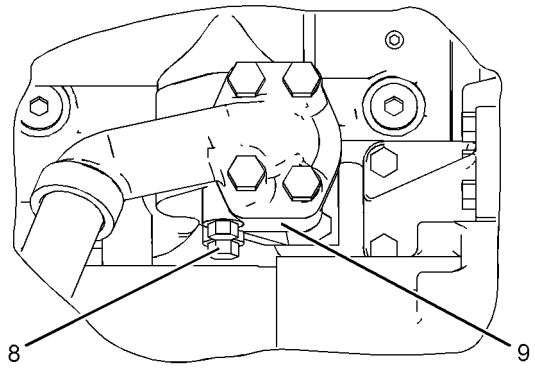


Illustration 137 g01145708

6. Remove bolts (8) from each end of engine oil cooler (9). Slide engine oil cooler (9) toward the front of the engine and remove engine oil cooler (9).

i08116890

Engine Oil Cooler - Remove

SMCS Code: 1378-011

Removal Procedure

Table 24

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

Note: Cleanliness is an important factor. Before the removal procedure, clean the exterior of the component thoroughly. Cleanliness will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes to prevent fluid loss and to keep contaminants from entering the system.

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant from the cooling system into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change”.

2. Drain the hydraulic tank into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the hydraulic tank. Refer to Operation and Maintenance Manual, “Hydraulic System Oil - Change” for the proper draining procedure.

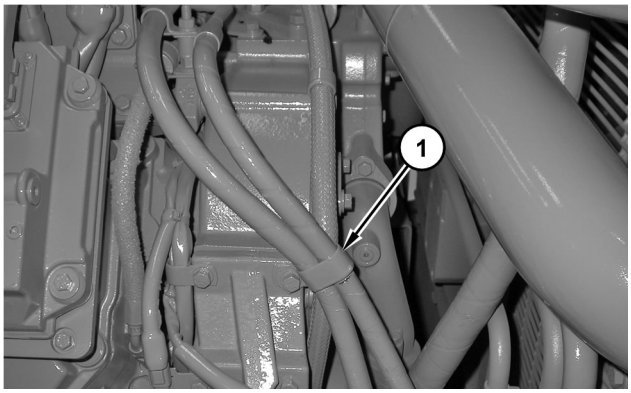


Illustration 138 g01440997

3. Remove clip (1).

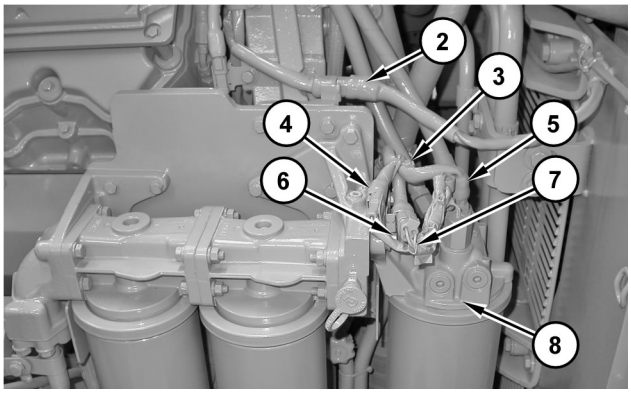


Illustration 139 g01440992

4. Cut cable strap (3). Disconnect harness assemblies (4), (5), (7), and (2). Remove two bolts (6) and the two clips. Position filter base (8) out of the way.

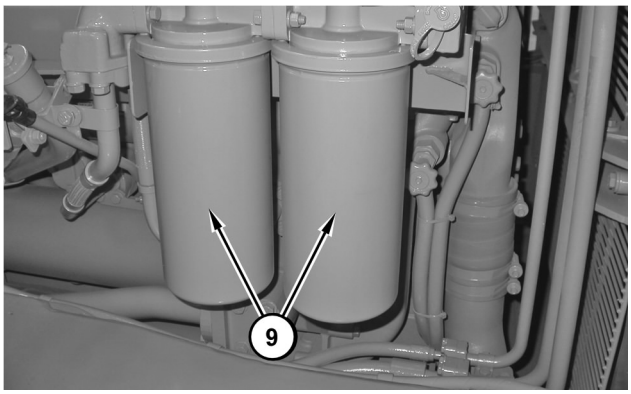


Illustration 140 g01441000

5. Use Tooling (A) to remove filter assemblies (9).

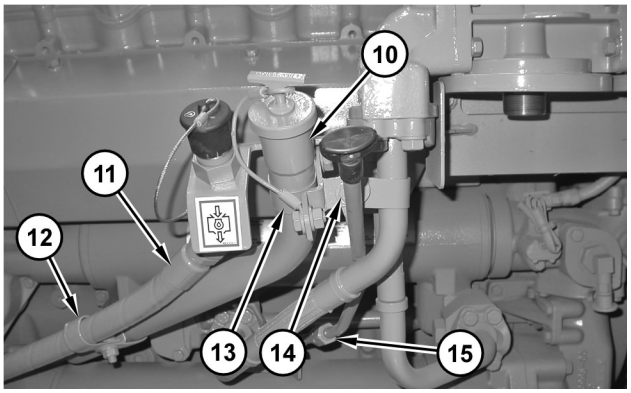


Illustration 141 g01441001
Typical example

6. Remove two clips (12). Disconnect hose assembly (11) (if equipped). Remove clip (13) and tube assembly (10). Remove bolt (14) and disconnect dipstick tube (15).

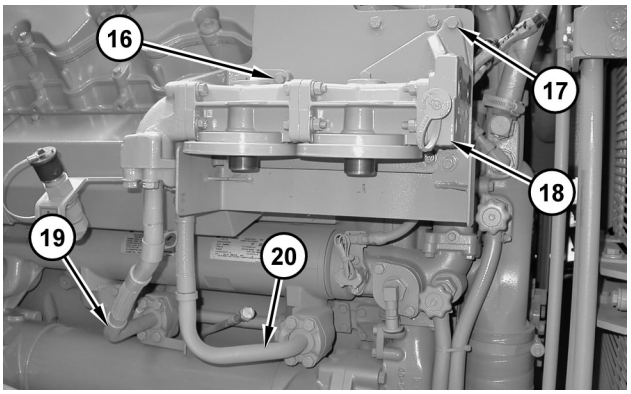


Illustration 142 g01441002
Typical example

7. Disconnect tube assemblies (19) and (20) from the engine. Remove three bolts (16) and four bolts (17). Remove filter base (18).

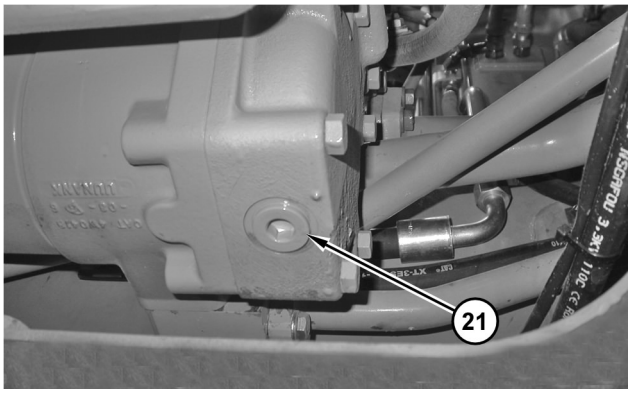


Illustration 143 g01441081

8. Remove plug (21) from the power train oil cooler. Drain the coolant from the cooling system into a suitable container for storage or disposal. Install plug (21).

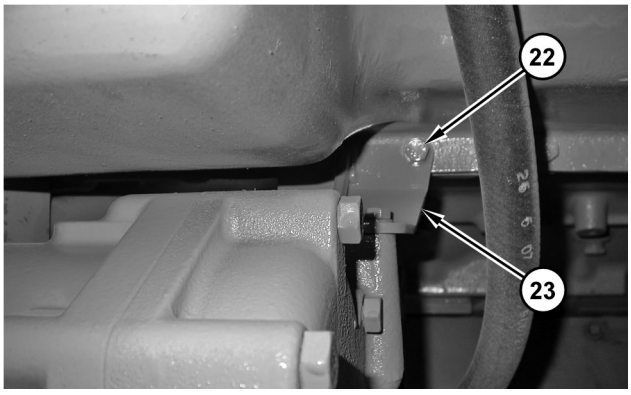


Illustration 144 g01441080

9. Remove four bolts (22) and bracket (23).

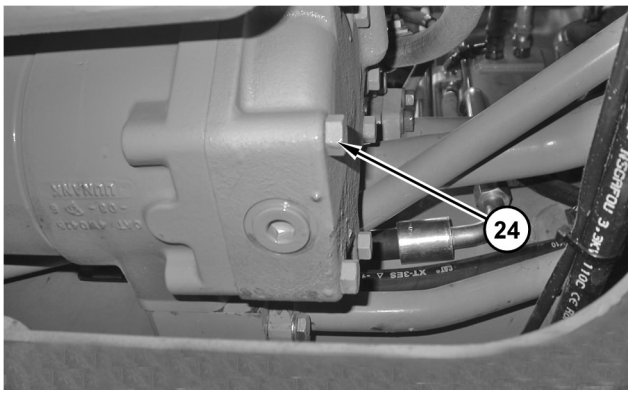


Illustration 145 g01441083

10. Remove six bolts (24).

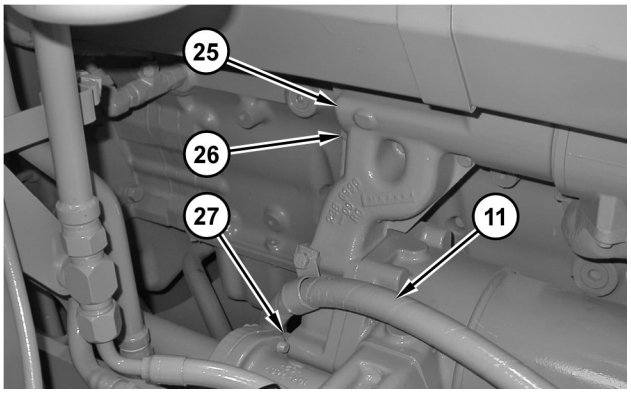


Illustration 146 g01441082
Typical example

11. Remove six bolts (27). Position hose assembly (11) out of the way. Remove six bolts (26), bonnet (25), and the O-ring seal.

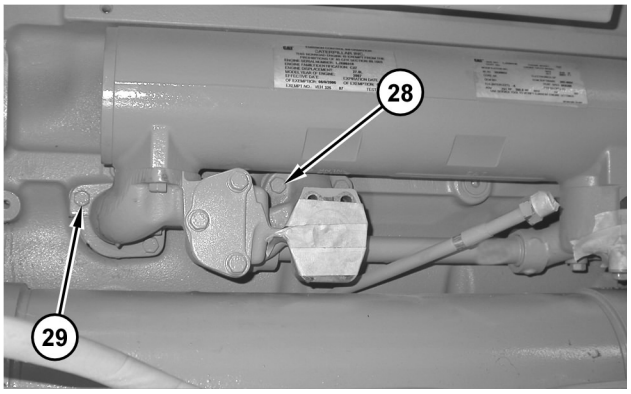


Illustration 147 g01441086

12. Remove two bolts (29) and two bolts (28).

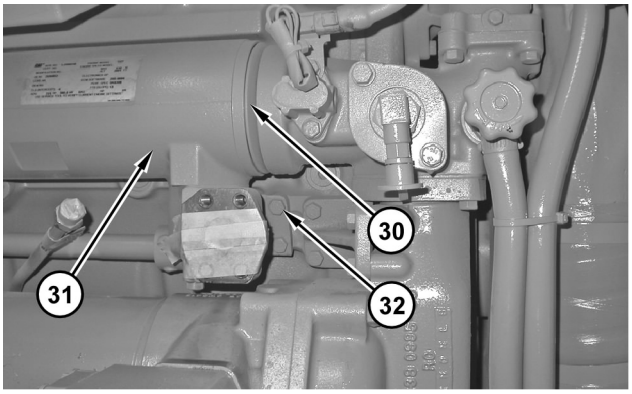


Illustration 148 g01441087

13. Remove two bolts (32). Remove engine oil cooler (31), adapter (30), and the two O-ring seals.

i02288750

Engine Oil Cooler - Install

SMCS Code: 1378-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–Up

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

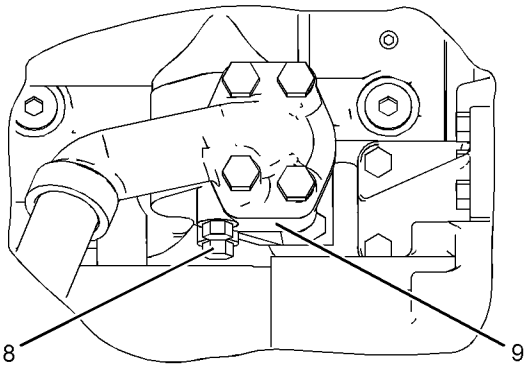


Illustration 149 g01145708

1. Slide engine oil cooler (9) toward the rear of the engine. Install bolts (8) on each end of engine oil cooler (9).

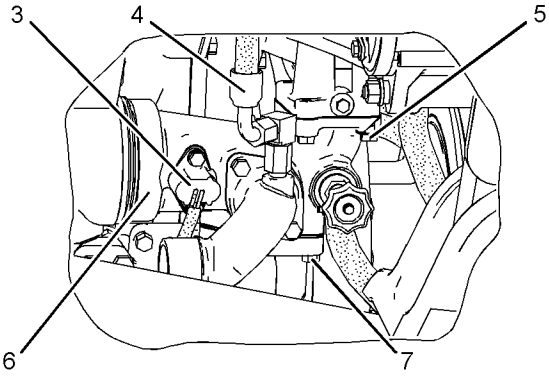


Illustration 150 g01145699

2. Position bonnet (6). Install bolts (5) and bolts (7).

3. Connect hose assembly (4).

4. Connect harness assembly (3).

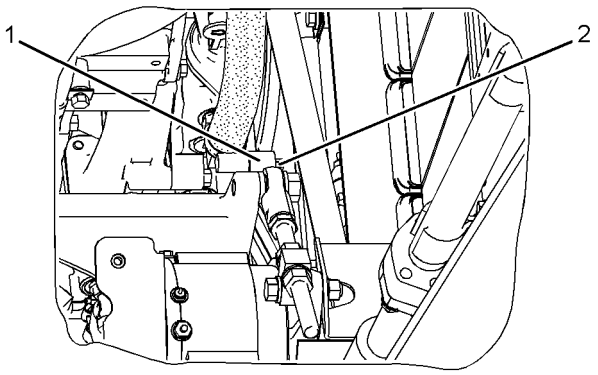


Illustration 151 g01145663

5. Position bonnet (1) and install bolts (2).

6. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i05162874

Engine Oil Cooler - Install

SMCS Code: 1378-012

Installation Procedure

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

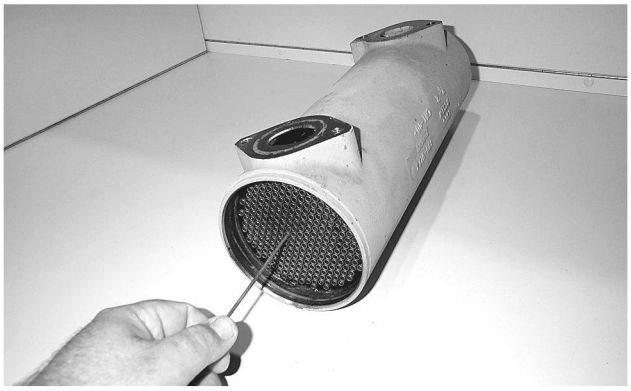


Illustration 152 g01005835
Typical Example

1. Clean the engine oil cooler core assembly with a suitable rod, as shown.

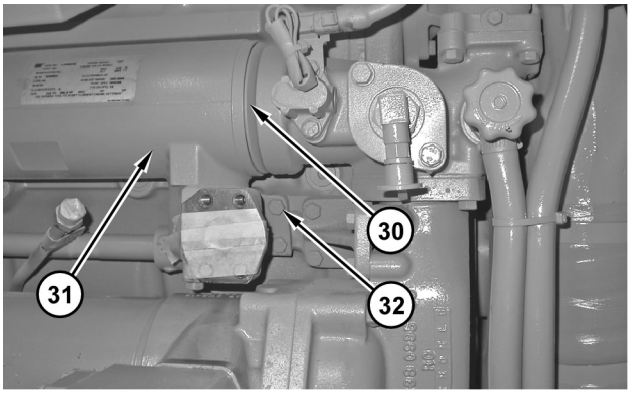


Illustration 153 g01441087

2. Install adapter (30) and engine oil cooler (31) . Install two bolts (32).

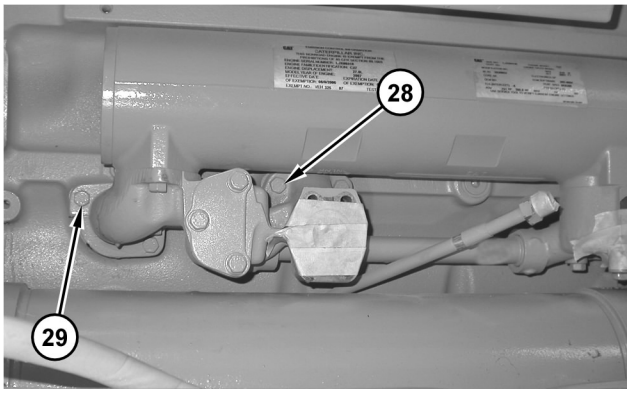


Illustration 154 g01441086

3. Install two bolts (29) and two bolts (28).

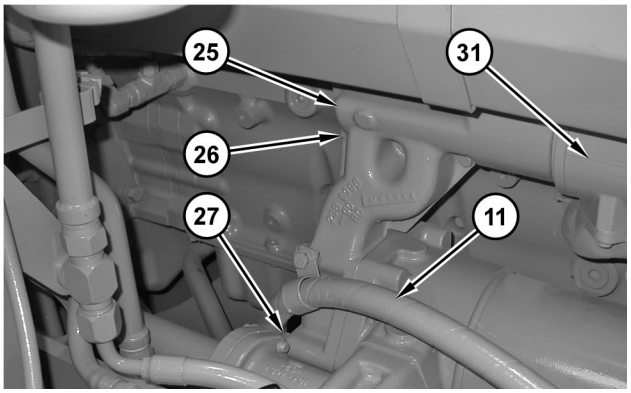


Illustration 155 g01441092
Typical example

4. Install bonnet (25) and six bolts (26).

5. Install six bolts (27) with hose assembly (11) and the clip.

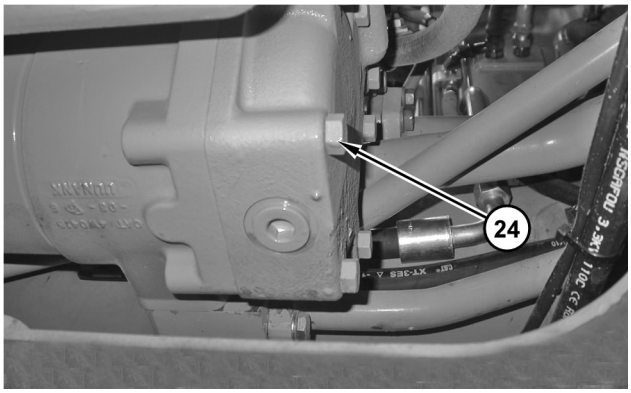


Illustration 156 g01441083

6. Install six bolts (24).

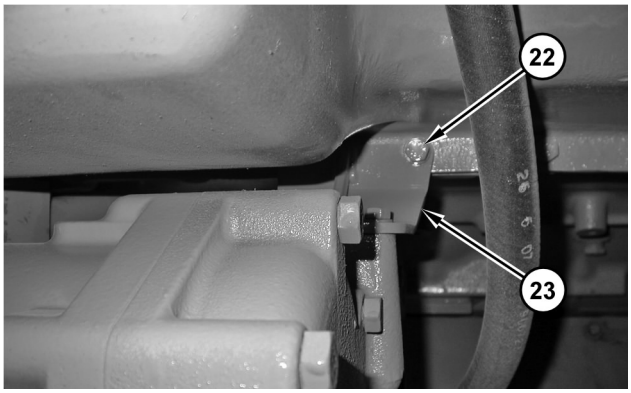


Illustration 157 g01441080

7. Install bracket (23) and four bolts (22).

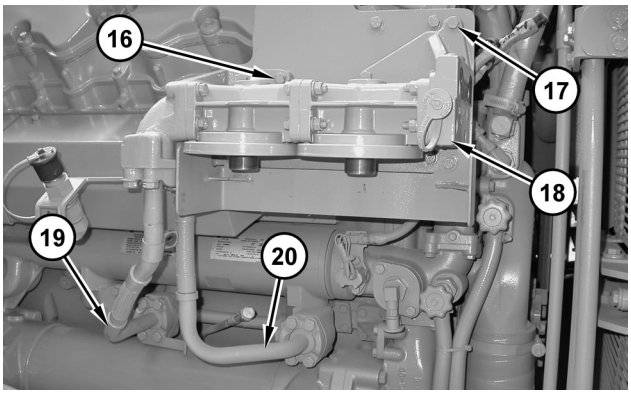


Illustration 158 g01441002
Typical example

8. Install filter base (18), four bolts (17) and three bolts (16).

9. Connect hose assemblies (20) and (19).

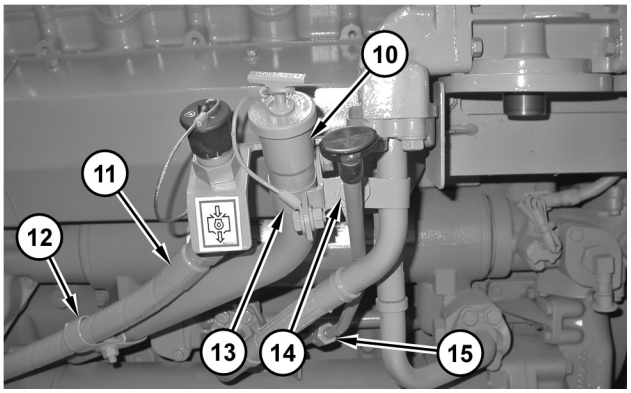


Illustration 159 g01441001
Typical example

10. Connect dipstick tube (15) and install bolt (14). Install tube assembly (10) and clip (13). Connect hose assembly (11) (if equipped) and two clips (12).

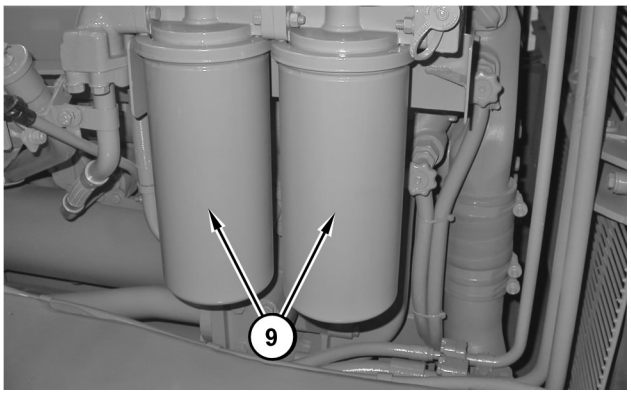


Illustration 160 g01441000

11. Install oil filters (9). Refer to Operation and Maintenance Manual, “Engine Oil and Filter - Change”.

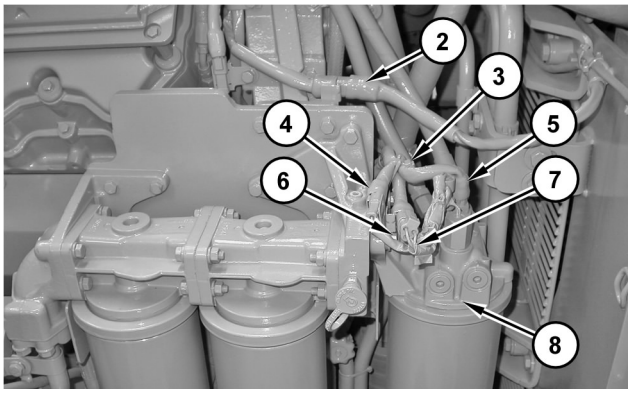


Illustration 161 g01440992

12. Install filter base (8), two bolts (6) and the clips. Connect harness assemblies (7), (5), (4) and (2). Attach cable strap (3).

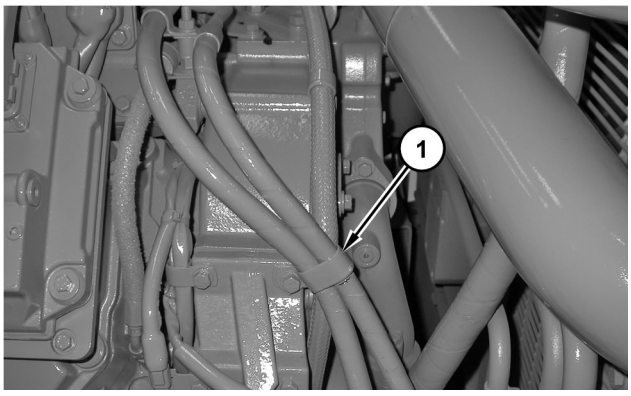


Illustration 162 g01440997

13. Install clip (1).

14. Check the engine oil level. Refer to Operation and Maintenance Manual, “Engine Oil Level - Check”.

15. Fill the cooling system. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change”

16. Fill the hydraulic tank. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the hydraulic tank. Refer to Operation and Maintenance Manual, “Hydraulic System Oil - Change” for the proper filling procedure.

End By:

a. Install the engine bottom guard. Refer to Disassembly and Assembly, “Bottom Guard (Engine) - Remove and Install”.

b. Install the transmission bottom guard. Refer to Disassembly and Assembly, “Bottom Guard (Engine) - Remove and Install”.

c. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02288785

Engine Oil Pump - Remove

SMCS Code: 1304-011

Removal Procedure

Start By:

a. Remove the engine oil pan. Refer to Disassembly and Assembly, “Engine Oil Pan - Remove and Install”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Disconnect the tube assemblies from the engine oil pump.

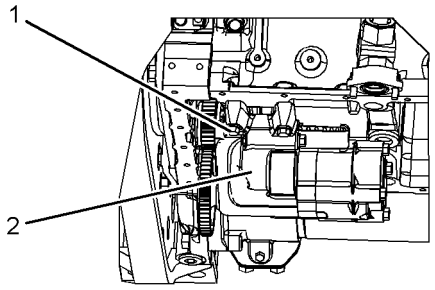


Illustration 163 g01145746

2. Remove bolts (1) and engine oil pump (2).

i02289189

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Table 25

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Group	1
B	1P-2320	Puller Assembly	1

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

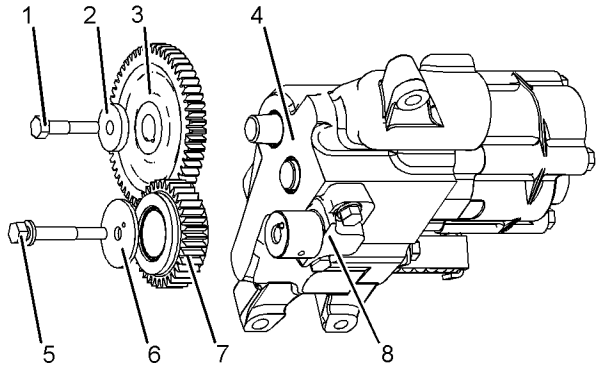


Illustration 164 g01145905

1. Remove bolt (5), thrust plate (6), and idler gear assembly (7) from shaft assembly (8).

2. Use Tooling (A) and a suitable press in order to remove the bearing from idler gear assembly (7).

3. Remove shaft assembly (8) from body (4). Remove bolt (1) and washer (2).

4. Use Tooling (A) and Tooling (B) to remove drive gear (3) from body (4). Remove the key from the pump shaft.

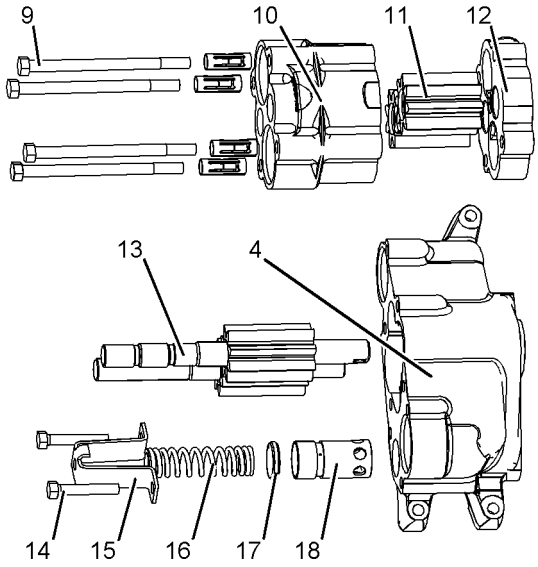


Illustration 165 g01145925

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

5. Remove bolts (9) and separate body (10) from spacer (12) and body (4).

6. Use Tooling (A) and a suitable press in order to remove the bearings from body (10).

7. Remove gears (11). Remove spacer (12).

8. Remove the bearings from spacer (12).

9. Remove shaft assemblies (13).

10. Remove bolts (14) and retainer (15).

11. Remove spring (16), plunger ring (17), and plunger (18).

12. Use Tooling (A) and a suitable press in order to remove the bearings from body (4).

i02289486

Engine Oil Pump - Assemble

SMCS Code: 1304-016

Assembly Procedure

Table 26

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Group	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

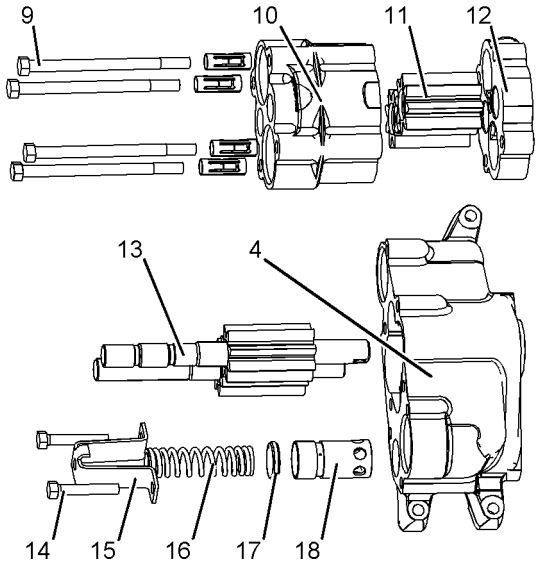


Illustration 166 g01145925

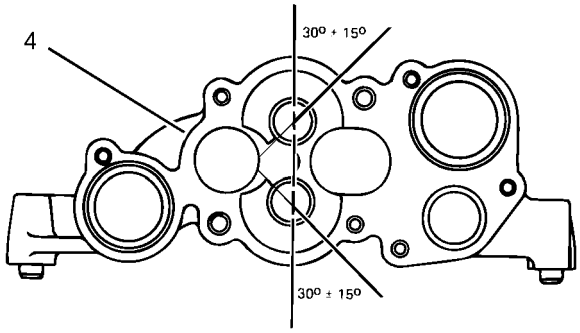


Illustration 167 g01146257

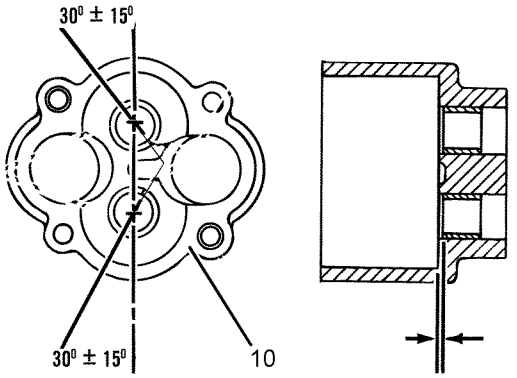


Illustration 168 g01146265

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

1. Use Tooling (A) to install the bearings in body (4) until the bearings are even with the outside surface of body (4). Install the bearings so the junctions in the bearings are 30 ± 15 degrees from the center line of the bearing bores and toward the outlet passage in the oil pump.
2. Install plunger (18), plunger ring (17), and spring (16).
3. Install retainer (15) and bolts (14).
4. Install shaft assemblies (13) into body (4).
5. Use Tooling (A) to install the bearings in spacer (12). Install the bearings in the center of the bores. Make sure that the oil holes in the bearings are in alignment with the oil holes in the spacer. Make sure that the junctions in the bearings are in alignment with the cavity in the spacer.
6. Use Tooling (A) to install the bearings in body (10) until the bearings are 1.52 ± 0.25 mm (0.060 ± 0.010 inch) from the inside edge of the bearing bores. Install the bearings so the junctions in the bearings are 30 ± 15 degrees from the center line of the bearing bores, and toward the outlet passage. The outlet passage has a cavity between the bearing bores.
7. Install spacer (12). Install gears (11) onto shaft assemblies (13).
8. Install body (10) on spacer (12). Install bolts (9).

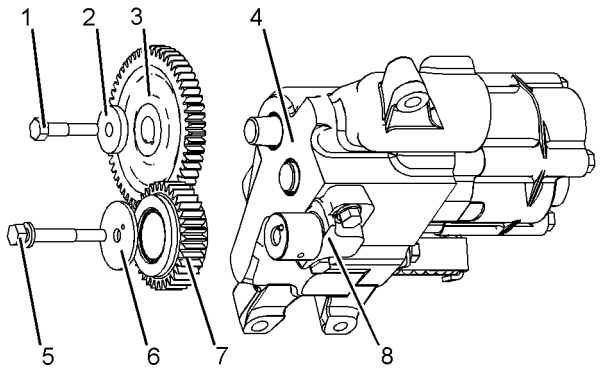


Illustration 169 g01145905

9. Install the key into the pump shaft. Install drive gear (3). Install washer (2) and bolt (1). Tighten bolt (1) to a torque of 55 ± 7 N·m (40 ± 5 lb ft). Install shaft assembly (8) on body (4).

10. Use Tooling (A) and a suitable press in order to install the bearing in idler gear assembly (7).

11. Install idler gear assembly (7), thrust plate (6), and bolt (5).

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i04158549

Engine Oil Pump - Install

SMCS Code: 1304-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

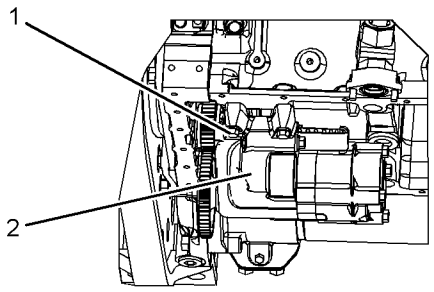


Illustration 170 g01145746

1. Position engine oil pump (2) and install bolts (1).

2. Connect the tube assemblies to engine oil pump (2).

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

i02289620

Water Pump - Remove

SMCS Code: 1361-011

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

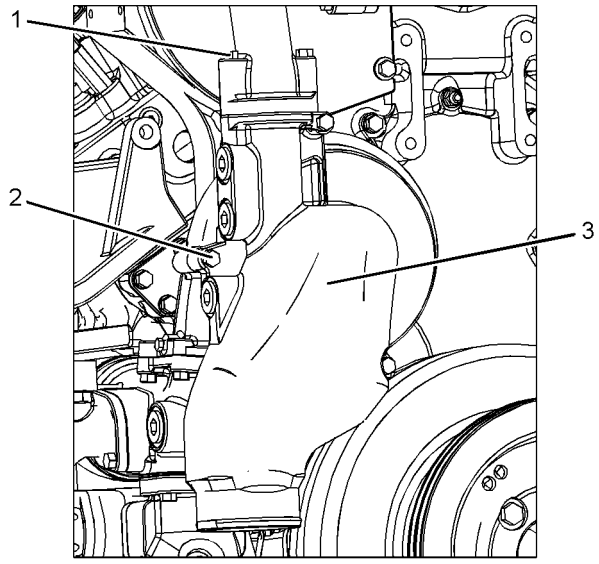


Illustration 171 g01146307

2. Remove bolts (1) and bolts (2).

3. Remove cover (3).

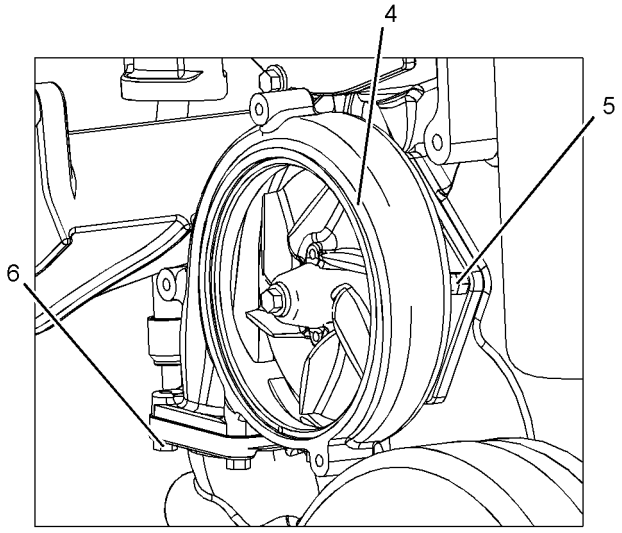


Illustration 172 g01146308

4. Remove bolts (6) and nuts (5).

5. Remove water pump (4).

i04948128

Water Pump - Disassemble

SMCS Code: 1361-015

Disassembly Procedure

Table 27

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2264	Puller Group	1
	4B-3903	Bolt 5/16 - 18 NC by 4 inch	2
	1P-0456	Plate	1
	4B-4277	Washer	2
B	1P-0510	Driver Group	1

Start By:

a. Remove the water pump. Refer to Disassembly and Assembly, “Water Pump - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The water pump seal can be replaced without removing the water pump from the engine.

Note: An intermittent leakage of a small amount of coolant from the hole in the water pump housing is not an indication of a water pump seal failure. This is required to provide lubrication for the seal. Do not replace the water pump seal unless a large amount of leakage or a constant flow of coolant is draining from the water pump housing.

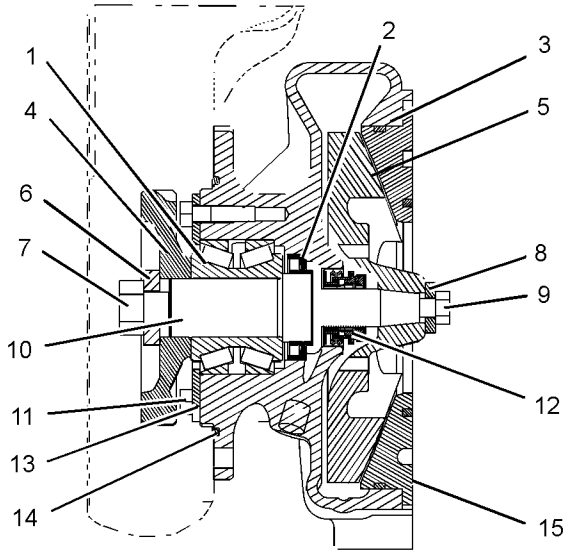


Illustration 173 g01195730

1. Remove adapter (15).

2. Remove bolt (9) and washer (8).

3. Use Tooling (A) to remove impeller (5) from shaft (10).

4. Remove bolt (7), washer (6), and gear (4) from shaft (10).

5. Remove bolts (11) and retainer (13).

6. Remove O-ring seal (14) from housing (3).

7. Use a suitable press to remove shaft (10) and bearing assembly (1) from housing (3).

8. Use a suitable press to remove bearing assembly (1) from shaft (10).

9. Remove seal assembly (12) from housing (3).

10. Use Tooling (B) to remove lip seal (2) from the housing.

i08309085

Water Pump - Disassemble

SMCS Code: 1361-015

S/N: PZB1–Up

S/N: NZG1–Up

Disassembly Procedure

Table 28

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-9895	Crossblock	1
	1P-0820	Hydraulic Puller	1
	126-7181	Sliding Plate	2
	3H-0465	Push-Puller Plate	6
	599-6282	Puller Stud	2
	3S-6224	Electric Hydraulic Pump Gp	1
	2L-4523	Bolt	2
	5P-8244	Hard Washer	2
	6B-6682	Full Nut	4
B	521-4900	Puller As.	1

Start By:

a. Remove the water pump.

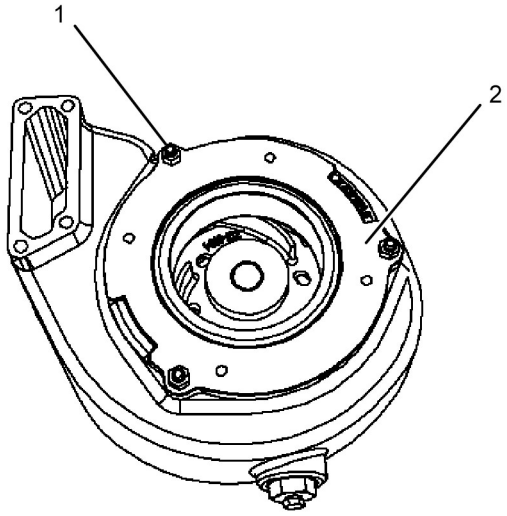


Illustration 174 g03475023

1. Remove nuts (1) and the studs from cover assembly (2). Remove cover assembly (2).

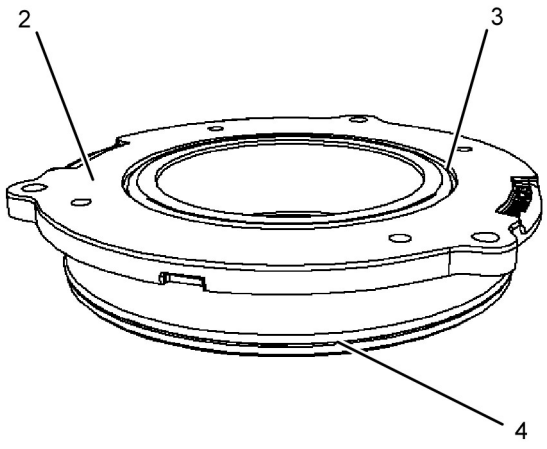


Illustration 175 g03475339

2. Remove O-ring seal (3) and O-ring seal (4) from cover assembly (2).

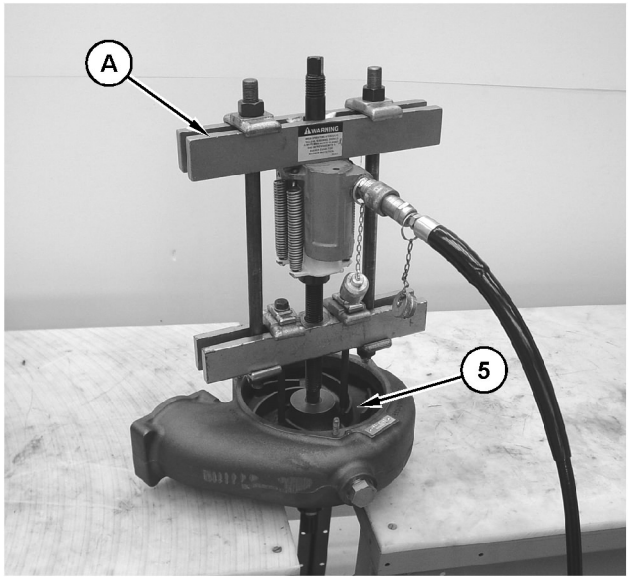


Illustration 176 g06133692

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

3. Use Tooling (A) to remove impeller (5).

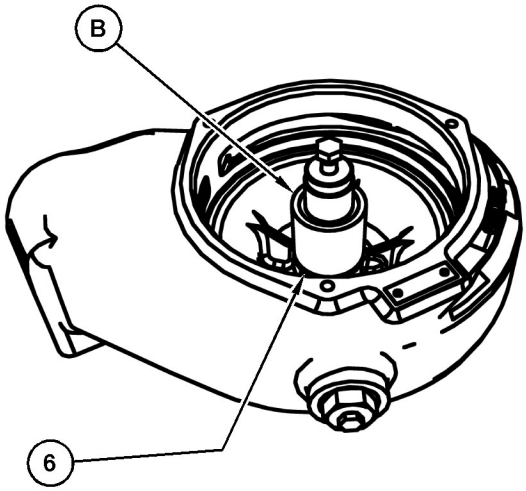


Illustration 177 g06133697

4. Use Tooling (B) to remove the rotating seal group (6).

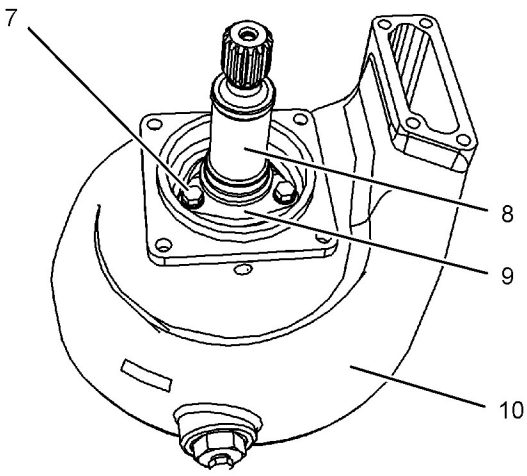


Illustration 178 g06133750

5. Remove bolts (7) and the washers from thrust washer (8) from pump housing (9).

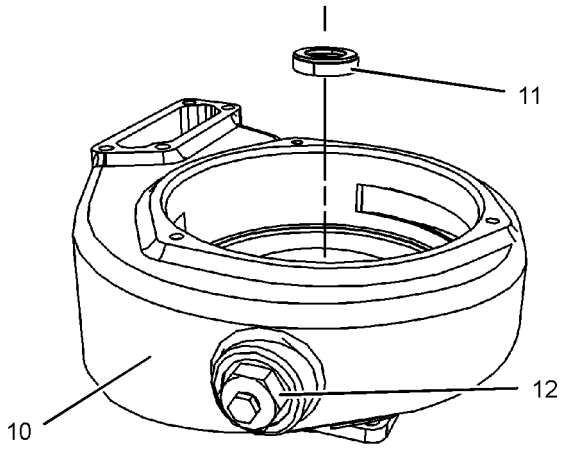


Illustration 179 g06133752

6. Remove stationary seal group (11).

7. Remove plug assembly (12) from pump housing (10).

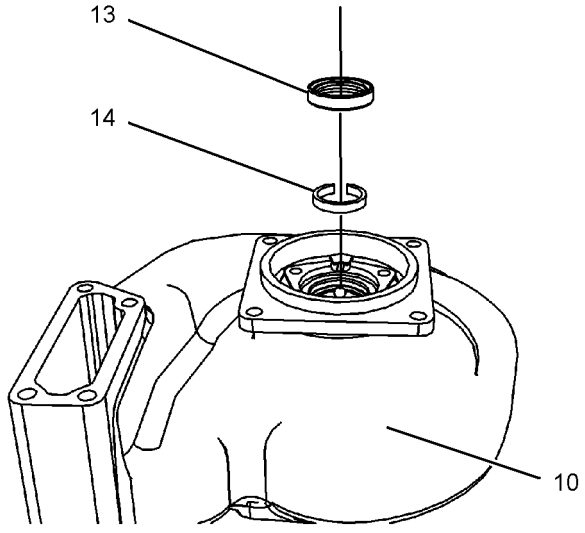


Illustration 180 g06133753

8. Remove lip seal (13), ring assembly (14), and the locating pin from pump housing (10).

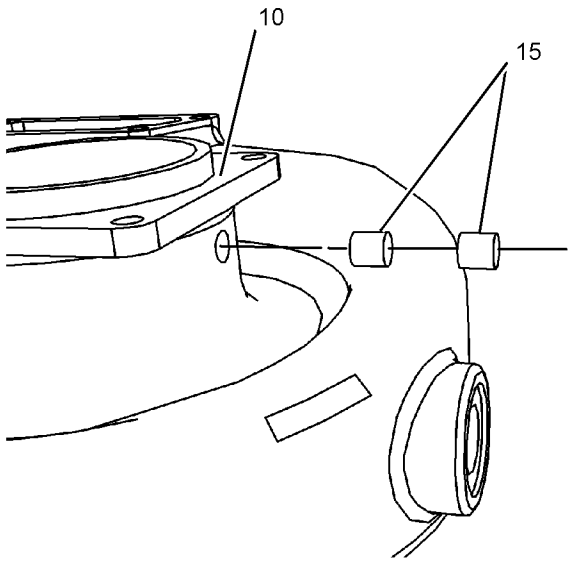


Illustration 181 g06133754

9. Remove filters (15) from pump housing (10).

Reference: Refer to Reuse and Salvage Guidelines, SEBF8418, “Salvage of Water Pumps in 3500 Series Engines” for reuse and salvage guidelines.

i06831538

Water Pump - Assemble

SMCS Code: 1361-016

S/N: WZH1–Up

Assembly Procedure

Table 29

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	1P-0510	Driver Gp	1
D	7N-8268	Installation Tool	1
E	438-8155	Installation Tool	1

Reference: Refer to Reuse and Salvage Guidelines, SEBF8418, “Salvage of Water Pumps in 3500 Series Engines” for reuse and salvage guidelines.

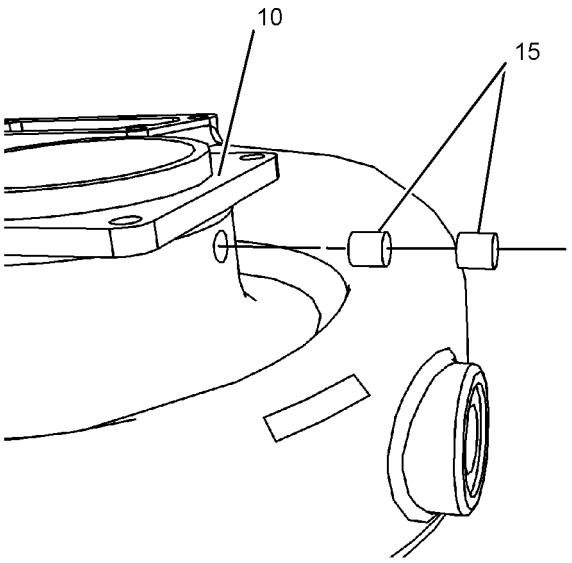


Illustration 182 g06133754

1. Install filters (15) into pump housing (10).

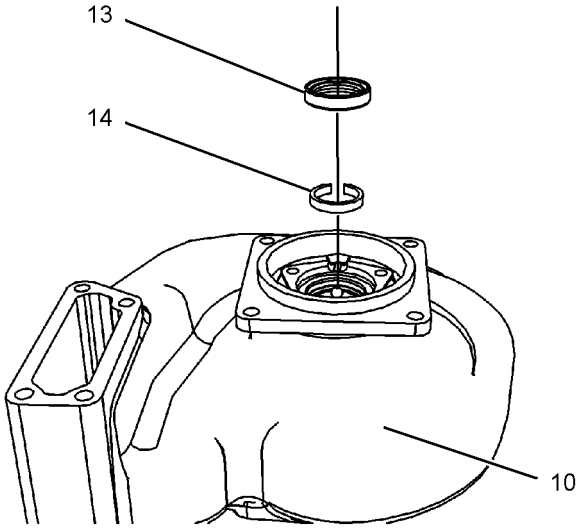


Illustration 183 g06133753

2. Install ring (14) and the locating pin.

3. Use Tooling (C) to install lip seal (13) into pump housing (10).

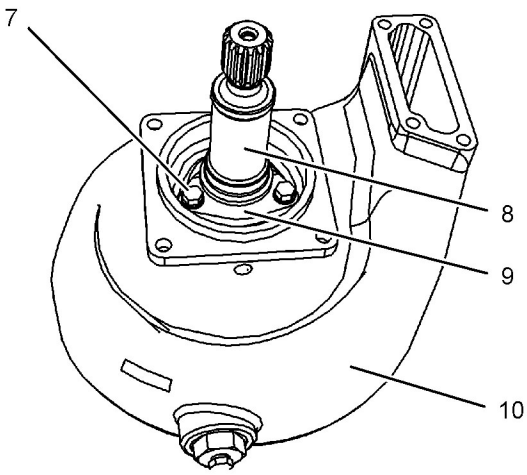


Illustration 184 g06133750

4. Install shaft assembly (8), thrust washer (9), bolts (7), and the washers into pump housing (10).

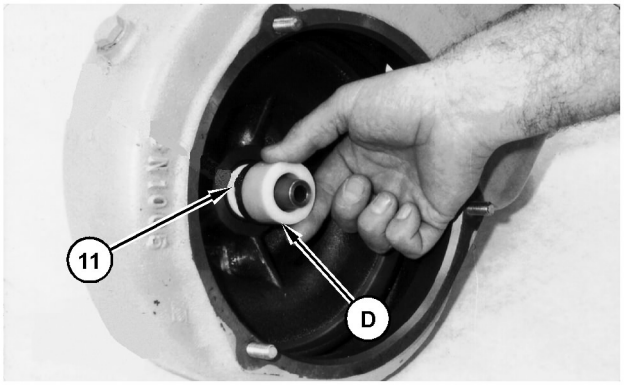


Illustration 185 g06133755

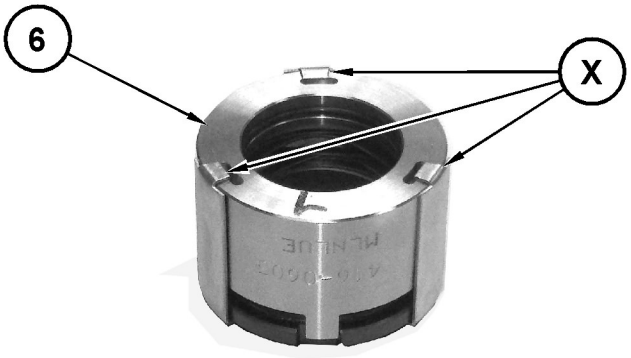


Illustration 187 g06133756

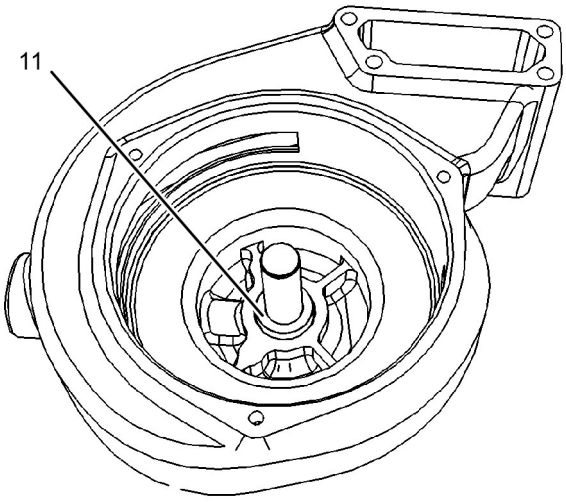


Illustration 186 g03476619

5. Use Tooling (D) to install stationary seal group (11) with the ceramic side facing out.

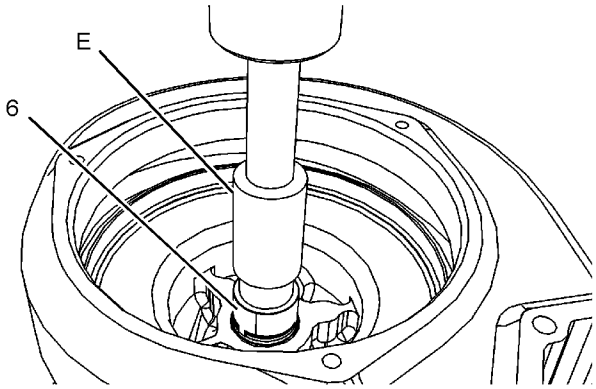


Illustration 188 g06133757

6. Use Tooling (E) and a suitable press to install rotating seal group (6). Rotating seal group (6) is to be installed with installation clips (X) in place until rotating seal group (6) is fully seated. Remove installation clips (X).

Note: Do not use hammer to install seal groups as damage to the ceramic faces on the seal groups will occur.

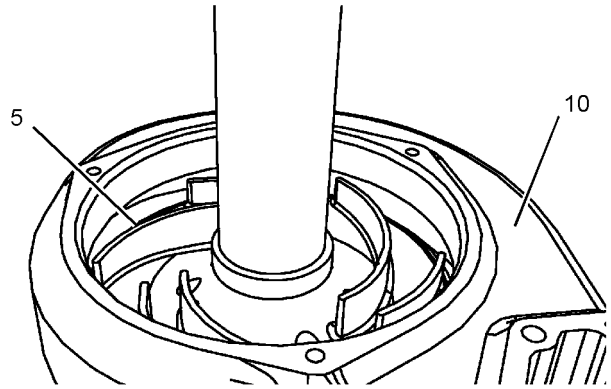


Illustration 189 g06133758

7. Lubricate the shaft assembly with a light coat of engine oil. Use a suitable press to install impeller (5) into pump housing (10) and onto the shaft assembly. Install impeller (5) to a depth of 0.0 ± 0.15 mm (0.00000 ± 0.00591 inch) from the end of the shaft assembly to the outer face of the impeller.

Note: Support the shaft assembly to prevent damage to the thrust washer.

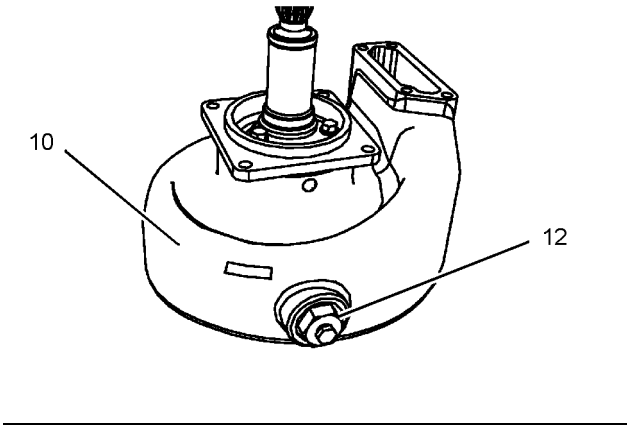


Illustration 190 g06133759

8. Install plug assembly (12) and the O-ring seal into pump housing (10).

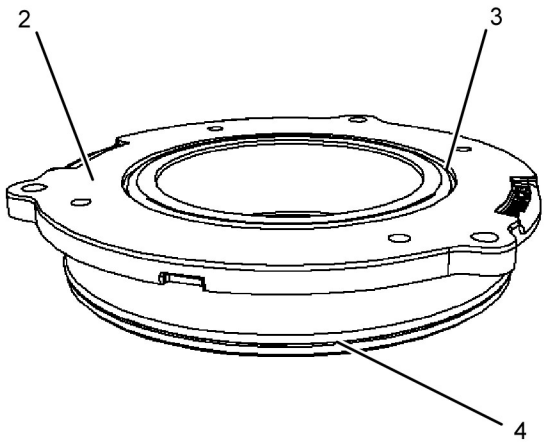


Illustration 191 g03475339

9. Install O-ring seal (4) and O-ring seal (3) onto cover assembly (2).

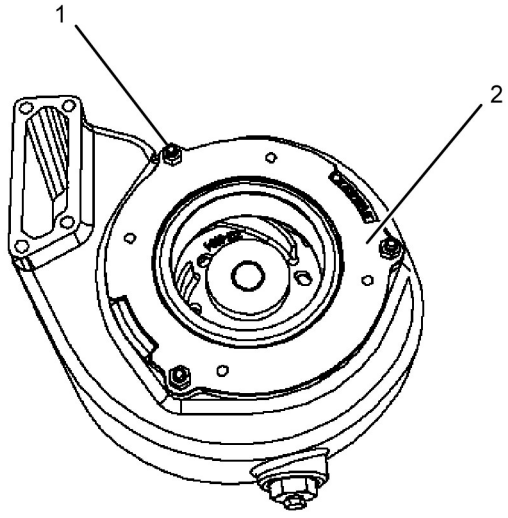


Illustration 192 g03475023

10. Install cover assembly (2), the studs, and nuts (1). Tighten the studs to a torque of 35 ± 5 N·m (25 ± 3 lb ft). Tighten nuts (1) to a torque of 27 ± 5 N·m (19 ± 3 lb ft).

End By:

a. Install the water pump.

i07157605

Water Pump - Assemble

SMCS Code: 1361-016

Assembly Procedure

Table 30

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	1P-0510	Driver Group	1
C	139-0088	Seal Installation Tool	1
D	-	Loctite Quick Cure Primer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

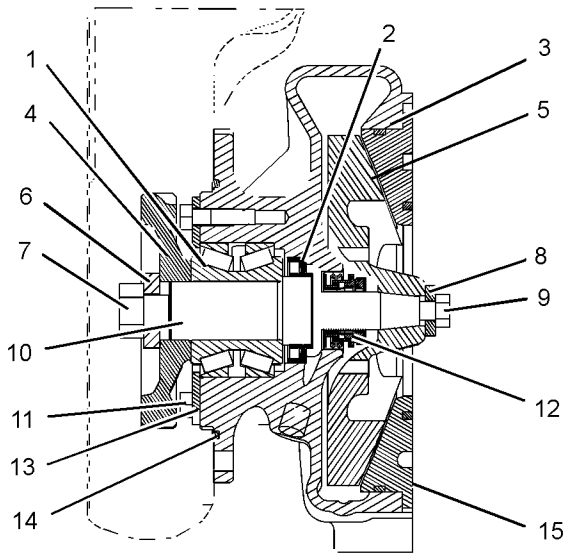


Illustration 193 g01195730

1. Use Tooling (B) to install lip seal (2) into the housing.

2. Apply Tooling (D) to shaft (10). Use a suitable press to install bearing assembly (1) on shaft (10).

3. Install shaft (10) and bearing assembly (1) in housing (3).

4. Install O-ring seal (14) on housing (3).

5. Install retainer (13) and bolts (11).

6. Position gear (4) on shaft (10). Install washer (6) and bolt (7).

7. Use Tooling (C) to install seal assembly (12) onto shaft (10) until the stationary cup is fully seated into housing (3).

8. Install impeller (5) on shaft (10). Install washer (8) and bolt (9). Tighten bolt (9) to a torque of 39 ± 3 N·m (29 ± 2 lb ft).

9. Install adapter (15).

End By:

a. Install the water pump. Refer to Disassembly and Assembly, “Water Pump - Install”.

i02290018

Water Pump - Install

SMCS Code: 1361-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

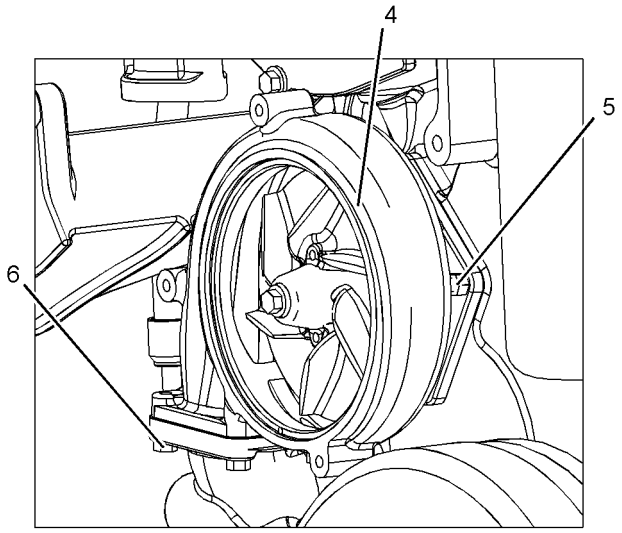


Illustration 194 g01146308

1. Position water pump (4) in the front housing.

2. Install nuts (5) and bolts (6).

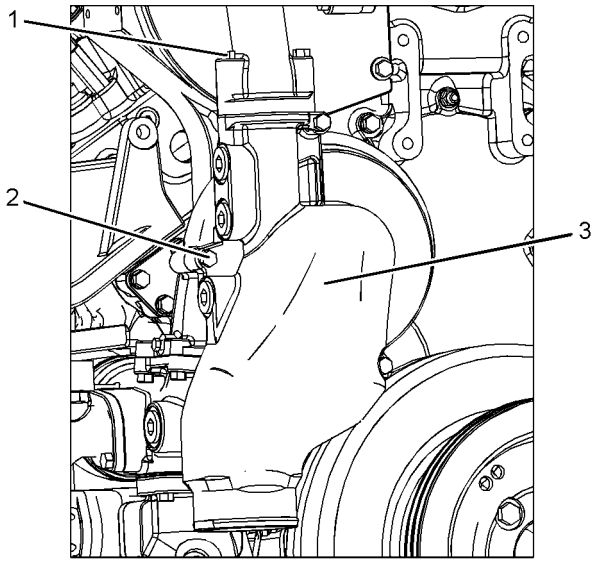


Illustration 195 g01146307

3. Position cover (3) on the water pump.

4. Install bolts (2) and bolts (1).

5. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i08287082

Water Temperature Regulator Housing - Remove and Install

SMCS Code: 1393-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

Table 31

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT - 3578	Driver As	1
B	FT - 3642	Driver Tool	1
C	221 - 8647	Seal Installer Gp	1
D	-	Loctite 540	-

⚠ WARNING

Personal injury can result from hot coolant, steam, and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and allow sufficient time for the cooling system to cool.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all hose assemblies, on all tube assemblies, and on all wire harnesses for installation purposes. Plug all hose assemblies and all tube assemblies to prevent fluid loss and prevent contaminants from entering the system.

1. Drain the cooling system coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct draining procedure.

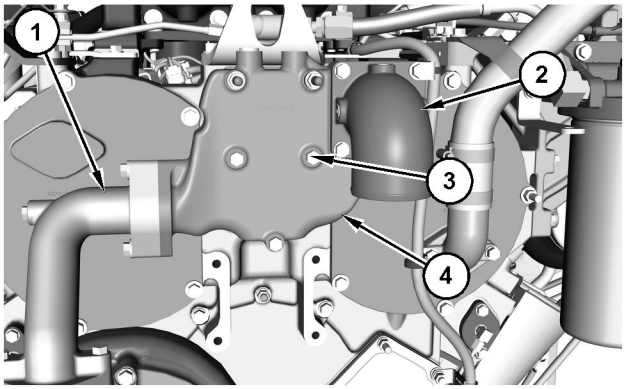


Illustration 196 g06612386

Some components are hidden for photographic purposes

2. Remove the bolts and disconnect elbow (1). Remove the bolts and disconnect elbow (2).

3. Remove bolts (3) and water temperature regulator assembly (4).

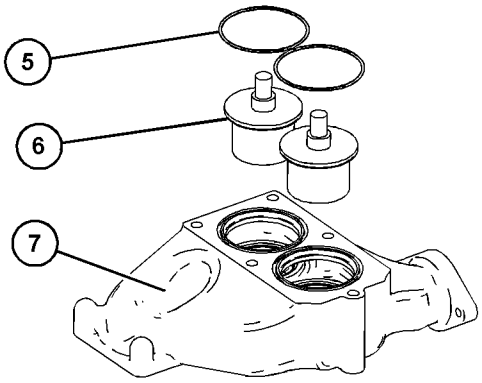


Illustration 197 g06612152

4. Remove O-ring seals (5) and water temperature regulators (6) from water temperature regulator housing (7).



Illustration 198 g06612158

5. Remove lip seals (8).

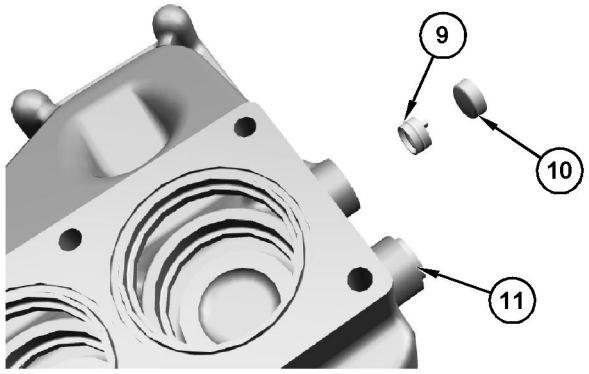


Illustration 199 g06612042

6. Remove plug (10) and valve assembly (9).

7. Remove plug (11) and the O-ring seal.

Installation Procedure

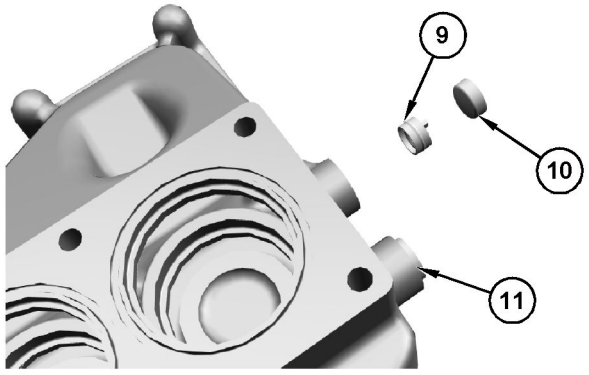


Illustration 200 g06612042

1. Install the O-ring seal and plug (11).

2. Use Tooling (A) (not shown) to install valve assembly (9). Install valve assembly (9).

3. Apply Tooling (D) to plug (10). Use Tooling (B) (not shown) to install plug (10). Install plug (10).



Illustration 201 g06612158

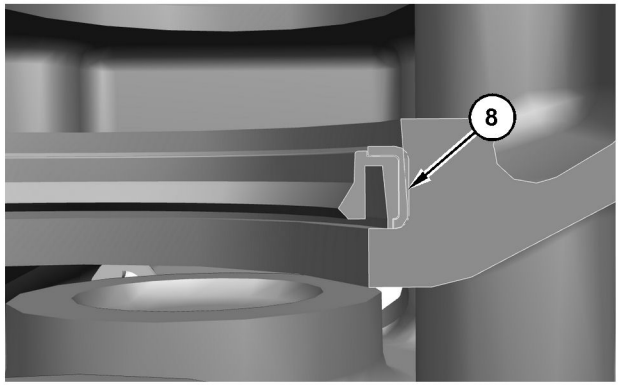


Illustration 202 g06612412

Orientation of the lip seals.

4. Use Tooling (C) (not shown) to install lip seals (8). Install lip seals (8) in the orientation as shown in Illustration 202 .

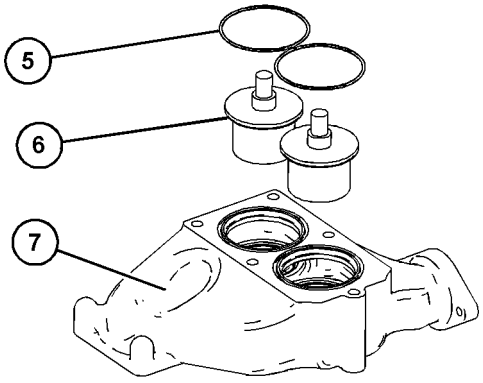


Illustration 203 g06612152

5. Install water temperature regulators (6) and O-ring seals (5) into water temperature regulator housing (7).

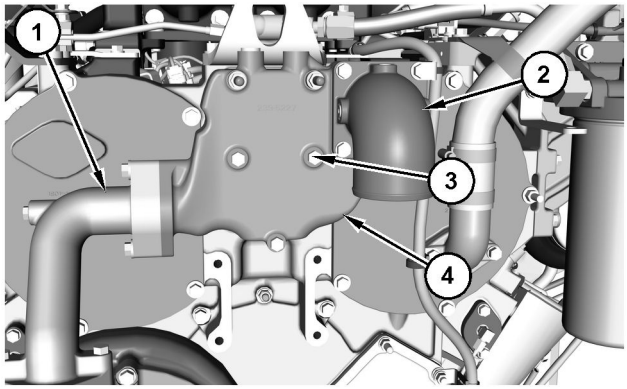


Illustration 204 g06612386

6. Position water temperature regulator assembly (4) on the engine and install bolts (3).

7. Connect elbow (2) and install the bolts. Connect elbow (1) and install the bolts.

8. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change” for the correct filling procedure.

i08289026

Water Temperature Regulator Housing - Remove and Install

SMCS Code: 1393-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 32

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT-3578	Driver As	1
B	FT-3642	Driver Tool	1
C	221-8647	Seal Installer Gp	1
D	-	Loctite 540	-

⚠ WARNING

Personal injury can result from hot coolant, steam, and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and allow sufficient time for the cooling system to cool.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all hose assemblies, on all tube assemblies, and on all wire harnesses for installation purposes. Plug all hose assemblies and all tube assemblies to prevent fluid loss and prevent contaminants from entering the system.

1. Release the system pressure. Refer to Operation and Maintenance Manual, “System pressure - Release”.
2. Drain the coolant from the cooling system into a suitable container for storage or disposal until the coolant is below the level of the water temperature regulator housing. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct draining procedure.

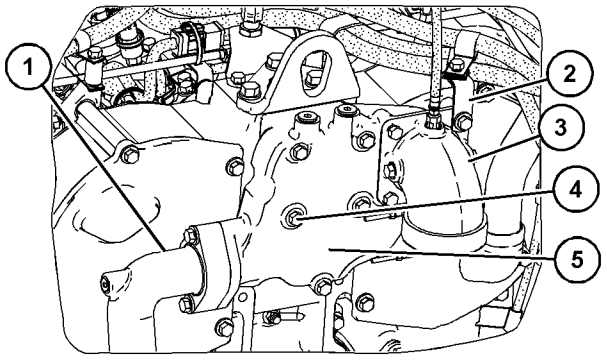


Illustration 205 g06613971

3. Remove the bolts and disconnect bracket (2).
4. Remove the bolts and disconnect elbow (3). Remove the bolts and disconnect elbow (1)
5. Remove bolts (4) and water temperature regulator assembly (5).

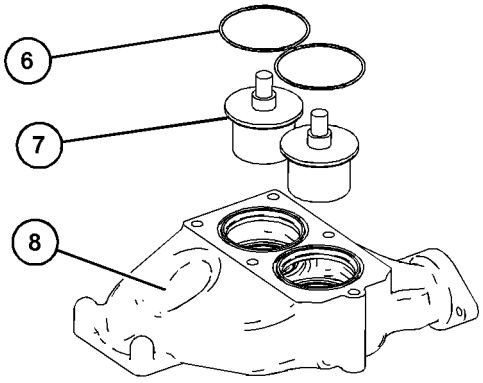


Illustration 206 g06613980

6. Remove O-ring seals (6) and water temperature regulators (7) from water temperature regulator housing (8).



Illustration 207 g06613985

7. Remove lip seals (9).

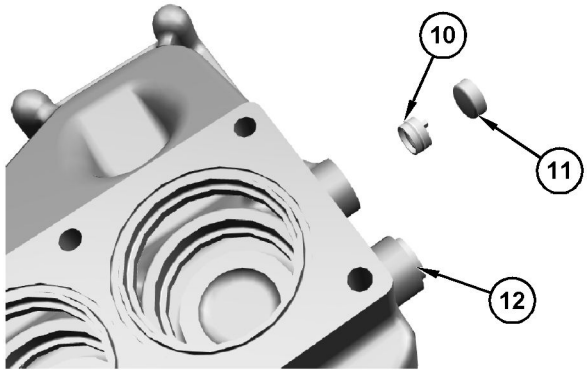


Illustration 208 g06613986

8. Remove plug (11) and valve assembly (10).

9. Remove plug (12) and the O-ring seal.

Installation Procedure

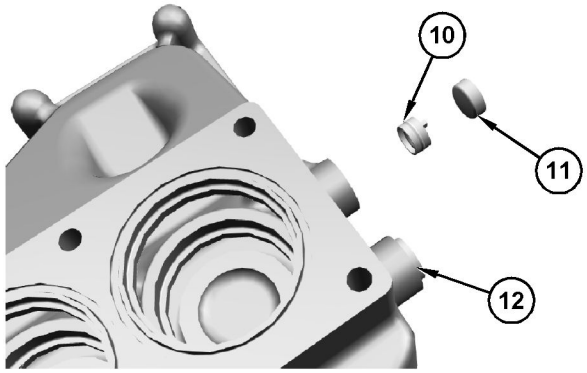


Illustration 209 g06613986

1. Install the O-ring seal and plug (12).

2. Use Tooling (A) (not shown) to install valve assembly (10). Install valve assembly (10).

3. Apply Tooling (D) to plug (11). Use Tooling (B) (not shown) to install plug (11). Install plug (11).



Illustration 210 g06613985

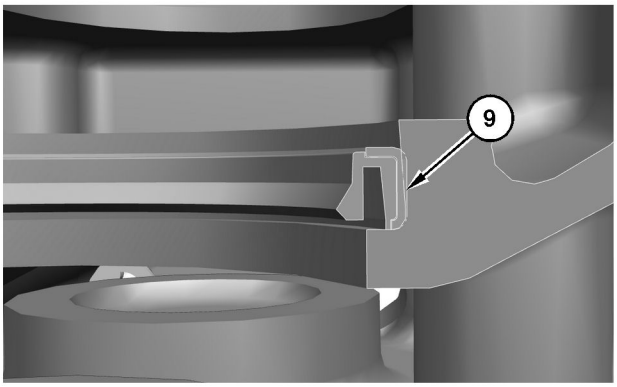


Illustration 211 g06614007

Orientation of the lip seals

4. Use Tooling (C) (not shown) to install lip seals (9). Install lip seals (9) in the orientation as shown in Illustration 211 .

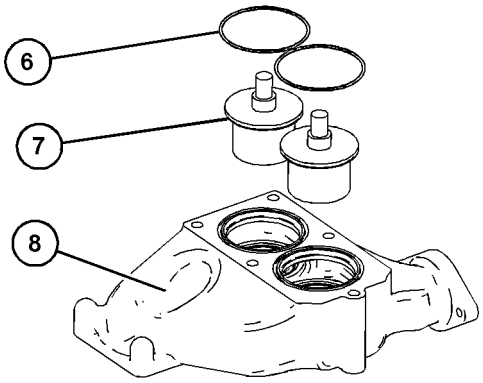


Illustration 212 g06613980

5. Install water temperature regulators (7) and O-ring seals (6) into water temperature regulator housing (8).

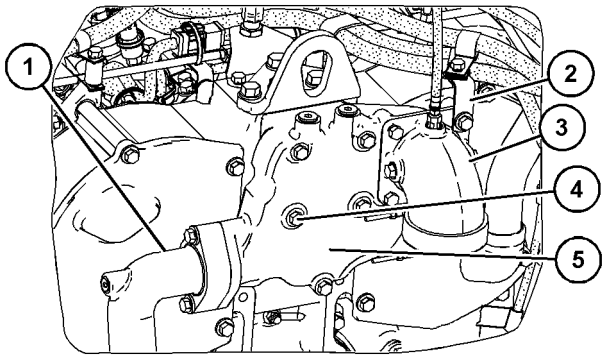


Illustration 213 g06613971

6. Position water temperature regulator assembly (5) on the engine and install bolts (4).

7. Connect elbow (1) and install the bolts. Connect elbow (3) and install the bolts.

8. Connect bracket (2) and install the bolt.

9. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct filling procedure.

i05430736

Gear Group (Rear) - Remove

SMCS Code: 1206-011; 1212-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

C27 Removal Procedure

Table 33

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Group	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Prior to removal of the flywheel, position the number one piston in the top center position (TC). The engine should be at the top center position in order to properly install the rear gear group. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

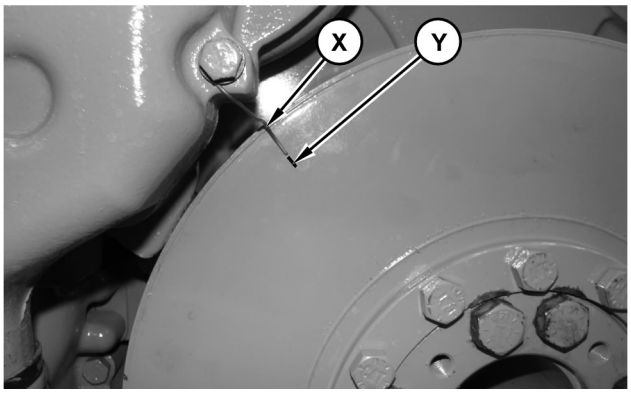


Illustration 214 g02087895

(X) Marker
(Y) Alignment Mark

1. With the number one piston in the top center position (TC), attach a Marker to the engine and place an Alignment Mark on the vibration damper.

2. Remove the flywheel housing.

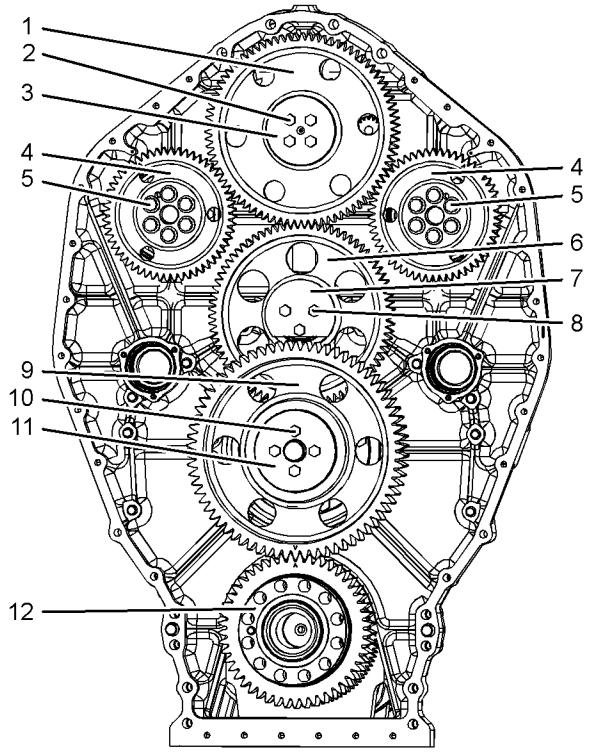


Illustration 215 g01151801

3. Remove bolts (10), thrust plate (11), and gear assembly (9).

4. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (9).

5. Remove bolts (8), gear assembly (6), and shaft assembly (7).

6. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (6).

7. Remove bolts (2), gear assembly (1), and shaft assembly (3).

8. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (1).

9. Remove gear assembly (12).

10. Remove bolts (5) and gear assemblies (4).

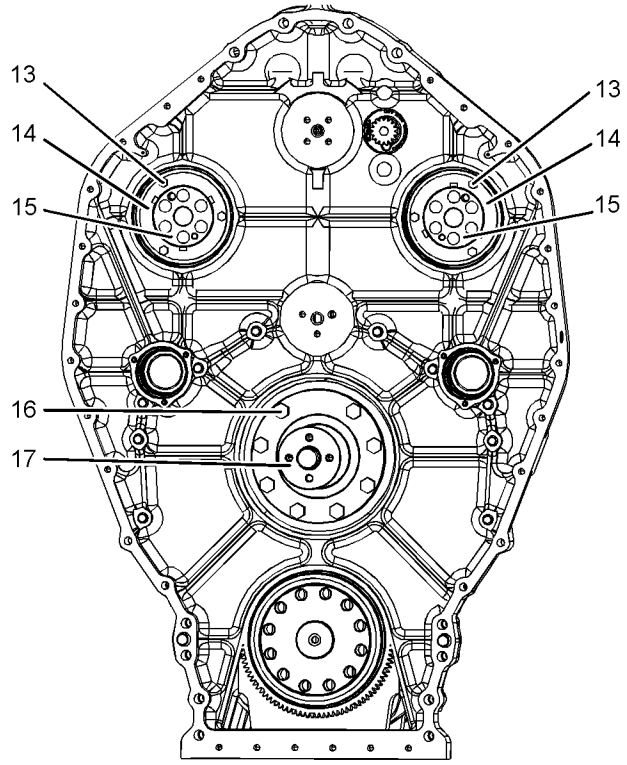


Illustration 216 g01151842

11. Remove bolts (16) and shaft assembly (17).

12. Remove bolts (13), thrust plates (14), and adapter assemblies (15).

13. Use bolt (13) in order to remove the sealing plates. Remove the O-ring seals.

C32 Removal Procedure

Table 34

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Group	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Prior to removal of the flywheel, position the number one piston in the top center position (TC). The engine should be at the top center position in order to properly install the rear gear group. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

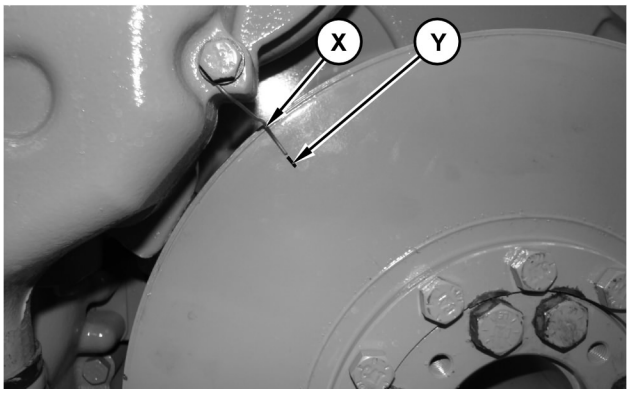


Illustration 217 g02087895

(X) Marker
(Y) Alignment Mark

1. With the number one piston in the top center position (TC), attach a Marker to the engine and place an Alignment Mark on the vibration damper.

2. Remove the flywheel housing.

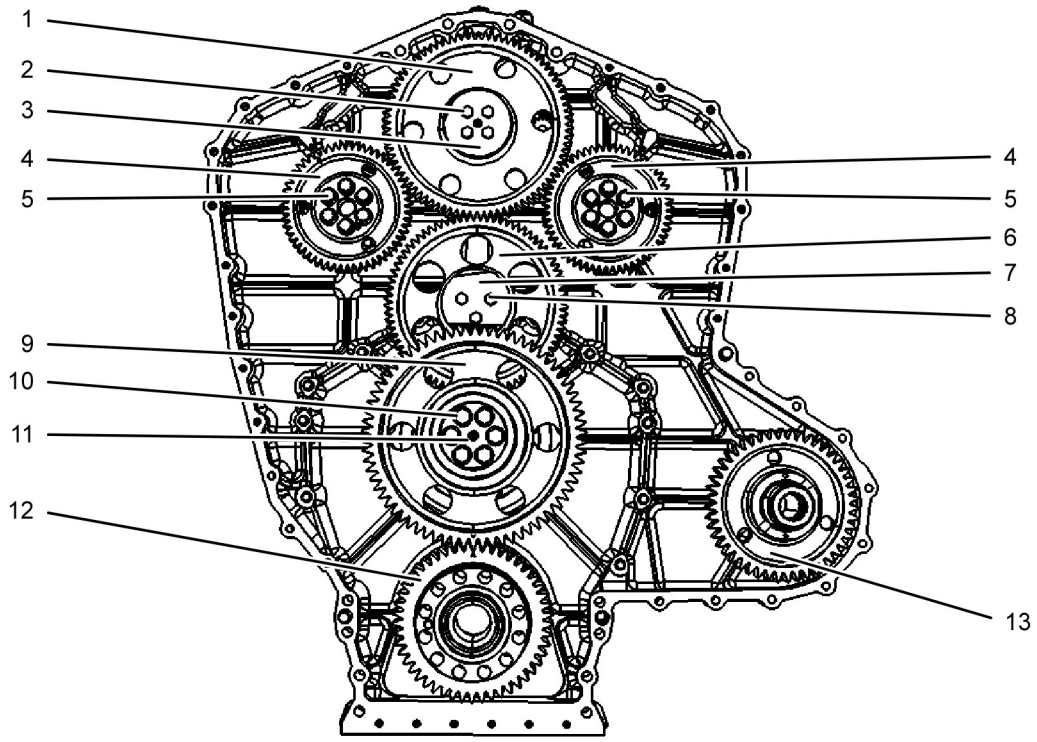


Illustration 218 g03427967

3. Remove bolts (10), retainer assembly (11), the O-ring seal, and gear assembly (9).

4. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (9).

5. Remove bolts (8), gear assembly (6), and stub shaft assembly (7).

6. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (6).

7. Remove bolts (2), gear assembly (1), and stub shaft assembly (3).

8. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (1).

9. Remove gear assembly (12).

10. Remove bolts (5) and gear assemblies (4).

11. Remove gear assembly (13) and the thrust washers.

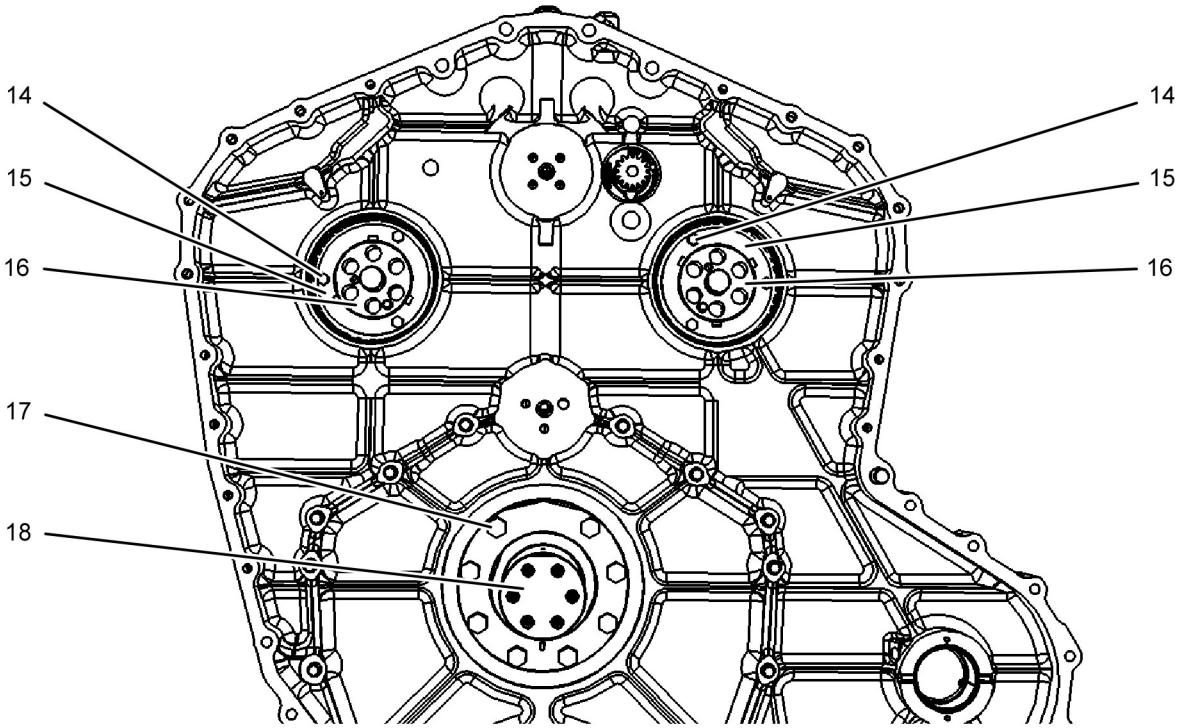


Illustration 219 g03428001

12. Remove bolts (17) and shaft assembly (18).

13. Remove bolts (14), thrust plates (15), and adapter assemblies (16).

14. Use bolt (14) in order to remove the sealing plates. Remove the O-ring seals.

i05713891

Gear Group (Rear) - Remove

SMCS Code: 1206-011; 1212-011

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

C27 Removal Procedure

Table 35

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Group	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Prior to removal of the flywheel, position the number one piston in the top center position (TC). The engine should be at the top center position in order to properly install the rear gear group. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

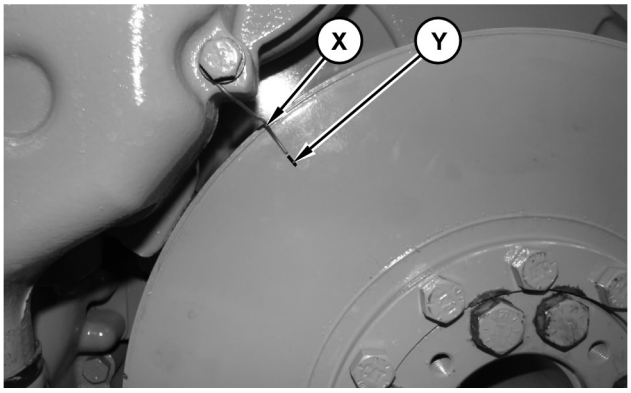


Illustration 220 g02087895

(X) Marker
(Y) Alignment Mark

1. With the number one piston in the top center position (TC), attach a Marker to the engine and place an Alignment Mark on the vibration damper.

2. Remove the flywheel housing.

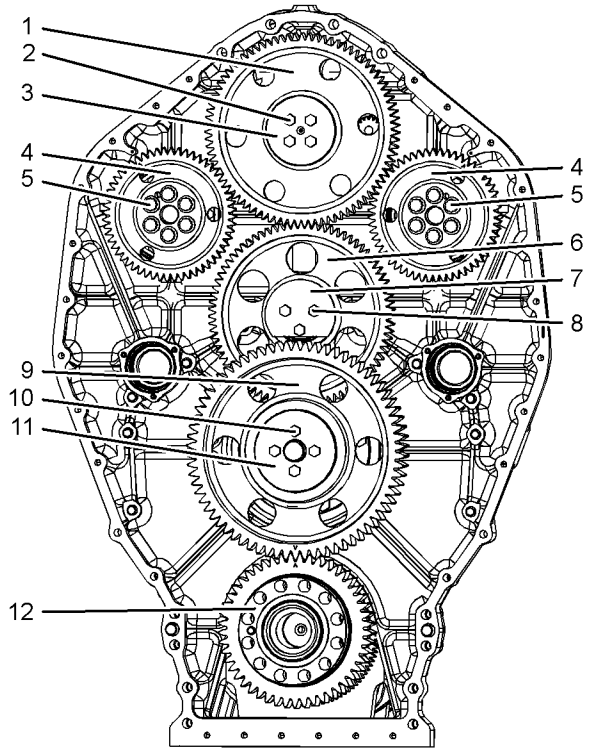


Illustration 221 g01151801

3. Remove bolts (10), thrust plate (11), and gear assembly (9).

4. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (9).

5. Remove bolts (8), gear assembly (6), and shaft assembly (7).

6. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (6).

7. Remove bolts (2), gear assembly (1), and shaft assembly (3).

8. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (1).

9. Remove gear assembly (12).

10. Remove bolts (5) and gear assemblies (4).

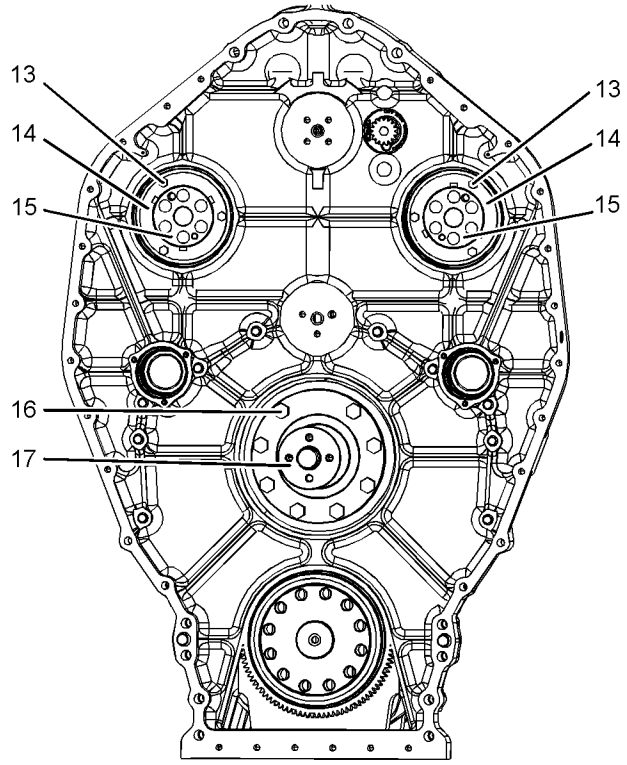


Illustration 222 g01151842

11. Remove bolts (16) and shaft assembly (17).

12. Remove bolts (13), thrust plates (14), and adapter assemblies (15).

13. Use bolt (13) in order to remove the sealing plates. Remove the O-ring seals.

i05714210

Gear Group (Rear) - Install

SMCS Code: 1206-012; 1212-012

S/N: TZC1–Up

S/N: HPE1–Up

S/N: JHM1–Up

S/N: TZR1–Up

C27 Installation Procedure

Table 36

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Gp	1
B	-	Guide Stud 5/8 - 18 by 12 inch	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Apply clean engine oil to the bearings and the shaft assemblies prior to installation on the engine.

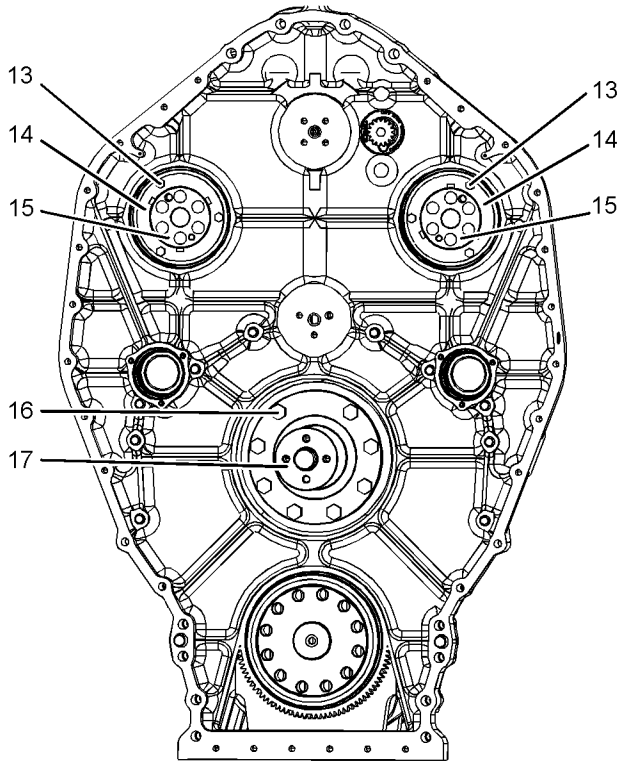


Illustration 223 g01151842

1. Install the O-ring seals and the sealing plates on the cylinder head.

2. Install adapter assemblies (15), thrust plates (14), and bolts (13).

3. Position shaft assembly (17) and install bolts (16).

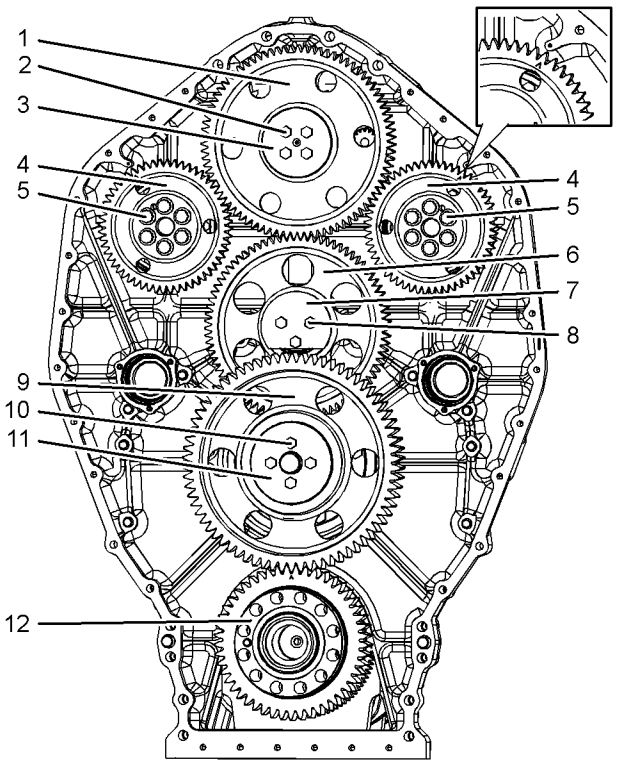


Illustration 224 g02087918

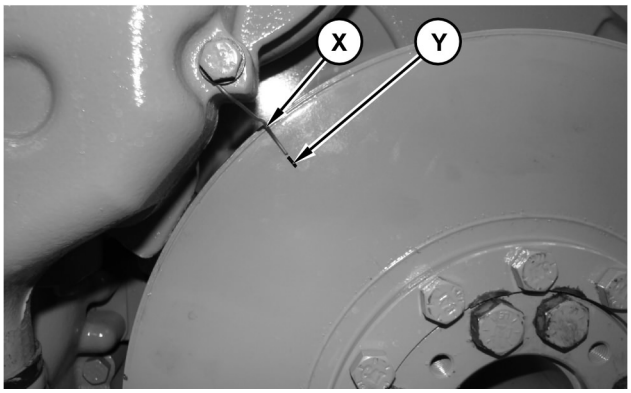


Illustration 225 g02087895

(X) Marker
(Y) Alignment Mark

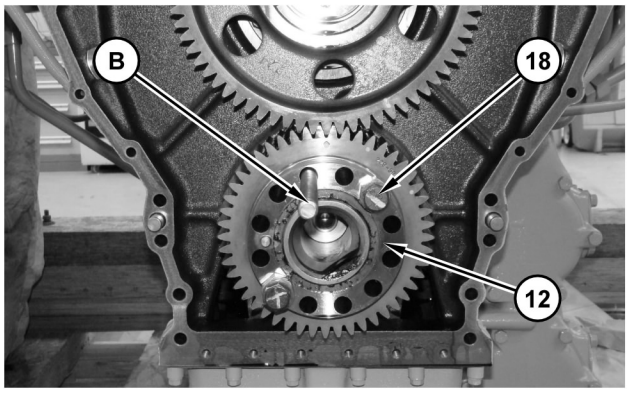


Illustration 226 g02088394

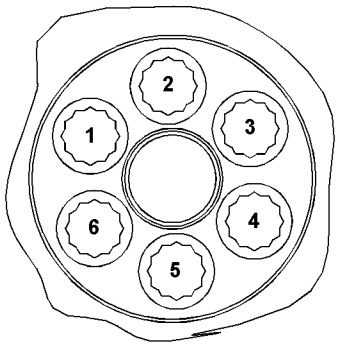


Illustration 227 g01151468

Note: Align the timing marks on gear assemblies (4) with the timing marks on the rear housing and align the dowels on gear assemblies (4) with the adapter assemblies.

4. Position gear assemblies (4) and install bolts (5).

5. Install Tooling (B) in the crankshaft. Install gear assembly (12).

6. If the top center position is already marked on the vibration damper, proceed to Step 7.

a. Install the flywheel housing and the flywheel temporarily. Two bolts in the flywheel housing and the flywheel are sufficient.

b. Position the number one piston in the top center position (TC). The engine should be at the top center position in order to install the rear gear group. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

c. With the number one piston in the top center position (TC), attach a marker to the engine and place an Alignment Mark on the vibration damper.

d. Remove the flywheel and the flywheel housing.

7. Install two nuts on two bolts for the flywheel (18). The nuts will provide spacing when the bolts are installed. Install two bolts for the flywheel (18) in gear assembly (12).

8. Use Tooling (A) and a suitable press to install the bearing in gear assembly (1). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch).

9. Install shaft assembly (3), gear assembly (1), and bolts (2). Tighten the bolts (2) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

10. Use Tooling (A) and a suitable press to install the bearing in gear assembly (6). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch).

11. Install shaft assembly (7), gear assembly (6), and bolts (8).

12. Use Tooling (A) and a suitable press to install the bearing in gear assembly (9). Install the bearing to a depth of 3.2 ± 0.5 mm (0.13 ± 0.02 inch).

Note: Ensure that the number one piston is in the top center position (TC). Ensure that the timing marks on gear assemblies (4) are in alignment with the timing marks on the rear housing.

Note: Do not use the alignment marks found on gears (9) and (12). Doing so will create errors. Use the following steps to align gear (9).

13. Hold gear assembly (6) in the direction of normal engine rotation in order to remove the backlash. Place gear assembly (9) on the shaft assembly. The teeth on gear assembly (9) will engage with gear assembly (12) first. The teeth on gear assembly (9) will engage with the teeth on gear assembly (6) next. If the teeth on gear assembly (9) do not engage properly, turn the gear assembly to the next tooth and try again.

14. Install thrust plate (11) and bolts (10).

15. Turn the engine in the opposite direction of normal engine rotation for approximately 45 degrees. Turn the engine in the direction of normal engine rotation until the alignment mark on the vibration damper and the marker on the engine are aligned. Ensure that timing marks on gear assemblies (4) are in alignment with the marks on the rear housing.

16. Tighten the bolts on gear assemblies (4) to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

End By:

a. Install the flywheel housing.

i07702985

Gear Group (Rear) - Install

SMCS Code: 1206-012; 1212-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

C27 Installation Procedure

Table 37

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Gp	1
B	-	Guide Stud 5/8 - 18 by 12 inch	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Prior to rear gear group installation, inspect the screens integral to the external lubrication adaptors (Part # 297-7956) located in the housing. Clean or replace adaptors as needed. Part is non-serviceable. Proper inspection/cleaning and or replacing the external lubrication adaptors will prevent contamination of the rear gear group.

Note: Apply clean engine oil to the bearings and the shaft assemblies prior to installation on the engine.

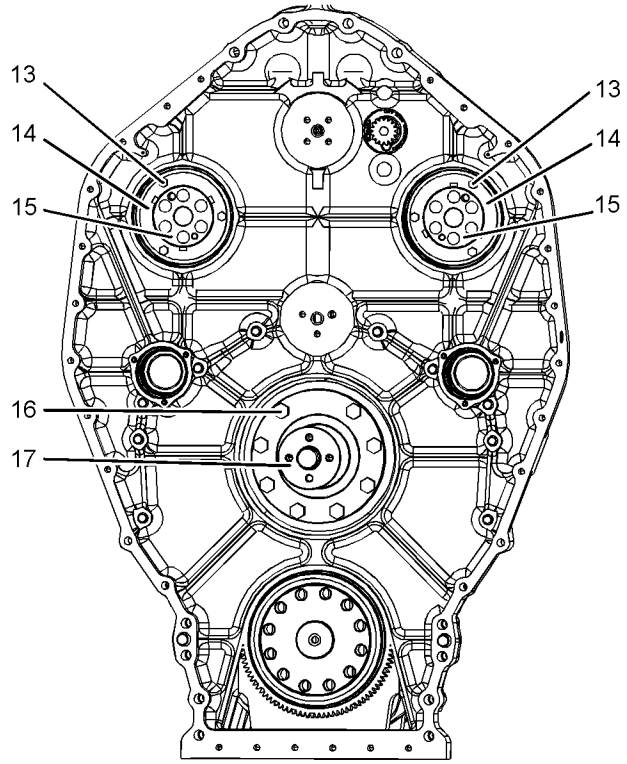


Illustration 228 g01151842

1. Install the O-ring seals and the sealing plates on the cylinder head.

2. Install adapter assemblies (15), thrust plates (14), and bolts (13).

3. Position shaft assembly (17) and install bolts (16).

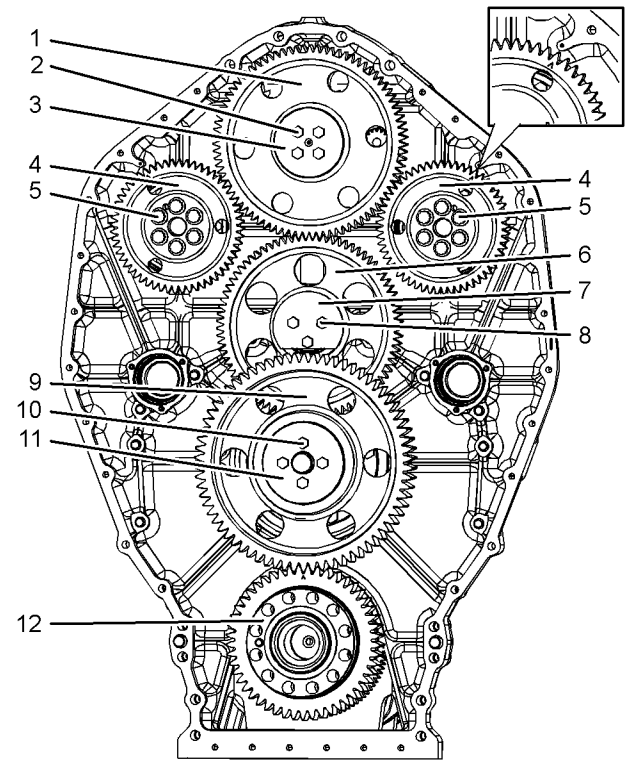


Illustration 229 g02087918

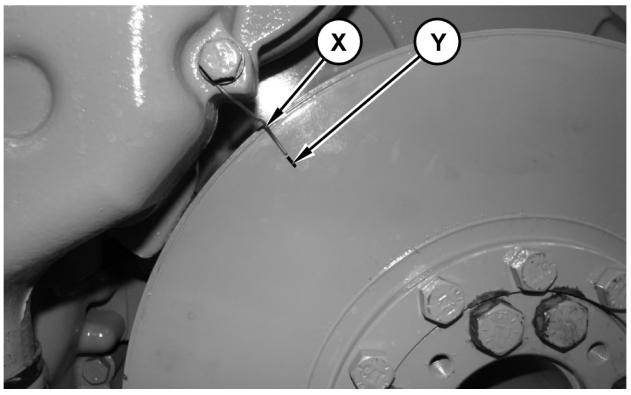


Illustration 230 g02087895

(X) Marker
(Y) Alignment Mark

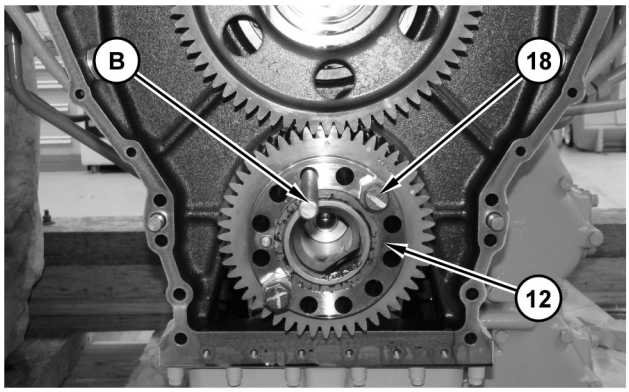


Illustration 231 g02088394

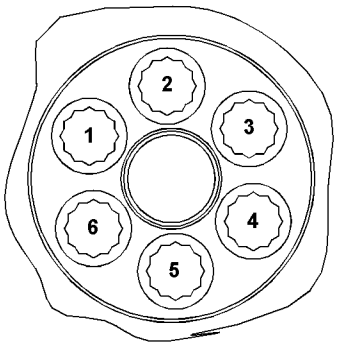


Illustration 232 g01151468

Note: Align the timing marks on gear assemblies (4) with the timing marks on the rear housing and align the dowels on gear assemblies (4) with the adapter assemblies.

4. Position gear assemblies (4) and install bolts (5).

5. Install Tooling (B) in the crankshaft. Install gear assembly (12).

6. If the top center position is already marked on the vibration damper, proceed to Step 7.

a. Install the flywheel housing and the flywheel temporarily. Two bolts in the flywheel housing and the flywheel are sufficient.

b. Position the number one piston in the top center position (TC). The engine should be at the top center position to install the rear gear group. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

c. With the number one piston in the top center position (TC), attach a marker to the engine and place an Alignment Mark on the vibration damper.

d. Remove the flywheel and the flywheel housing.

7. Install two nuts on two bolts for the flywheel (18). The nuts will provide spacing when the bolts are installed. Install two bolts for the flywheel (18) in gear assembly (12).

8. Use Tooling (A) and a suitable press to install the bearing in gear assembly (1). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch). The bearing must be machined once installed into the gear. Refer to Reuse and Salvage Guidelines, SEBF9244 for the correct after machining dimension and surface requirements.

9. Install shaft assembly (3), gear assembly (1), and bolts (2). Tighten the bolts (2) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

10. Use Tooling (A) and a suitable press to install the bearing in gear assembly (6). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch). The bearing must be machined once installed into the gear. Refer to Reuse and Salvage Guidelines, SEBF9244 for the correct after machining dimension and surface requirements.

11. Install shaft assembly (7), gear assembly (6), and bolts (8).

12. Use Tooling (A) and a suitable press to install the bearing in gear assembly (9). Install the bearing to a depth of 3.2 ± 0.5 mm (0.13 ± 0.02 inch). The bearing must be machined once installed into the gear. Refer to Reuse and Salvage Guidelines, SEBF9244 for the correct after machining dimension and surface requirements.

Note: Ensure that the number one piston is in the top center position (TC).

Note: Align the timing mark on gear assembly (9) with the timing mark on gear assembly (12).

13. Install gear assembly (9), thrust plate (11), and bolts (10).

14. Tighten the bolts on gear assemblies (4) to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

End By:

a. Install the flywheel housing.

C32 Installation Procedure

Table 38

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Gp	1
B	-	Guide Stud 5/8 - 18 by 12 inch	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Apply clean engine oil to the bearings and the shaft assemblies prior to installation on the engine.

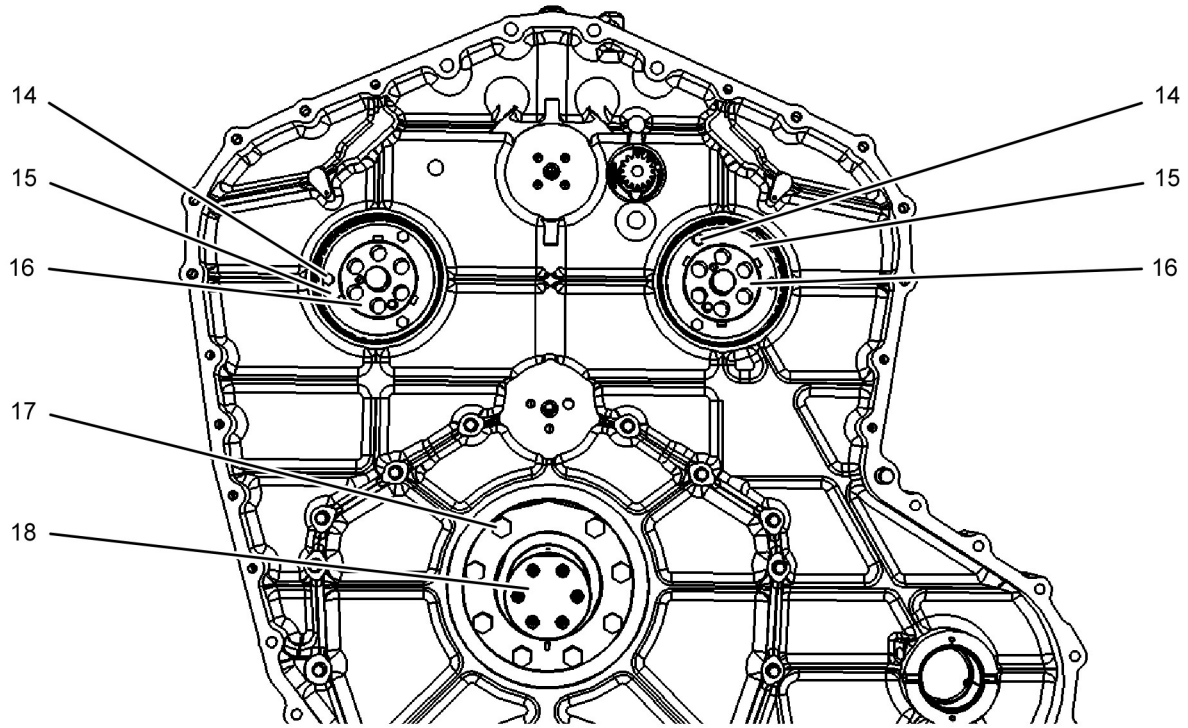


Illustration 233 g03428001

1. Install the O-ring seals and the sealing plates on the cylinder head.

2. Install adapter assemblies (16), thrust plates (15), and bolts (14).

3. Position shaft assembly (18) and install bolts (17).

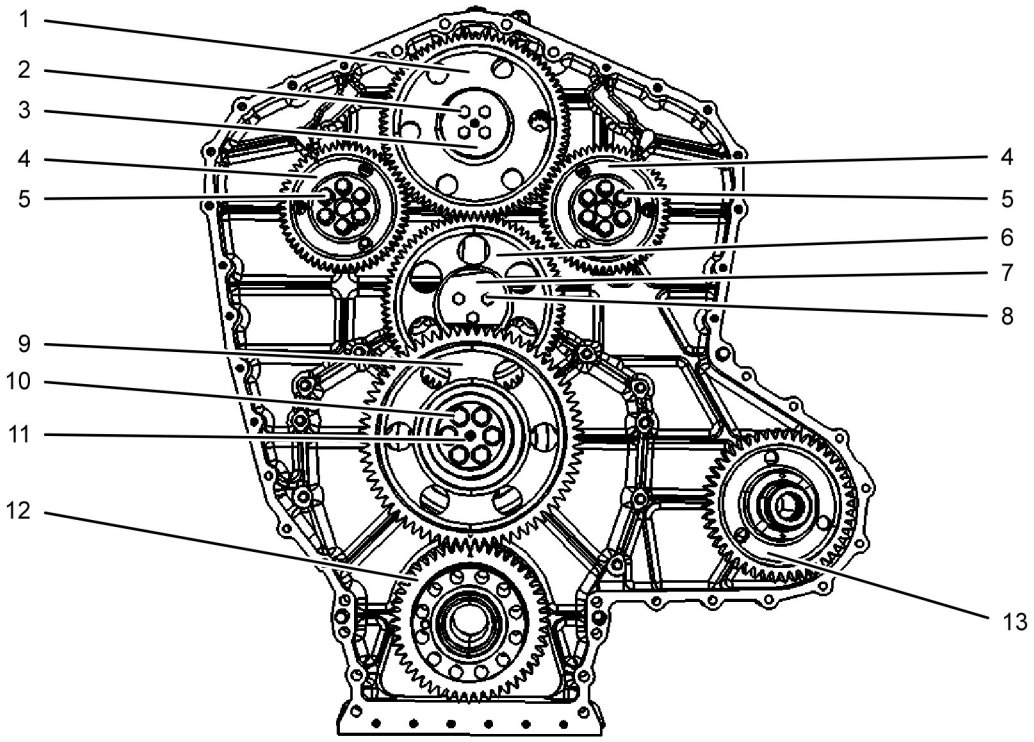


Illustration 234 g03427967

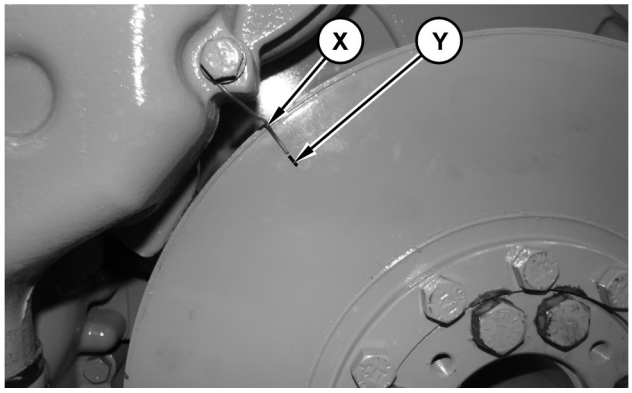


Illustration 235 g02087895

(X) Marker
(Y) Alignment Mark

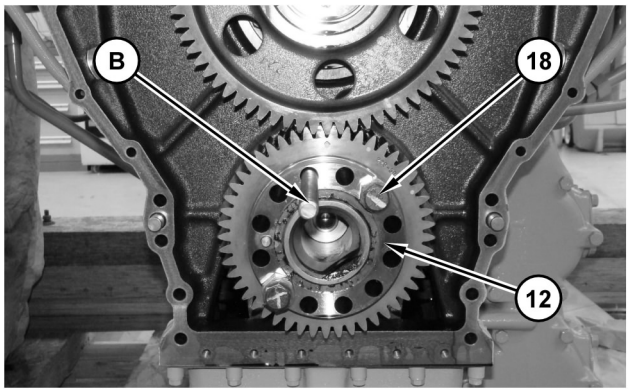


Illustration 236 g02088394

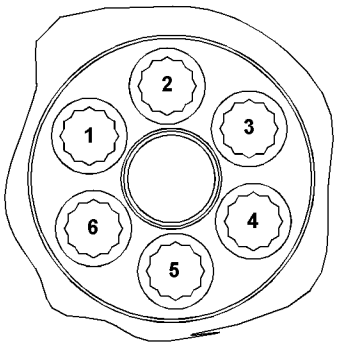


Illustration 237 g01151468

Note: Align the timing marks on gear assemblies (4) with the timing marks on the rear housing and align the dowels on gear assemblies (4) with the adapter assemblies.

4. Position gear assemblies (4) and install bolts (5).

5. Install Tooling (B) in the crankshaft. Install gear assembly (12).

6. If the top center position is already marked on the vibration damper, proceed to Step 7.

a. Install the flywheel housing and the flywheel temporarily. Two bolts in the flywheel housing and the flywheel are sufficient.

b. Position the number one piston in the top center position (TC). The engine should be at the top center position to install the rear gear group. Refer to Testing and Adjusting, “Finding Top Center Position for No. 1 Piston”.

c. With the number one piston in the top center position (TC), attach a marker to the engine and place an Alignment Mark on the vibration damper.

d. Remove the flywheel and the flywheel housing.

7. Install two nuts on two bolts for the flywheel (19). The nuts will provide spacing when the bolts are installed. Install two bolts for the flywheel (19) in gear assembly (12).

8. Use Tooling (A) and a suitable press to install the bearing in gear assembly (1). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch). The bearing must be machined once installed into the gear. Refer to Reuse and Salvage Guidelines, SEBF9244 for the correct after machining dimension and surface requirements.

9. Install stub shaft assembly (3), gear assembly (1), and bolts (2). Tighten the bolts (2) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

10. Use Tooling (A) and a suitable press to install the bearing in gear assembly (6). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch). The bearing must be machined once installed into the gear. Refer to Reuse and Salvage Guidelines, SEBF9244 for the correct after machining dimension and surface requirements.

11. Install stub shaft assembly (7), gear assembly (6), and bolts (8).

12. Use Tooling (A) and a suitable press to install the bearing in gear assembly (9). Install the bearing to a depth of 3.2 ± 0.5 mm (0.13 ± 0.02 inch). The bearing must be machined once installed into the gear. Refer to Reuse and Salvage Guidelines, SEBF9244 for the correct after machining dimension and surface requirements.

13. Install retainer assembly (11), the O-ring seal, and bolts (10).

Note: Ensure that the number one piston is in the top center position (TC). Ensure that the timing marks on gear assemblies (4) are in alignment with the timing marks on the rear housing.

Note: Do not use the alignment marks found on gears (9) and (12). Doing so will create errors. Use the following steps to align gear (9).

14. Hold gear assembly (6) in the direction of normal engine rotation to remove the backlash. Place gear assembly (9) on the shaft assembly. The teeth on gear assembly (9) will engage with gear assembly (12) first. The teeth on gear assembly (9) will engage with the teeth on gear assembly (6) next. If the teeth on gear assembly (9) do not engage properly, turn the gear assembly to the next tooth, and try again.

15. Turn the engine in the opposite direction of normal engine rotation for approximately 45 degrees. Turn the engine in the direction of normal engine rotation until the alignment mark on the vibration damper and the marker on the engine are aligned. Ensure that timing marks on gear assemblies (4) are in alignment with the marks on the rear housing.

16. Tighten the bolts on gear assemblies (4) to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

17. Install gear assembly (13) and the thrust washers.

End By:

a. Install the flywheel housing.

i07137719

Flywheel - Remove and Install

SMCS Code: 1156-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 39

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud 5/8 - 18 UNF by 11 inch	2

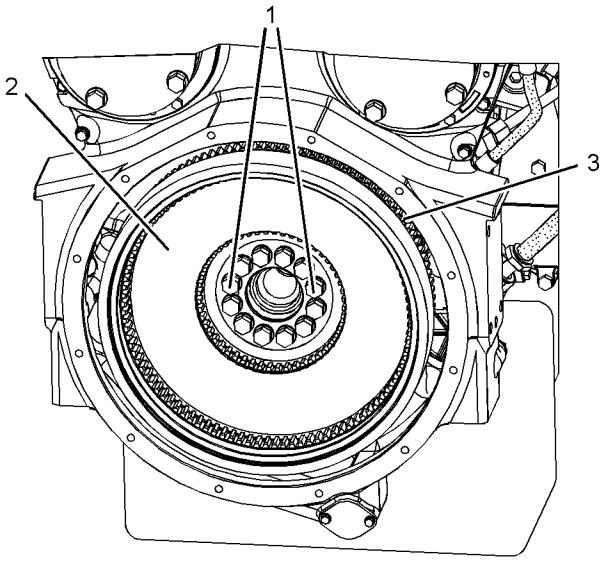


Illustration 238 g01146830

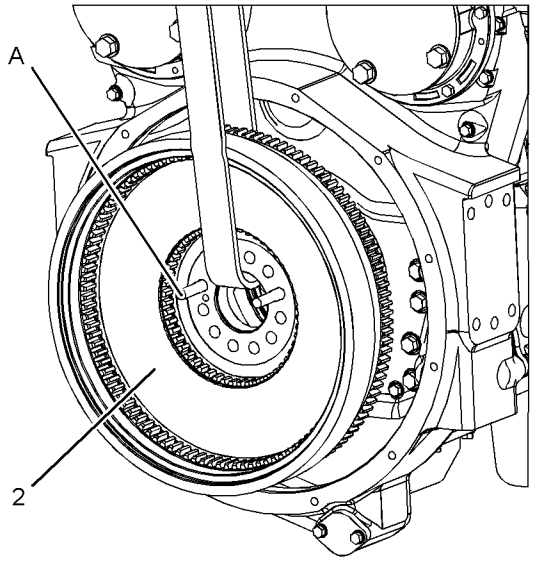


Illustration 239 g01146857

1. Remove two bolts (1). Install Tooling (A) in the crankshaft.

2. Remove remaining bolts (1) and the flywheel spline, if equipped. Slide flywheel (2) away from the engine on Tooling (A).

3. Attach a suitable lifting device to flywheel (2). The weight of flywheel (2) is approximately 86 kg (190 lb). Remove flywheel (2).

4. If necessary, use a hammer and a punch to remove ring gear (3) from flywheel (2).

Installation Procedure

Table 40

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud 5/8 - 18 UNF by 11 inch	2

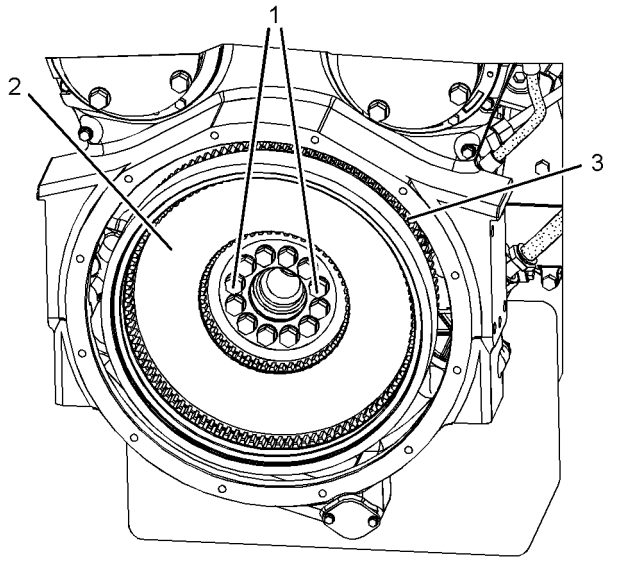


Illustration 240 g01146830

Note: Ring gear (3) must be installed with the chamfered side of the teeth upward. The chamfered side of the gear teeth will be facing toward the starting motor when the flywheel is installed.

1. Raise the temperature of ring gear (3). Install ring gear (3) on flywheel (2).

2. Install Tooling (A) in the crankshaft.

3. Attach a suitable lifting device to flywheel (2). The weight of flywheel (2) is approximately 86 kg (190 lb). Position flywheel (2) on the crankshaft.

4. Apply clean engine oil to the threads of bolts (1).

5. Install bolts (1). Remove Tooling (A). Install remaining bolts (1).

6. Tighten bolts (1) to a torque of 270 ± 40 N·m (199 ± 29.5 lb ft).

7. Check the flywheel runout. Refer to Testing and Adjusting, “Flywheel - Inspect”.

i04314157

Crankshaft Rear Seal - Remove

SMCS Code: 1161-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 41

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7600	Slide Hammer Puller	1
B	-	Pry Bar	1
C	5P-7312	Seal Distorter	1
D	5P-7314	Distorter Ring	1

Start By:

a. Remove the flywheel. Refer to Disassembly and Assembly, “Flywheel - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Ensure that the rear gear remains in place when the crankshaft rear seal and crankshaft wear sleeve are removed.

1. Install two bolts from the flywheel and suitable washers through the rear gear in the crankshaft.

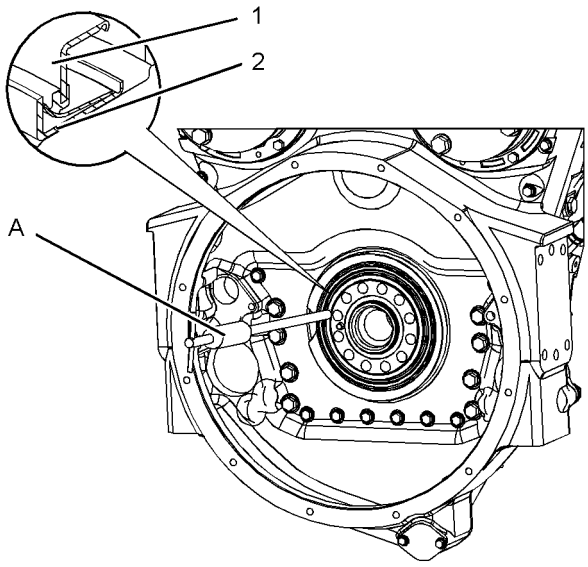


Illustration 241 g01146630

Note: Ensure that you do not damage the flywheel housing with Tooling (B).

Note: If the crankshaft wear sleeve starts to slide off the crankshaft, go to Step 3.

2. Use Tooling (B) to pry around the lip of crankshaft wear sleeve (2).

3. Use Tooling (A) or a punch and hammer in order to puncture three or more holes in crankshaft rear seal (1).

4. Use Tooling (A) to remove crankshaft rear seal (1).

5. If necessary, use Tooling (C) and Tooling (D) to remove crankshaft wear sleeve (2).

i07767181

Crankshaft Rear Seal - Install

SMCS Code: 1161-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 42

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
E	-	Seal Locator	-
	-	Bolt	-
	-	Nut (Seal Installer)	-
	-	Rear Seal Installer	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

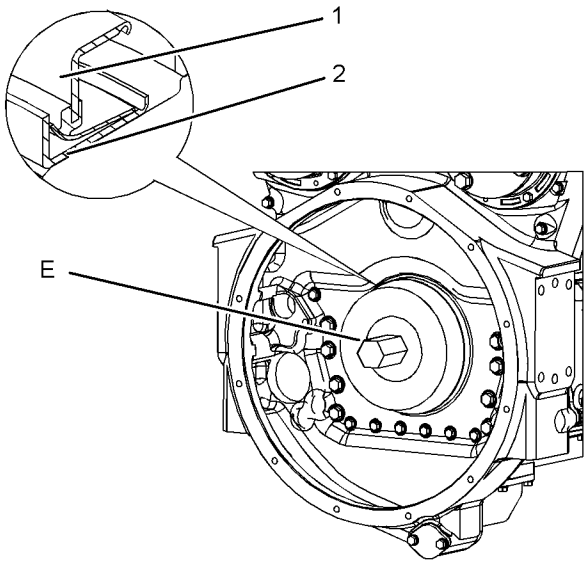


Illustration 242 g01513824

1. Clean the outside diameter of the crankshaft.

Note: Install the crankshaft rear seal with the arrow that shows the direction of crankshaft rotation toward the rear of the engine.

2. Use Tooling (E) to install crankshaft wear sleeve (2) and crankshaft rear seal (1) as a unit. Refer to Special Instruction, M0104958, “Crankshaft Seal Installation” for the correct rear main seal installation tooling required for the particular application.

End By:

a. Install the flywheel. Refer to Disassembly and Assembly, “Flywheel - Remove and Install”.

i03569320

Flywheel Housing - Remove and Install
(C27)

SMCS Code: 1157-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 43

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	-	Guide Stud 1/2 - 13 NC by 5 inch	2

Start By:

a. Remove the rear power take-off (RPTO). Refer to Disassembly and Assembly, “Rear Power Take-Off (RPTO) - Remove”.

b. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, “Crankshaft Rear Seal - Remove”.

c. Remove the electric starting motor. Refer to Disassembly and Assembly, “Electric Starting Motor - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

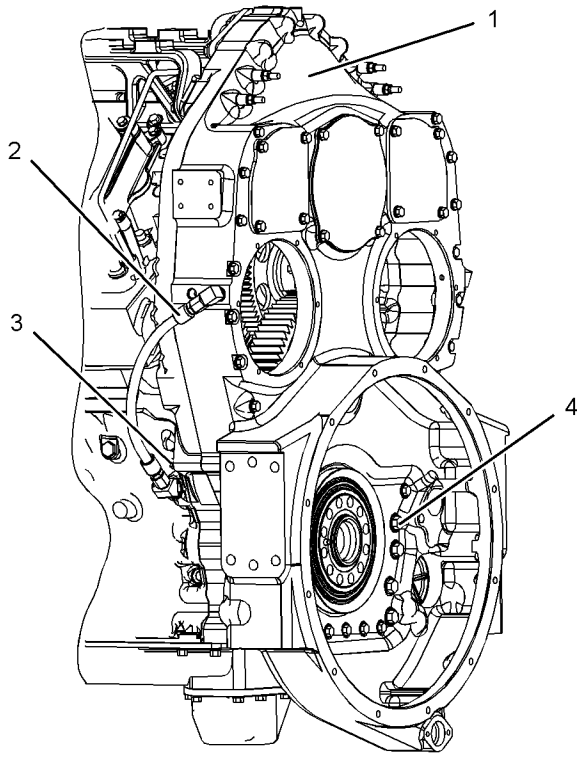


Illustration 243 g01265919

1. Disconnect hose assemblies (2) from flywheel housing (1).

2. Remove bolts (4) and install Tooling (B).

3. Attach Tooling (A) and a suitable lifting device to flywheel housing (1). The weight of flywheel housing (1) is approximately 145 kg (320 lb).

4. Remove remaining bolts (4) and bolts (3). Remove flywheel housing (1) and the gasket from the cylinder block.

Installation Procedure

Table 44

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	-	Guide Stud 1/2 - 13 NC by 5 inch	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

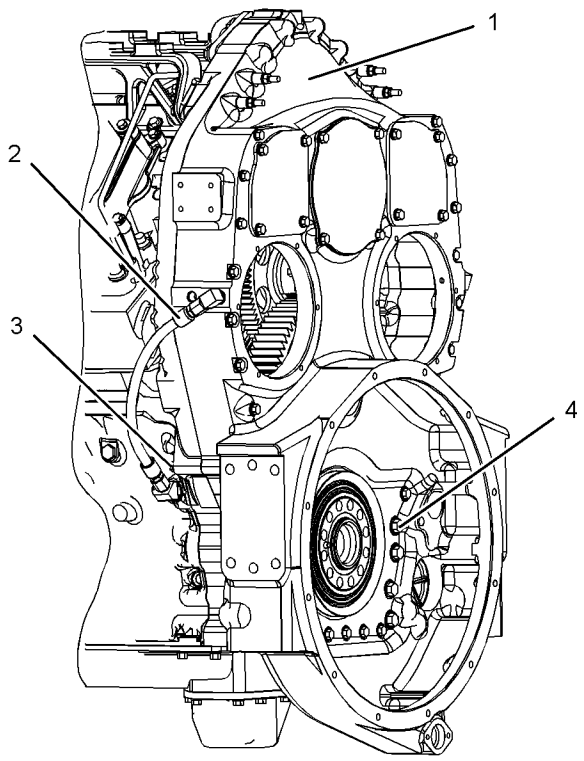


Illustration 244 g01265919

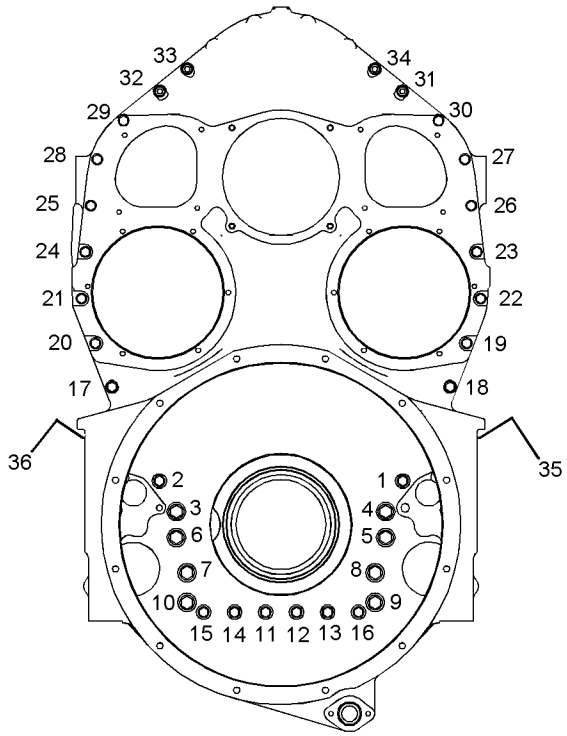


Illustration 245 g01146784

1. Install Tooling (B) in the cylinder block.

2. Attach Tooling (A) and a suitable lifting device to flywheel housing (1). The weight of flywheel housing (1) is approximately 145 kg (320 lb).

3. Position the gasket and flywheel housing (1) on the cylinder block. Install bolts (4) and bolts (3).

4. Remove Tooling (B) and install remaining bolts (4).

5. Tighten the bolts, as follows:

a. In a numerical sequence, tighten Bolt 1 through Bolt 2 to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

b. In a numerical sequence, tighten Bolt 3 through Bolt 10 to a torque of 135 ± 20 N·m (100 ± 15 lb ft).

c. In a numerical sequence, tighten Bolt 11 through Bolt 36 to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

6. Connect hose assemblies (2) to flywheel housing (1).

End By:

a. Install the electric starting motor. Refer to Disassembly and Assembly, “Electric Starting Motor - Remove and Install”.

b. Install the crankshaft rear seal. Refer to Disassembly and Assembly, “Crankshaft Rear Seal - Install”.

c. Install the rear power take-off. Refer to Disassembly and Assembly, “Rear Power Take-Off (RPTO) - Install”.

i03569324

Flywheel Housing - Remove and Install
(C32)

SMCS Code: 1157-010

S/N: PZB1–Up

S/N: TZC1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: EHX1–99999

S/N: MJX1–Up

Removal Procedure

Table 45

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	-	Guide Stud (1/2 - 13 NC by 5 inch)	2

Start By:

a. Remove the rear power take-off (RPTO). Refer to Disassembly and Assembly, “Rear Power Take-Off (RPTO) - Remove”.

b. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, “Crankshaft Rear Seal - Remove”.

c. Remove the electric starting motor. Refer to Disassembly and Assembly, “Electric Starting Motor - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

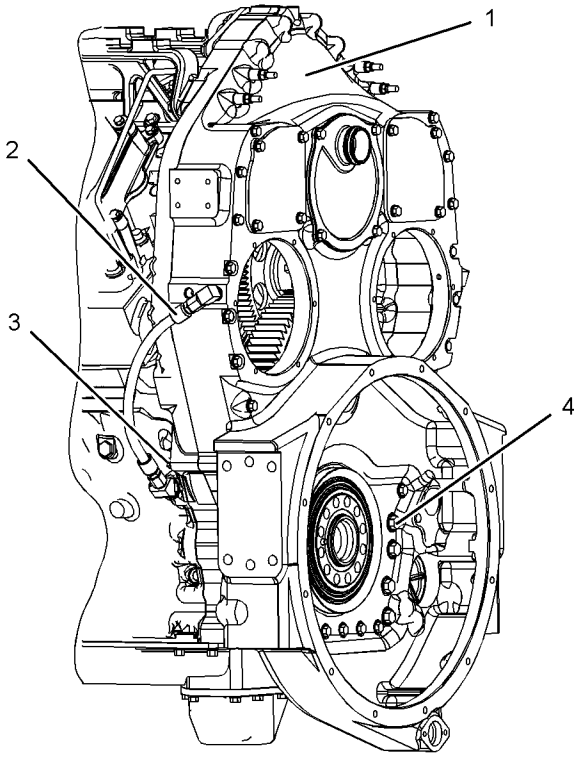


Illustration 246 g01146776

1. Disconnect hose assemblies (2) from flywheel housing (1).

2. Remove bolts (4) and install Tooling (B).

3. Attach Tooling (A) and a suitable lifting device to flywheel housing (1). The weight of flywheel housing (1) is approximately 145 kg (320 lb).

4. Remove remaining bolts (4) and bolts (3). Remove flywheel housing (1) and the gasket from the cylinder block.

Installation Procedure

Table 46

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	-	Guide Stud (1/2 - 13 NC by 5 inch)	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

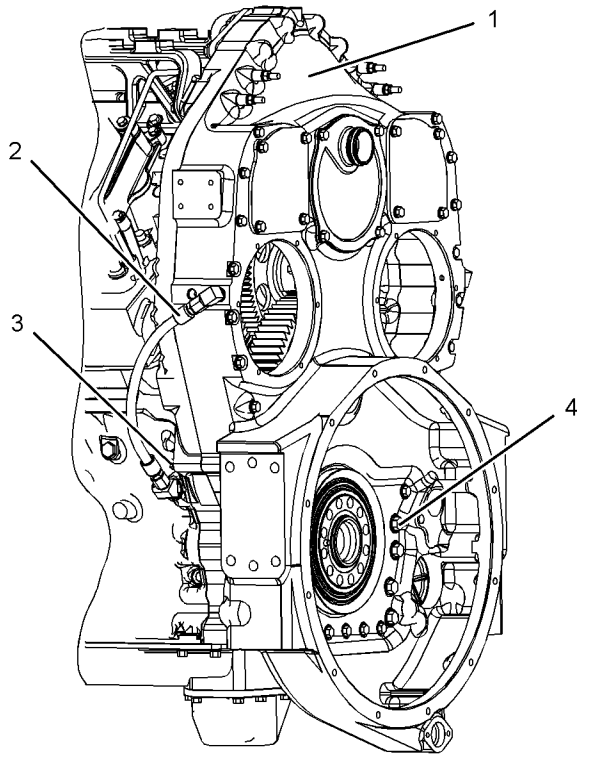


Illustration 247 g01146776

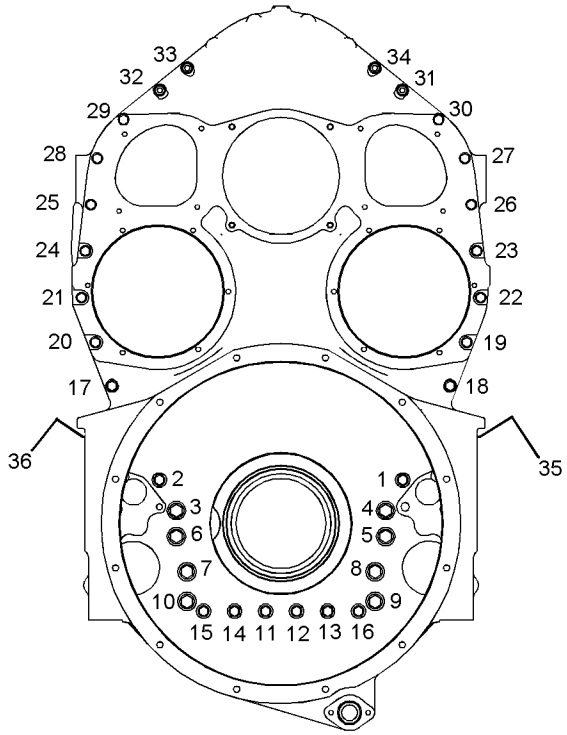


Illustration 248 g01146784

1. Install Tooling (B) in the cylinder block.

2. Attach Tooling (A) and a suitable lifting device to flywheel housing (1). The weight of flywheel housing (1) is approximately 145 kg (320 lb).

3. Position the gasket and flywheel housing (1) on the cylinder block. Install bolts (4) and bolts (3).

4. Remove Tooling (B) and install remaining bolts (4).

5. Tighten the bolts, as follows:

a. In a numerical sequence, tighten Bolt 1 through Bolt 2 to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

b. In a numerical sequence, tighten Bolt 3 through Bolt 10 to a torque of 135 ± 20 N·m (100 ± 15 lb ft).

c. In a numerical sequence, tighten Bolt 11 through Bolt 36 to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

6. Connect hose assemblies (2) to flywheel housing (1).

End By:

a. Install the electric starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

b. Install the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

c. Install the rear power take-off. Refer to Disassembly and Assembly, "Rear Power Take-Off (RPTO) - Install".

i07409320

Rear Power Take-Off (RPTO) - Remove

SMCS Code: 1165-011-RE

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 47

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-4073	Spanner Wrench	1
B	138-7574	Link Bracket	1

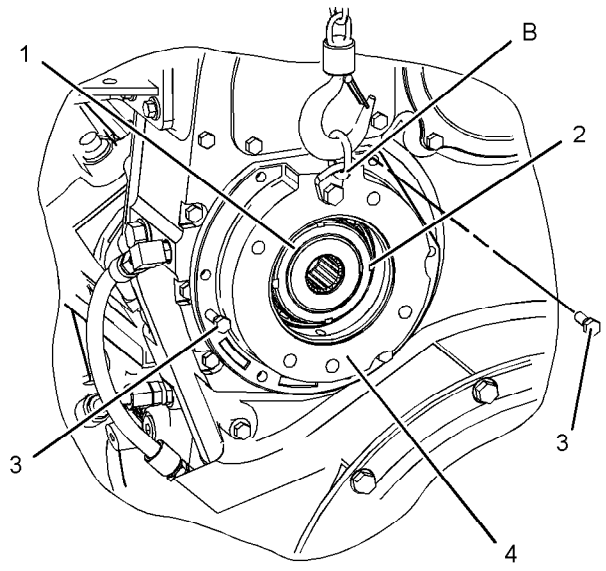


Illustration 249 g01095531

1. Bend the locking tabs on lock (2) out of the slots of nut (1). Use Tooling (A) to loosen nut (1), do not remove nut (1). Attach Tooling (B) and a suitable lifting device to pump drive (4). The weight of pump drive (4) is approximately 32 kg (70 lb).

2. Remove bolts (3). Use bolts (3) as forcing screws and remove pump drive (4).

i07416326

Rear Power Take-Off (RPTO) - Disassemble

SMCS Code: 1165-011-RE

Disassembly Procedure

Table 48

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-4073	Spanner Wrench	1
B	1P-0520	Driver Group	1
	6V-3010	Puller Gp	1
	126-7181	Sliding Plate	2
	6V-8336	Bolt	2
	5P-8245	Hard Washer	2
C	5F-7343	Bearing Puller Gp	1

Start By:

a. Remove the rear power take-off.

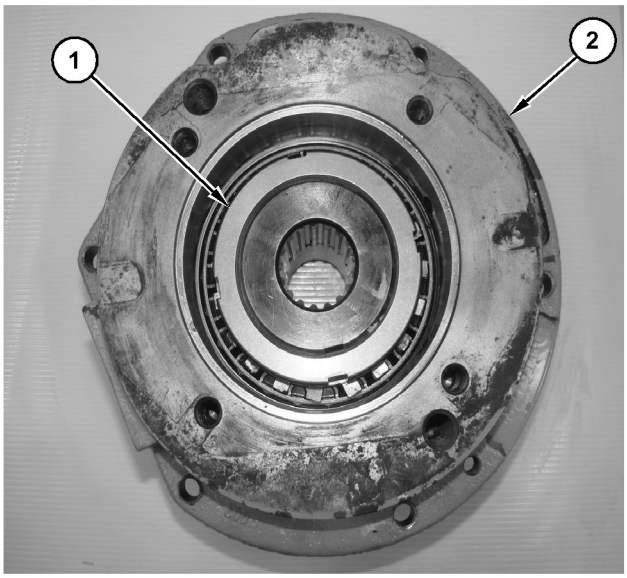


Illustration 250 g06316593

1. Use Tooling (A) to remove nut (1) from adapter (2).

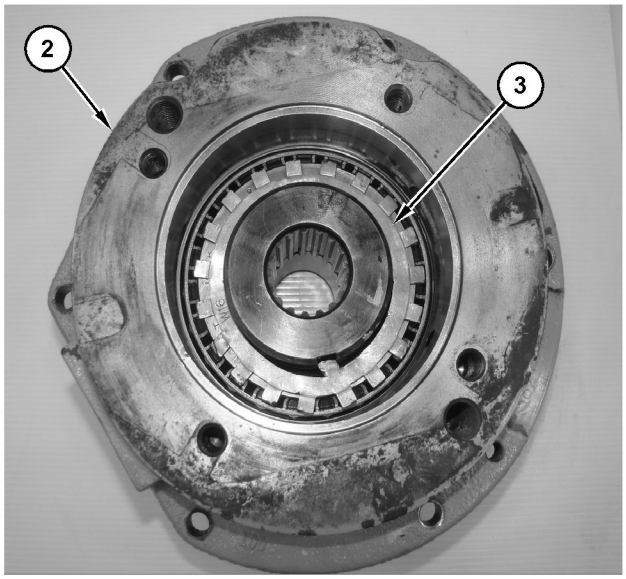


Illustration 251 g06316610

2. Remove bearing locknut (3) from adapter (2).

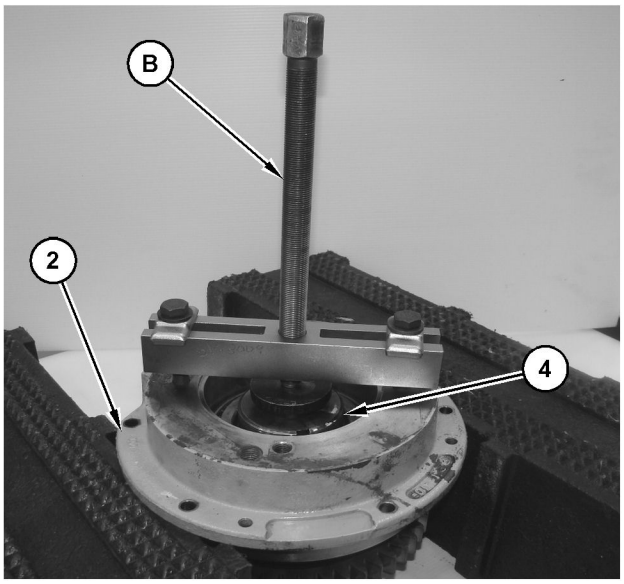


Illustration 252 g06316626

3. Use two people to lift adapter (2) on suitable cribbing.

4. Use Tooling (B) to remove hydraulic pump drive gear (4) from adapter (2).

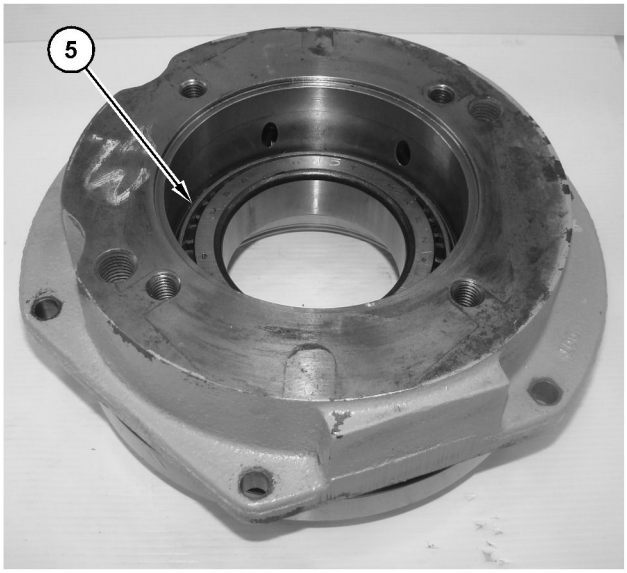


Illustration 253 g06316856

5. Remove bearing cone (5).

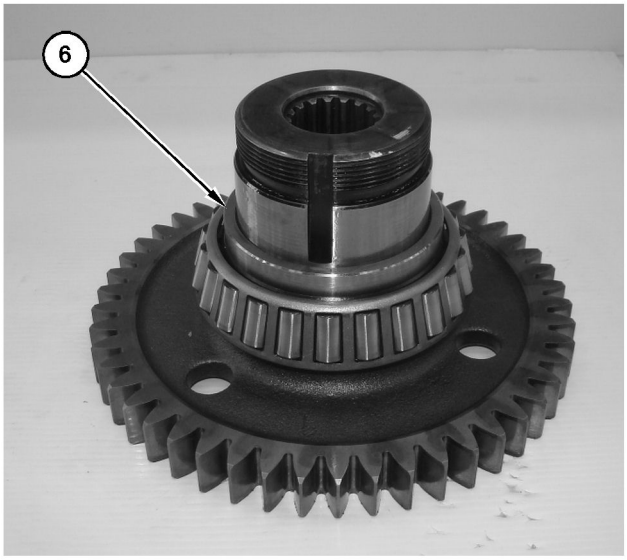


Illustration 254 g06316857

6. Remove bearing cone spacer (6).

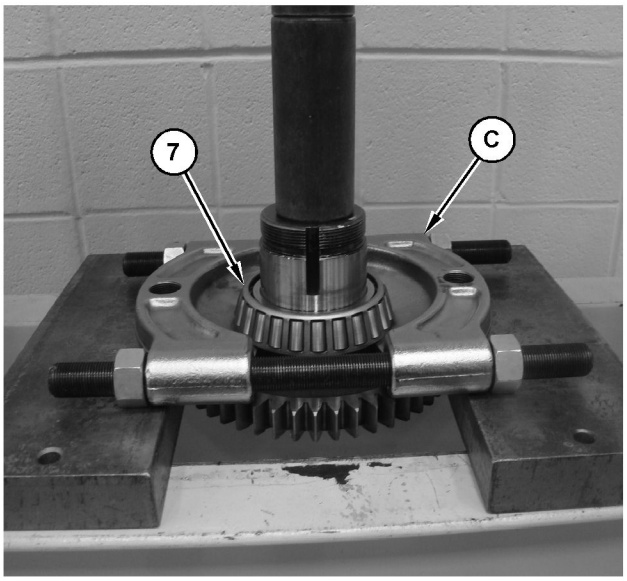


Illustration 255 g06316861

7. Use Tooling (C) and a suitable press to remove bearing cone (7).

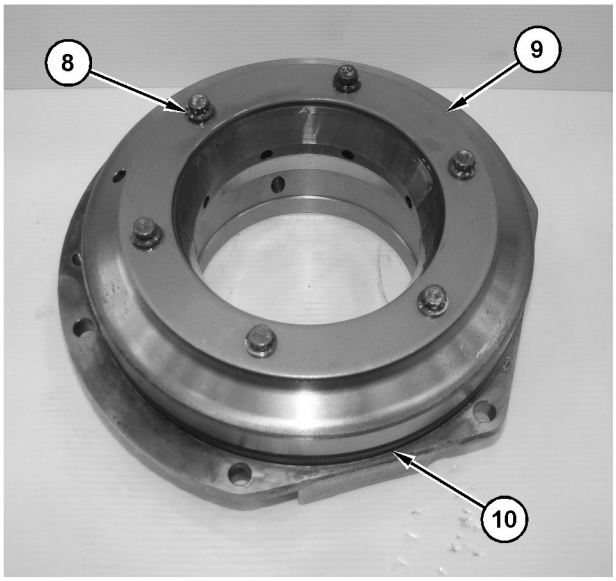


Illustration 256 g06316876

8. Remove bolts (8), retainer ring (9), and O-ring (10).



Illustration 257 g06316884

9. Remove bearing cup (11).

i07416327

Rear Power Take-Off (RPTO) - Assemble

SMCS Code: 1165-016-RE

Assembly Procedure



Illustration 258 g06316884

1. Lower the temperature of bearing cup (11). Install bearing cup (11).

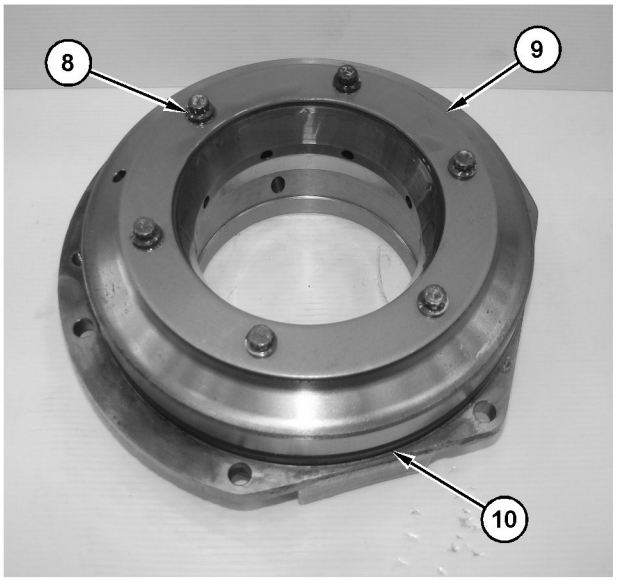


Illustration 259 g06316876

Note: Lubricate O-ring bore and seal lightly with lubricant being sealed.

2. Install O-ring (10)

3. Install retaining ring (9) and bolts (8).

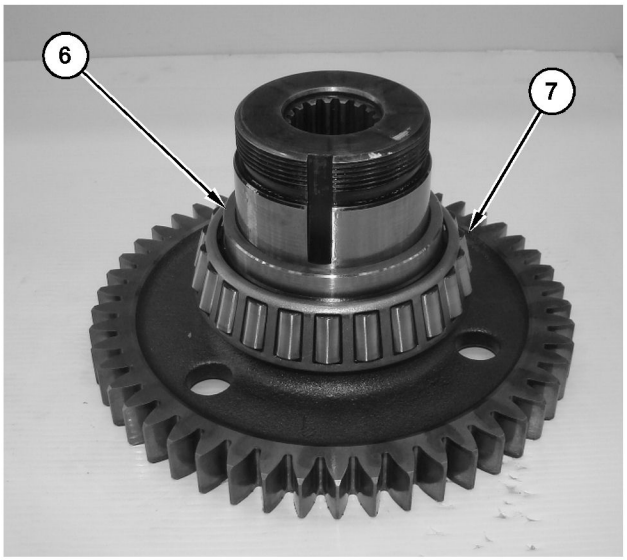


Illustration 260 g06317051

4. Raise the temperature of bearing cone (7). Install bearing cone (7).

5. Install cone spacer (6).

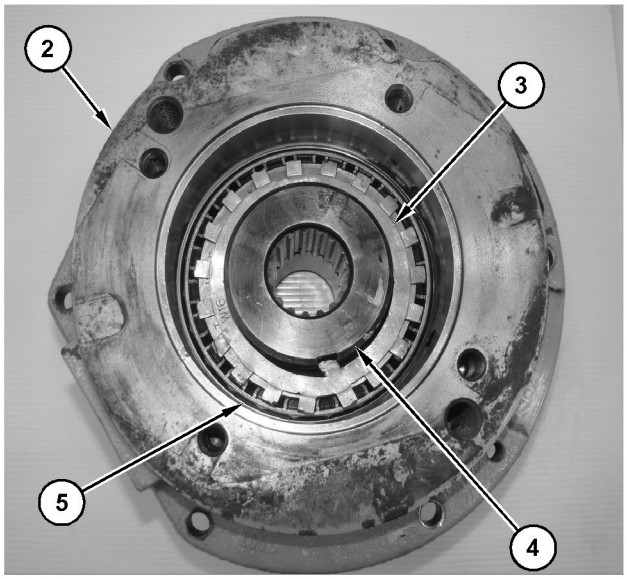


Illustration 261 g06317079

6. Use two people to lift adapter (2) onto hydraulic pump drive gear (4).

7. Raise the temperature of bearing cup (5). Install bearing cup (5) on hydraulic pump drive gear (4).

8. Install bearing locknut (3).

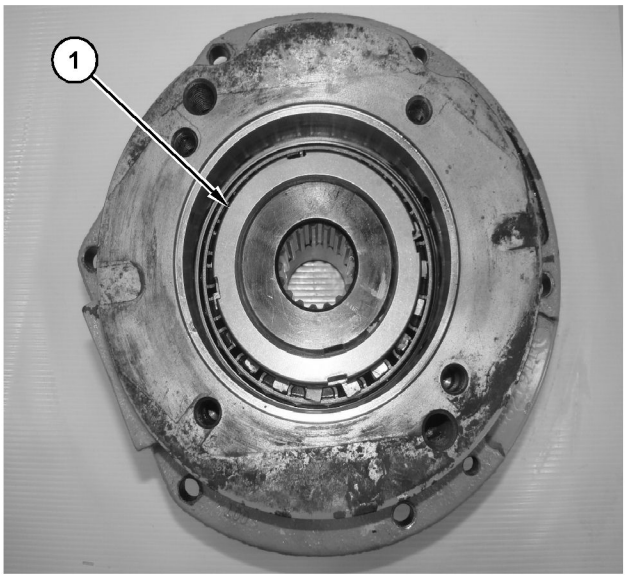


Illustration 262 g06317090

9. Install nut (1) loosely.

i02291930

Rear Power Take-Off (RPTO) - Install

SMCS Code: 1165-012-RE

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 49

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-4073	Spanner Wrench	1
B	138-7574	Link Bracket	1

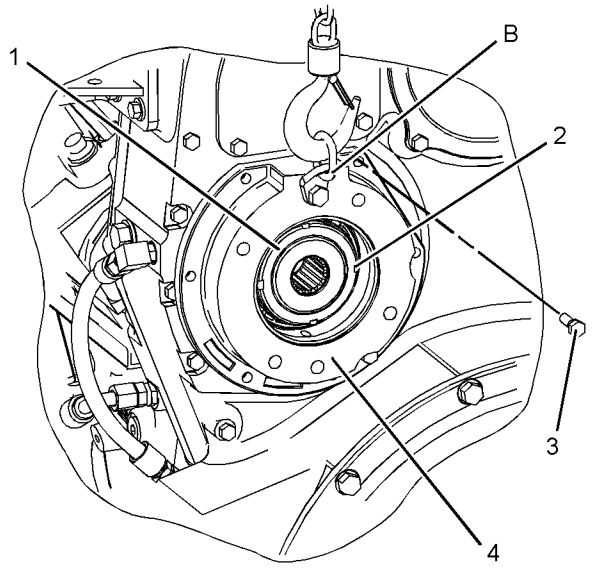


Illustration 263 g01151575

1. Attach Tooling (B) and a suitable lifting device to pump drive (4). The weight of pump drive (4) is approximately 32 kg (70 lb). Install pump drive (4).

2. Install bolts (3) and nut (1). Use Tooling (A) in order to tighten nut (1). Tighten nut (1) to a torque of 406 ± 68 N·m (299 ± 50 lb ft). Bend the locking tabs on lock (2) onto the slots of nut (1).

i03569332

Vibration Damper and Pulley - Remove and Install
(Type 1)

SMCS Code: 1205-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 50

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud 1/2 - 13 NC by 3 inch	2

1. Remove the belt from the engine.

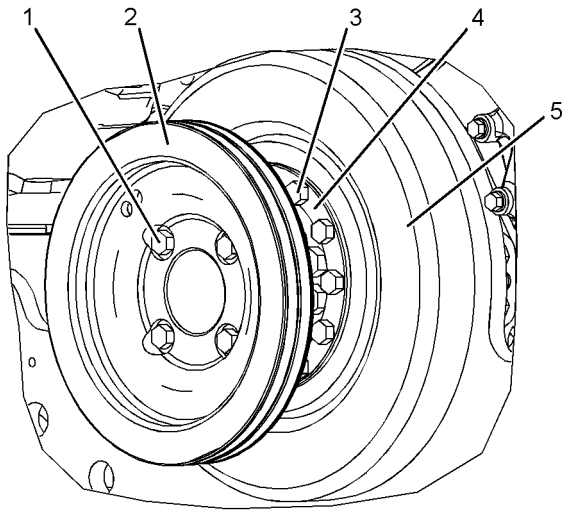


Illustration 264 g01147370

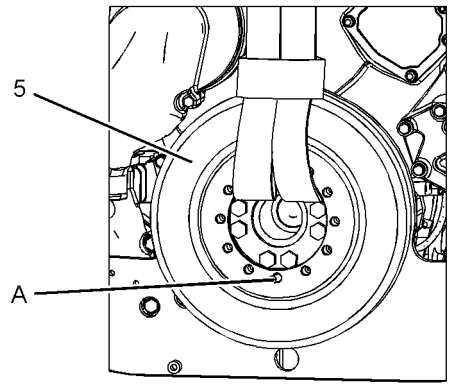


Illustration 265 g01147374

2. Remove bolts (1) and pulley (2).

3. Remove two bolts (3) and install Tooling (A).

4. Remove remaining bolts (3) and spacer (4).

5. Attach a suitable lifting device onto vibration damper (5). The weight of vibration damper (5) is approximately 34 kg (75 lb). Remove vibration damper (5) from the adapter.

Installation Procedure

Table 51

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud 1/2 - 13 NC by 3 inch	2

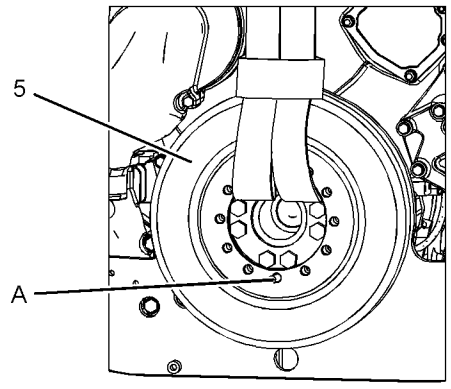


Illustration 266 g01147374

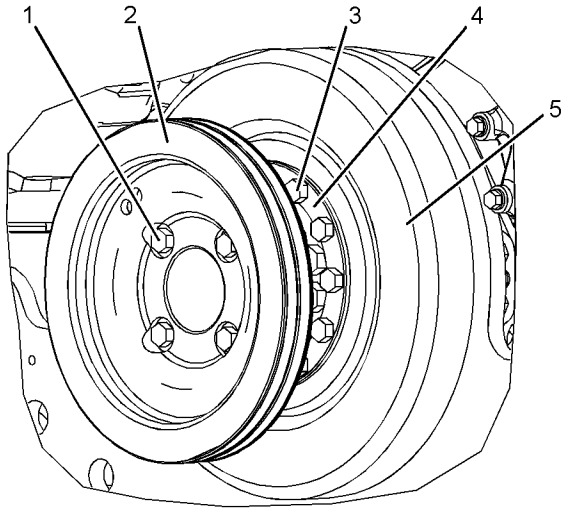


Illustration 267 g01147370

1. Install Tooling (A) in the adapter.

2. Attach a suitable lifting device onto vibration damper (5). The weight of vibration damper (5) is approximately 34 kg (75 lb). Position vibration damper (5) on the adapter.

3. Install spacer (4) and bolts (3). Remove Tooling (A).

4. Install remaining bolts (3). Tighten bolts (3) to a torque of 135 ± 20 N·m (100 ± 15 lb ft).

5. Install pulley (2) and bolts (1).

6. Install the belt on the engine.

i03569336

Vibration Damper and Pulley - Remove and Install
(Type 2)

SMCS Code: 1205-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 52

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud 1/2 - 13 NC by 6 inch	2

1. Remove the belt from the engine. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

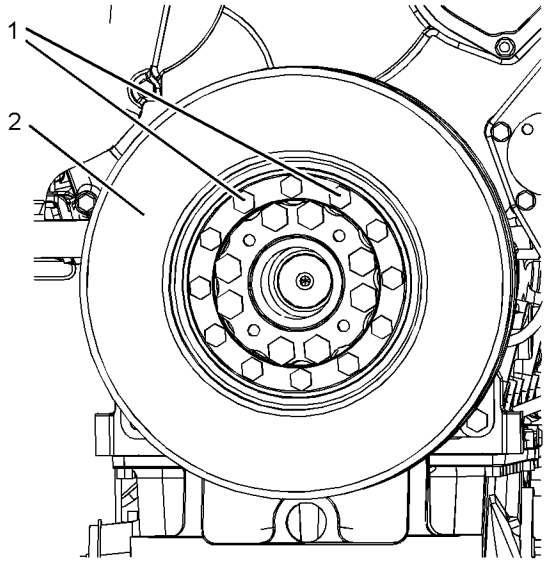


Illustration 268 g01524010

2. Remove bolts (1) and install Tooling (A).

3. Remove remaining bolts (1) and the spacer.

4. Slide first vibration damper (2) forward. Attach a suitable lifting device onto first vibration damper (2). The weight of vibration damper (2) is approximately 34 kg (75 lb). Remove first vibration damper (2) from the adapter.

5. Remove the pulley.

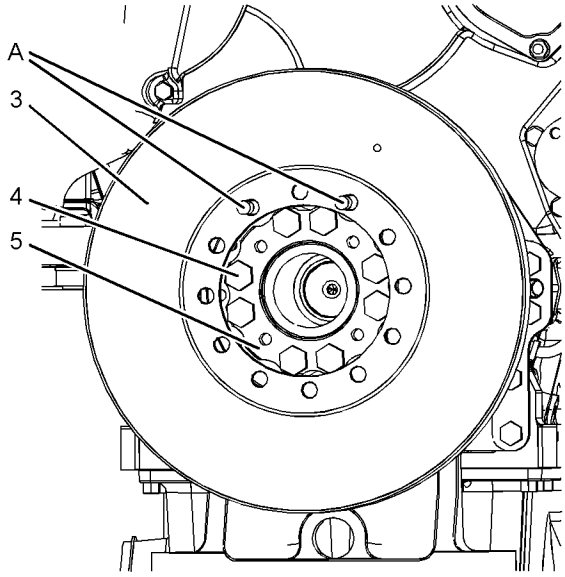


Illustration 269 g01524015

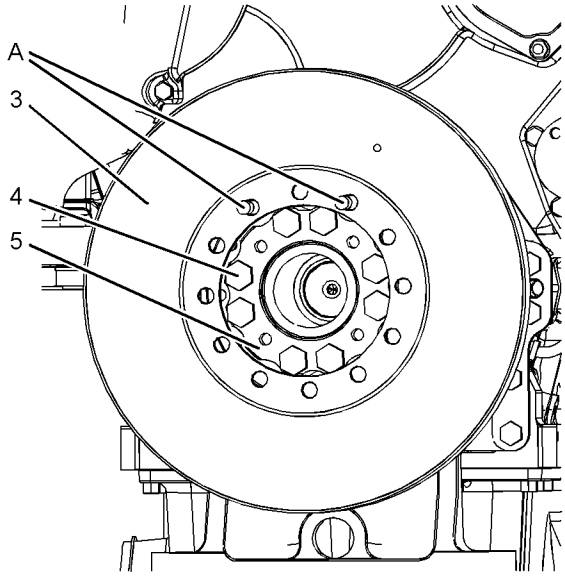


Illustration 270 g01524015

6. Slide second vibration damper (3) forward. Attach a suitable lifting device onto second vibration damper (3). The weight of vibration damper (3) is approximately 34 kg (75 lb). Remove second vibration damper (3) from adapter (5).

7. Attach a suitable lifting device onto adapter (5). The weight of adapter (5) is approximately 25 kg (55 lb). Remove bolts (4) and adapter (5).

Installation Procedure

Table 53

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud 1/2 - 13 NC by 6 inch	2

1. Attach a suitable lifting device to adapter (5). The weight of adapter (5) is approximately 25 kg (55 lb). Install adapter (5) and bolts (4).

2. Install Tooling (A) in adapter (5).

3. Attach a suitable lifting device onto second vibration damper (3). The weight of vibration damper (3) is approximately 34 kg (75 lb). Position second vibration damper (3) on adapter (5).

4. Install the pulley.

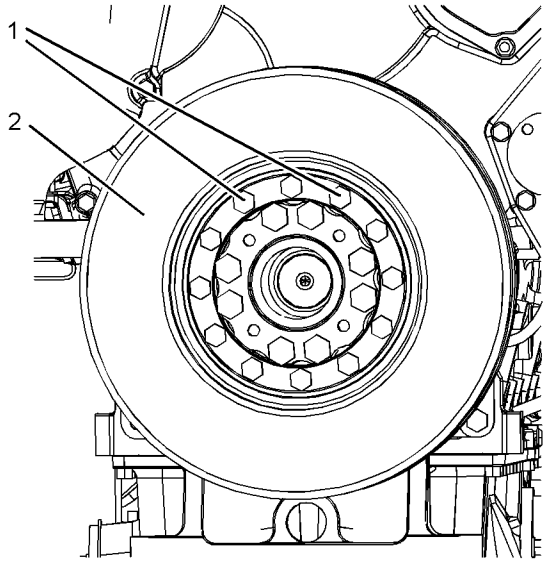


Illustration 271 g01524010

5. Attach a suitable lifting device onto first vibration damper (2). The weight of vibration damper (2) is approximately 34 kg (75 lb). Position first vibration damper (2) on the adapter.

6. Install the spacer and bolts (1). Remove Tooling (A) and install remaining bolts (1). Tighten bolts (1) to a torque of 135 ± 20 N·m (100 ± 15 lb ft).

7. Install the belt on the engine. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

i05727214

Vibration Damper and Pulley - Remove and Install

SMCS Code: 1205-010

Removal Procedure

1. If necessary, remove the belt from the engine. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

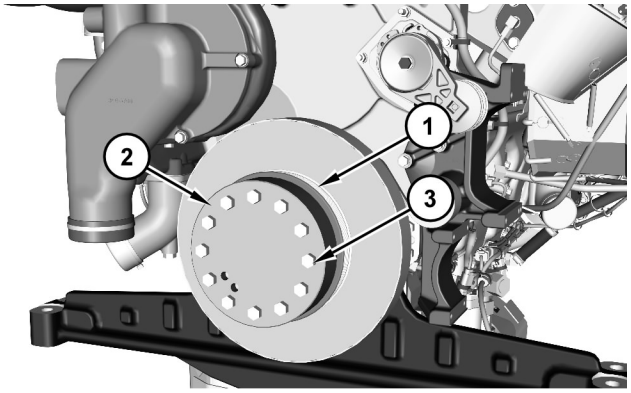


Illustration 272 g03641141

2. Remove bolts (3), adapter (2), and pulley (1).

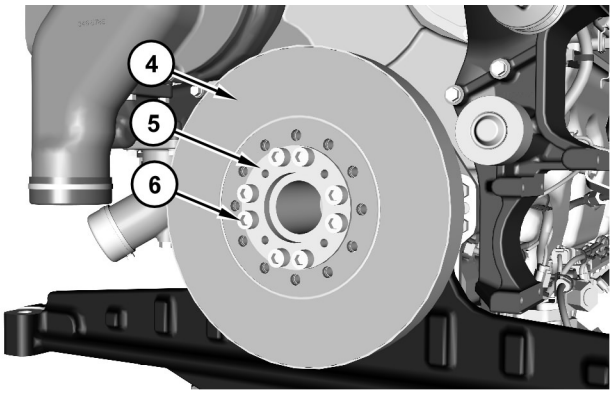


Illustration 273 g03641204

3. Attach a suitable lifting device onto damper (4). The weight of vibration damper (4) is approximately 35 kg (77 lb).

4. Remove bolts (6), then slide damper (4) and adapter (5) off.

Installation Procedure

1. Install damper (4) in the reverse order of removal.

i07391882

Vibration Damper and Pulley - Remove and Install

SMCS Code: 1205-010

Removal Procedure

1. If necessary, remove the belt from the engine. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

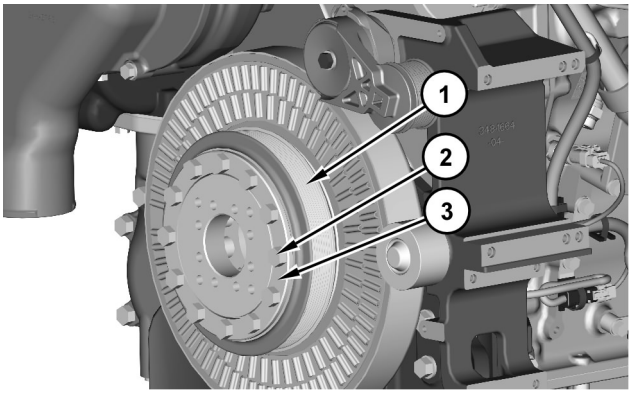


Illustration 274 g03687235

2. Remove bolts (2), adapter (3), and pulley (1).

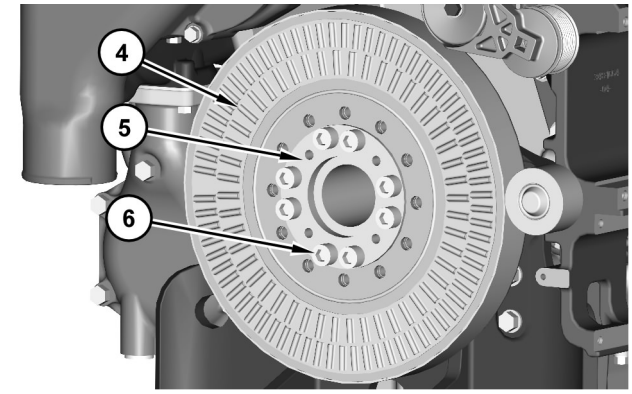


Illustration 275 g03687259

3. Attach a suitable lifting device onto damper (4). The weight of vibration damper (4) is approximately 35 kg (77 lb).

4. Remove bolts (6), then slide damper (4) and adapter (5) off.

Installation Procedure

1. Install damper (4) in the reverse order of removal.

a. Tighten bolts (2) to a torque of 135 ± 20 N·m (100 ± 15 lb ft).

i02986918

Crankshaft Front Seal - Remove

SMCS Code: 1160-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 54

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7600	Slide Hammer Puller	1
B	-	Pry Bar	1
C	5P-7312	Seal Distorter	1
D	5P-7314	Distorter Ring	1

Start By:

a. Remove the crankshaft vibration damper and pulley. Refer to Disassembly and Assembly, “Vibration Damper and Pulley - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

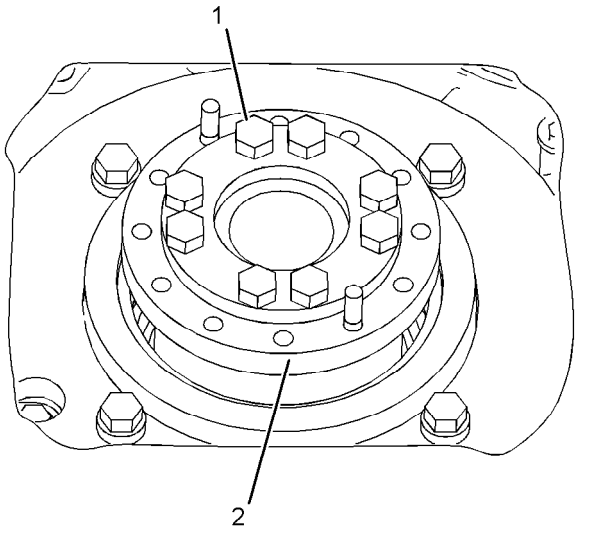


Illustration 276 g01098057

1. Remove bolts (1) and adapter (2).

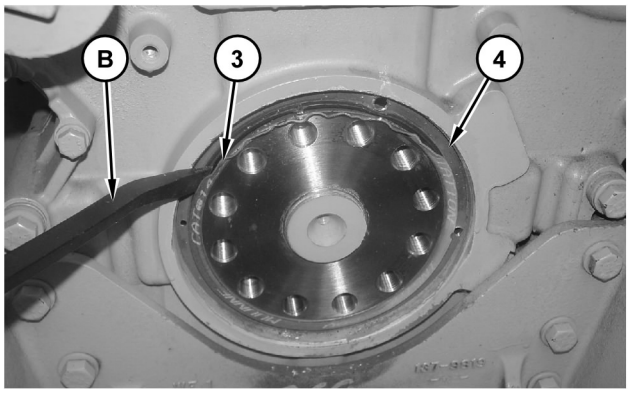


Illustration 277 g01513439

Note: Ensure that you do not damage the front housing with Tooling (B).

Note: If the crankshaft wear sleeve starts to slide off the crankshaft, go to Step 3.

2. Use Tooling (B) to pry around the lip of crankshaft wear sleeve (3).

3. Use Tooling (A) to puncture three or more holes in crankshaft front seal (4).

4. Use Tooling (A) to remove crankshaft front seal (4).

5. If necessary, use Tooling (C) and Tooling (D) to remove crankshaft wear sleeve (3).

i02986920

Crankshaft Front Seal - Install

SMCS Code: 1160-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 55

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
E	5P-1733	Seal Locator	1
	5P-1737	Bolt	3
	9S-8858	Nut (Seal Installer)	1
	6V-6142	Seal Installer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the outside diameter of the crankshaft.

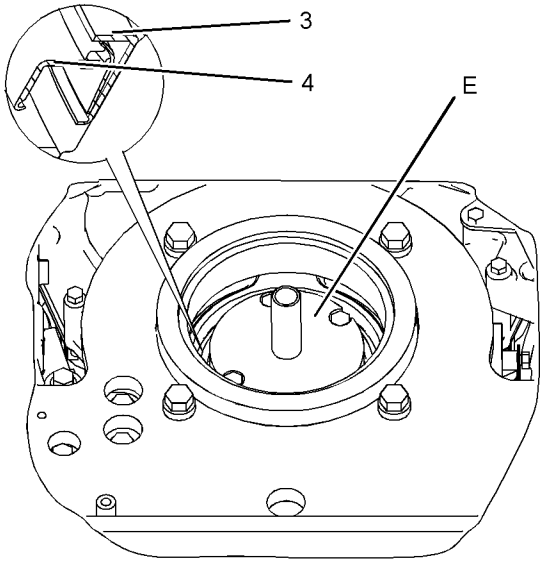


Illustration 278 g01513455

2. Use Tooling (E) to install crankshaft front seal (4) and crankshaft wear sleeve (3) as a unit.

Note: Install the crankshaft front seal with the arrow that shows the direction of crankshaft rotation toward the front of the engine.

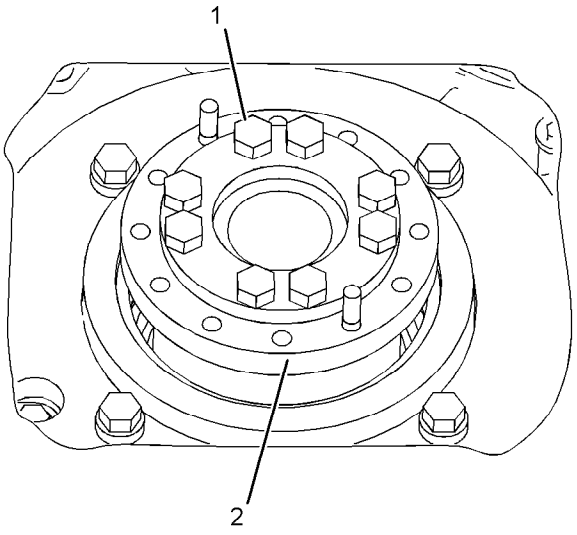


Illustration 279 g01098057

3. Install adapter (2) and bolts (1).

End By:

a. Install the crankshaft vibration damper and pulley. Refer to Disassembly and Assembly, “Vibration Damper and Pulley - Remove and Install”.

i05933887

Gear Group (Front) - Remove

SMCS Code: 1206-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 56

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	6V-4869	Adapter	1
	6V-6174	Plug	1

Start By:

a. Remove the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

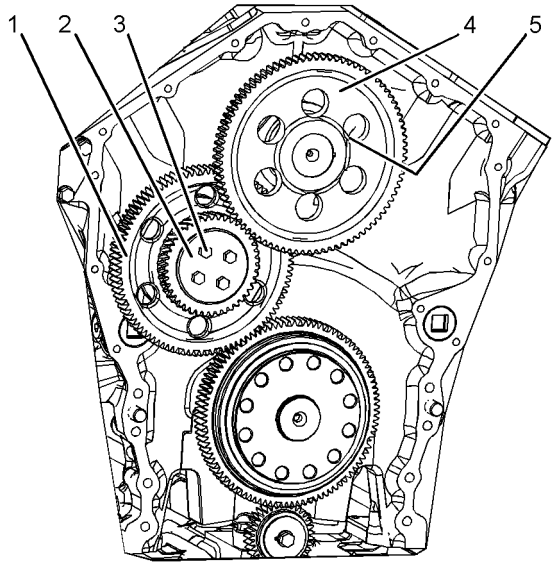


Illustration 280 g01147593

1. Remove bolts (5) and gear assembly (4).

2. Remove bolts (3) and plate (2). Remove gear assembly (1).

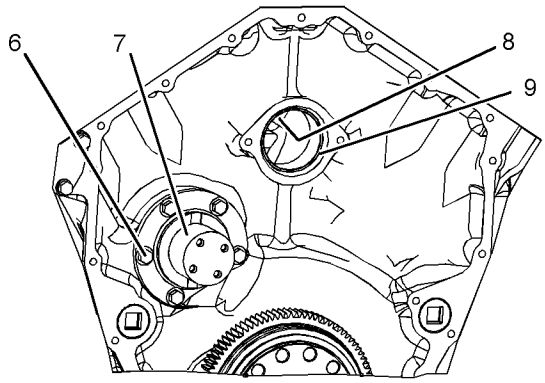


Illustration 281 g03729282

3. Remove bolts (6) and shaft (7).

Note: The crankshaft will have to be removed to remove and install bushings (8) and (9). Refer to Disassembly and Assembly, “Crankshaft - Remove”.

4. If necessary, use Tooling (A) to remove bushing (8) and (9).

i06280625

Gear Group (Front) - Install

SMCS Code: 1206-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 57

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	6V-4869	Adapter	1
	6V-6174	Plug	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

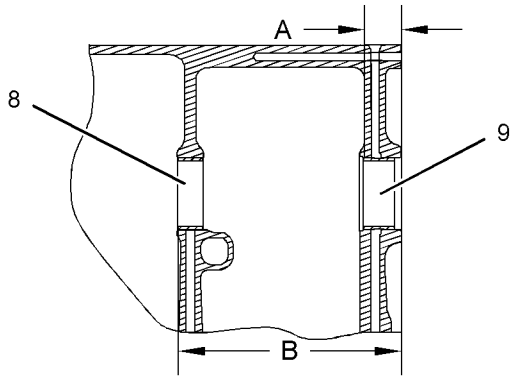


Illustration 282 g03729299

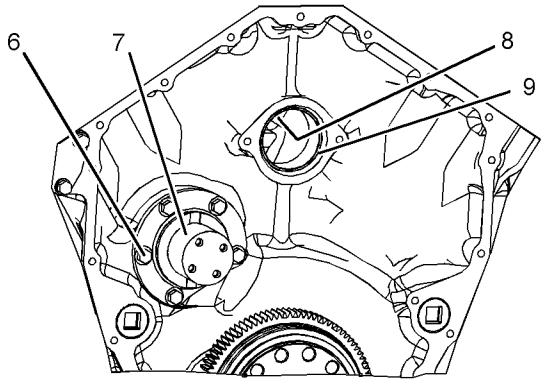


Illustration 283 g03729282

1. Use Tooling (A) to install bushings (8) and (9). Install bushing (8) to a Dimension (B). Dimension (B) is 236.7 ± 0.5 mm (9.32 ± 0.02 inch). Install bushing (9) to a Dimension (A). Dimension (A) is 40.4 ± 0.5 mm (1.59 ± 0.02 inch). Install the crankshaft. Refer to Disassembly and Assembly, “Crankshaft - Install”.

2. Apply clean engine oil to shaft (7), the bearing bore, and the thrust faces prior to installation. Install shaft (7) and bolts (6). Tighten bolts (6) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

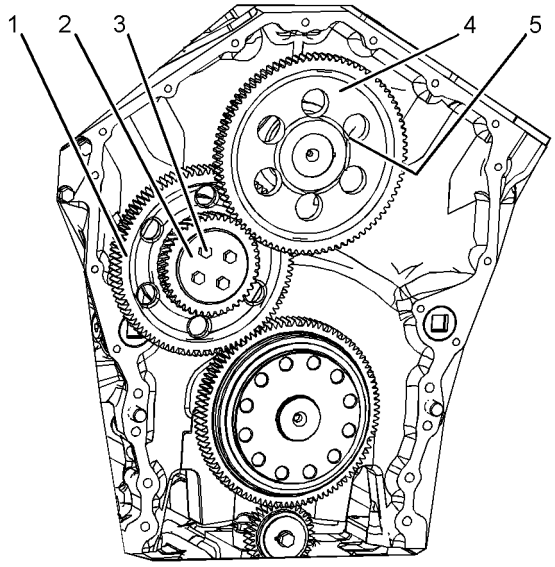


Illustration 284 g01147593

3. Position gear assembly (1) on the shaft. Install plate (2) and bolts (3).

4. Install gear assembly (4) and bolts (5).

End By:

a. Install the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Install”.

i02292574

Housing (Front) - Remove

SMCS Code: 1151-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 58

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

Start By:

a. Remove the water pump. Refer to Disassembly and Assembly, “Water Pump - Remove”.

b. Remove the crankshaft front seal. Refer to Disassembly and Assembly, “Crankshaft Front Seal - Remove”.

c. Remove the water temperature regulator housing. Refer to Disassembly and Assembly, “Water Temperature Regulator Housing - Remove and Install”.

d. Remove the front engine support. Refer to Disassembly and Assembly, “Engine Trunnion - Remove and Install”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

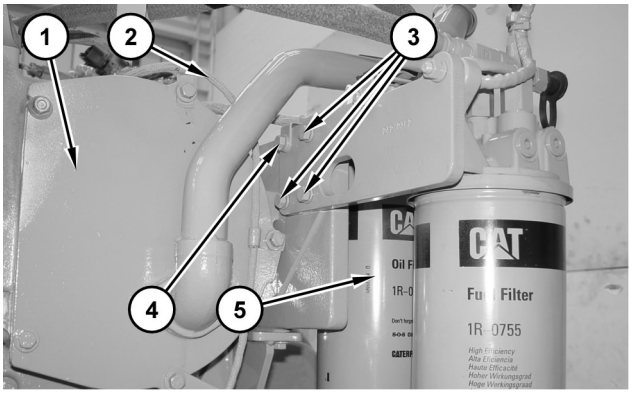


Illustration 285 g01147751

1. Remove covers (1).

2. Disconnect harness assembly (2).

3. Remove three bolts (3).

4. Loosen bolt (4) and reposition the filter housing assembly. Tighten bolt (4).

5. Use Tooling (A) to remove engine oil filter (5).

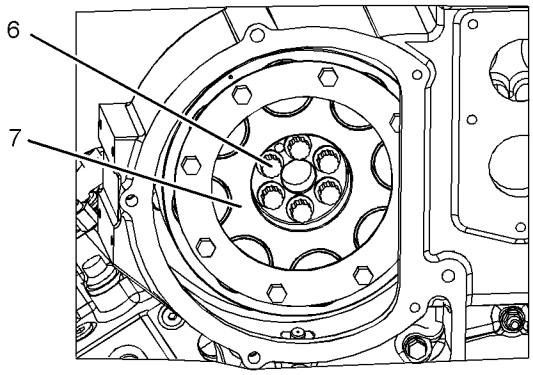


Illustration 286 g01147758

6. Remove bolts (6) and dampers (7).

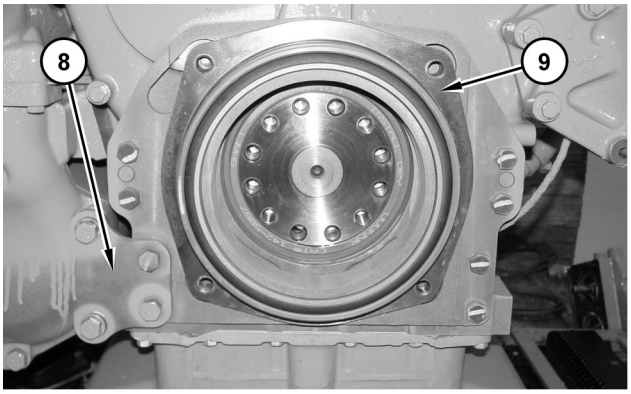


Illustration 287 g01147761

7. Remove bracket (8) and engine trunnion (9).

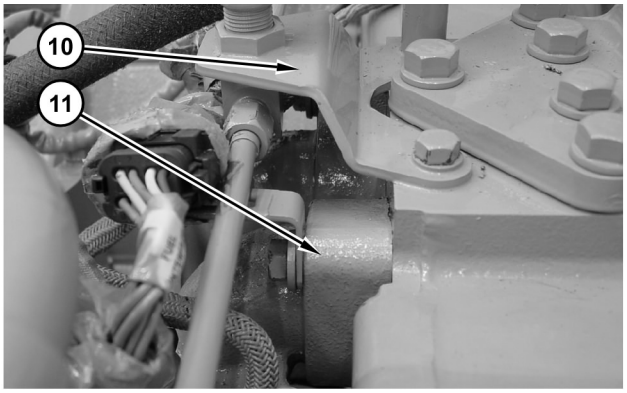


Illustration 288 g01147762

8. Disconnect bracket (10) and elbows (11).

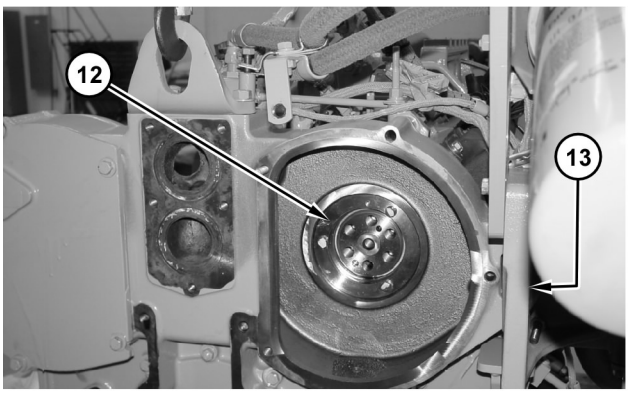


Illustration 289 g01147777

9. Remove adapters (12) and bolts (13).

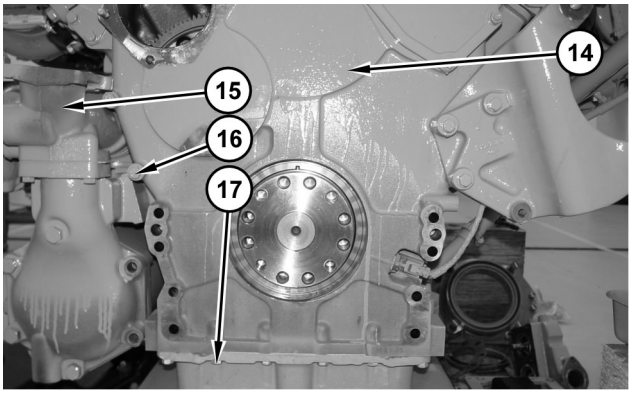


Illustration 290 g01147783

10. Attach a suitable lifting device to front housing (14). The weight of front housing (14) is approximately 70 kg (154 lb).

11. Remove bonnet (15).

12. Remove bolts (16) and bolts (17).

13. Remove front housing (14) and the gasket.

i06746008

Housing (Front) - Install

SMCS Code: 1151-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 59

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B		Loctite 598	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

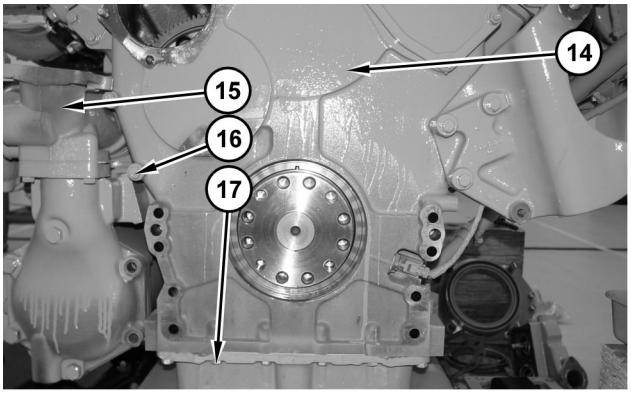


Illustration 291 g01147783

1. Apply Tooling (B) to the bottom of front housing (14) at the junction of the cylinder block and the engine oil pan.

2. Attach a suitable lifting device to front housing (14). The weight of front housing (14) is approximately 70 kg (154 lb). Position the gasket and front housing (14) on the dowel pins on the cylinder block.

3. Install bolts (16) and bolts (17).

4. Install bonnet (15).

5. Trim the gasket between the front housing and the cylinder block even with the bottom of the front housing.

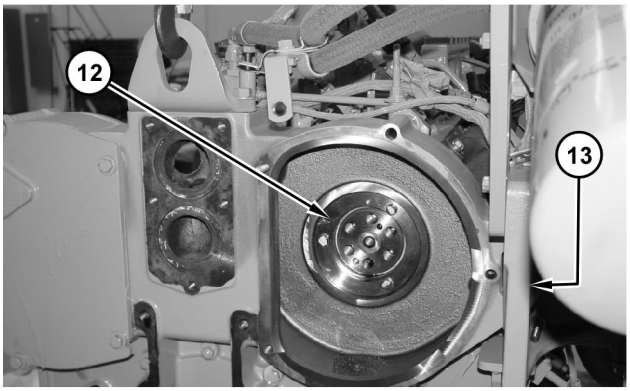


Illustration 292 g01147777

6. Install bolts (13) and adapters (12).

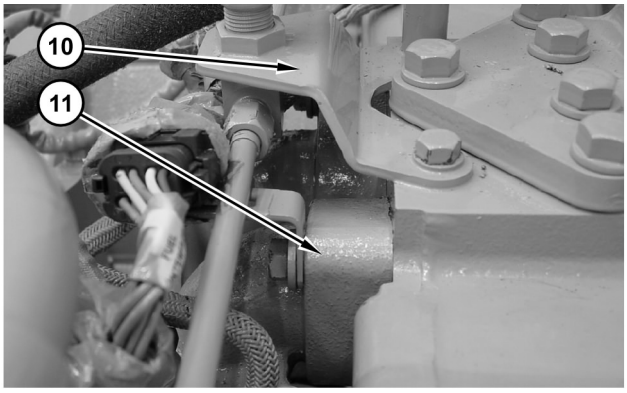


Illustration 293 g01147762

7. Connect elbows (11) and bracket (10).

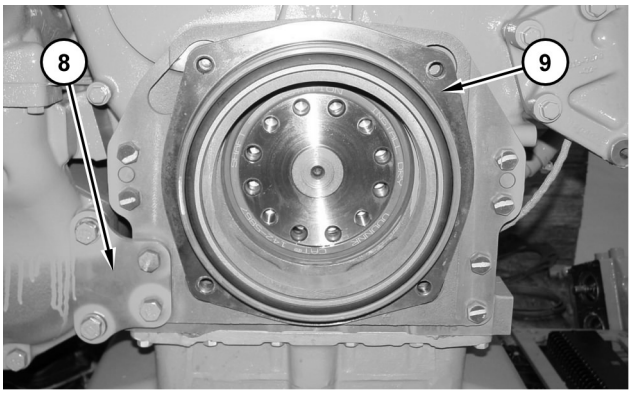


Illustration 294 g01147761

8. Install engine trunnion (9) and bracket (8).

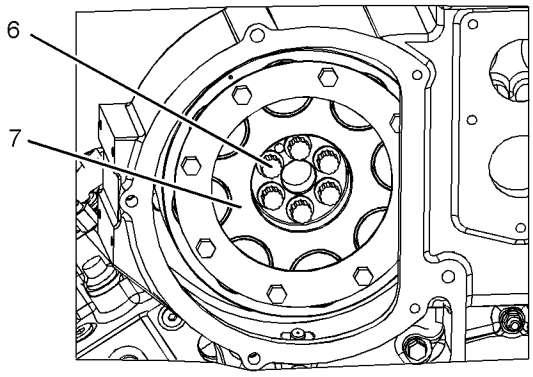


Illustration 295 g01147758

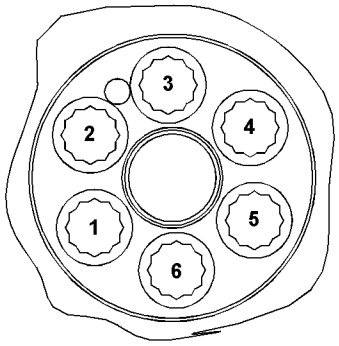


Illustration 296 g01151441

9. Install dampers (7) and bolts (6).

10. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

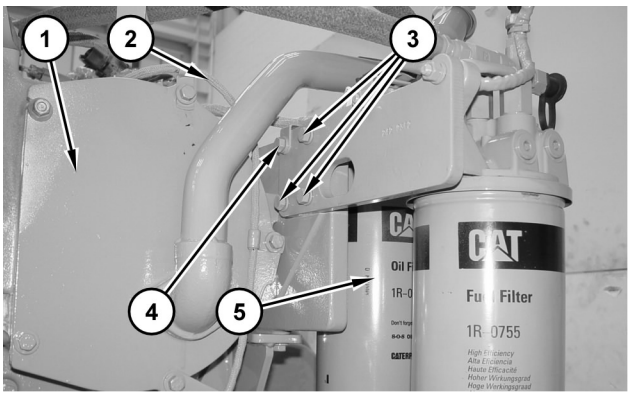


Illustration 297 g01147751

11. Install engine oil filter (5).

12. Reposition the filter housing assembly and tighten bolt (4).

13. Install bolts (3).

14. Connect harness assembly (2).

15. Install covers (1).

End By:

a. Install the front engine support. Refer to Disassembly and Assembly, “Engine Trunnion - Remove and Install”.

b. Install the water temperature regulator housing. Refer to Disassembly and Assembly, “Water Temperature Regulator Housing - Remove and Install”.

c. Install the crankshaft front seal. Refer to Disassembly and Assembly, “Crankshaft Front Seal - Install”.

d. Install the water pump. Refer to Disassembly and Assembly, “Water Pump - Install”.

i02290579

Housing (Rear) - Remove

SMCS Code: 1157-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Start By:

a. Remove the rear gear group. Refer to Disassembly and Assembly, “Gear Group (Rear) - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove the bolts that hold the engine oil pan to the rear housing.

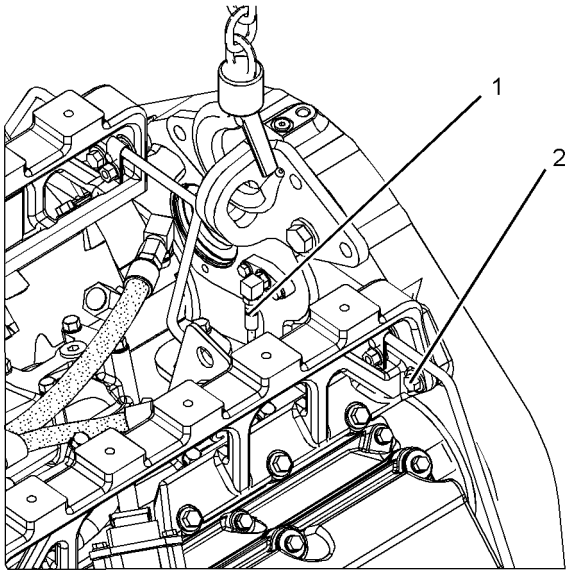


Illustration 298 g01147132

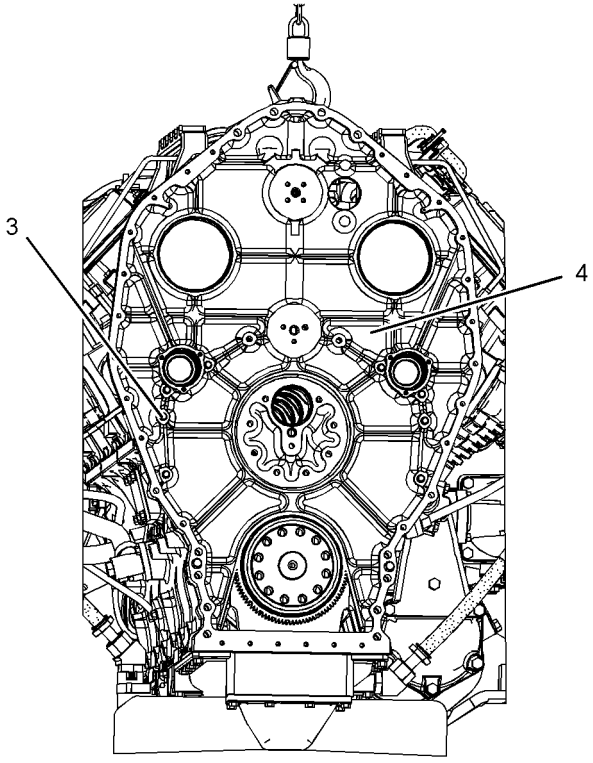


Illustration 299 g01147138

2. Disconnect hose assembly (1).

3. Remove bolts (2).

4. Attach a suitable lifting device to rear housing (4). The weight of rear housing (4) is approximately 84 kg (185 lb).

5. Remove bolts (3).

6. Remove rear housing (4) and the gasket.

i06674374

Housing (Rear) - Install

SMCS Code: 1157-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–Up

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

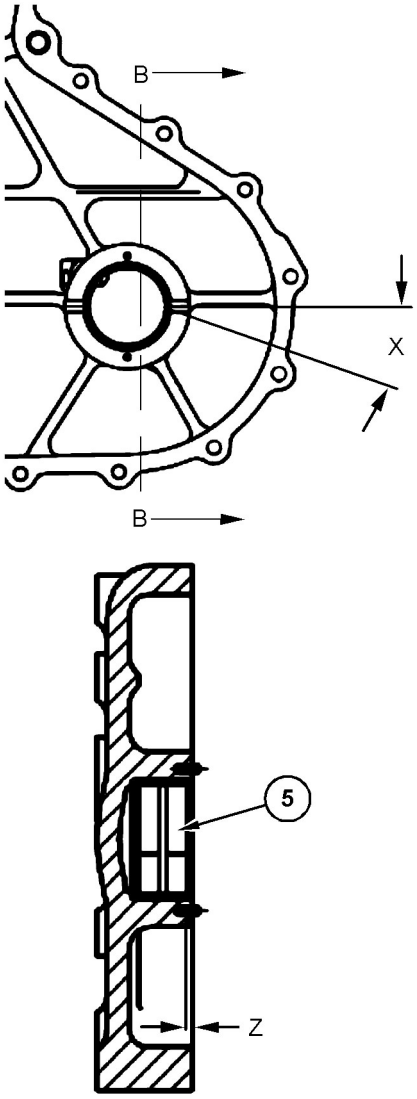
Table 60

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-9612	Silicone Sealant	1
B	1P-0510	Driver Gp	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Apply Tooling (A) to the bottom of the rear housing at the junction of the cylinder block and the engine oil pan.



SECTION B-B

Illustration 300 g06066575

2. Use Tooling (B) to install bearing (5). Installation depth (Z) should be 2.3 ± 0.5 mm (0.09 ± 0.02 inch).

3. The joint of bearing (5) should be within location (X).

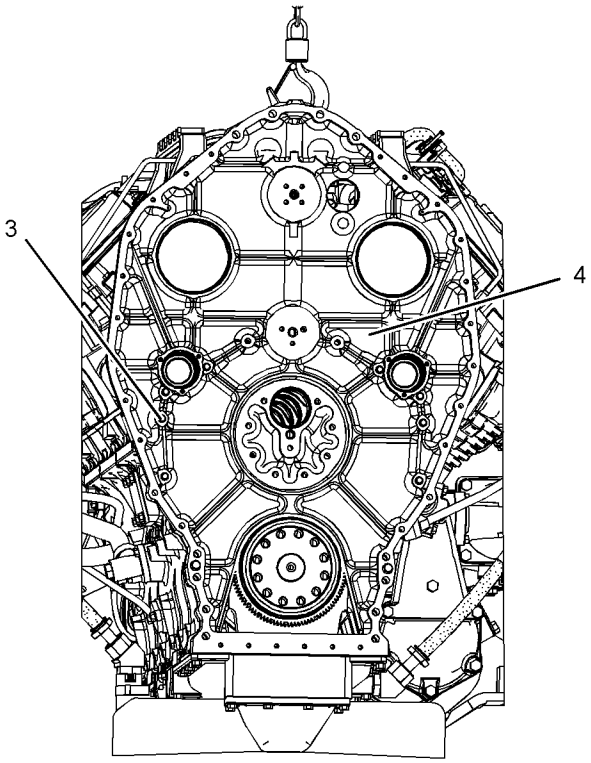


Illustration 301 g01147138

Typical example shown.

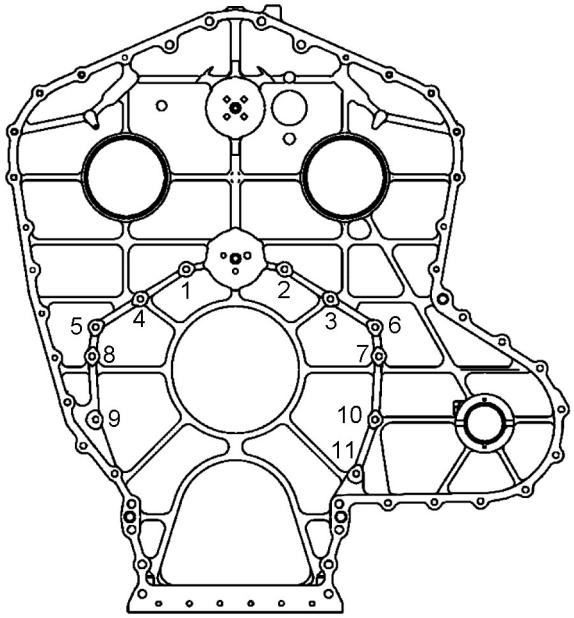


Illustration 302 g06064952

4. Attach a suitable lifting device to rear housing (4). The weight of rear housing (4) is approximately 84 kg (185 lb).

5. Position the gasket on rear housing (4).

6. Position rear housing (4) on the cylinder block. Install bolts (3). Tighten bolts (3) to a torque of 55 ± 10 N·m (41 ± 7 lb ft) in the numerical sequence shown in Illustration 302 .

7. Trim the gasket between the rear housing and the cylinder block even with the bottom of the rear housing.

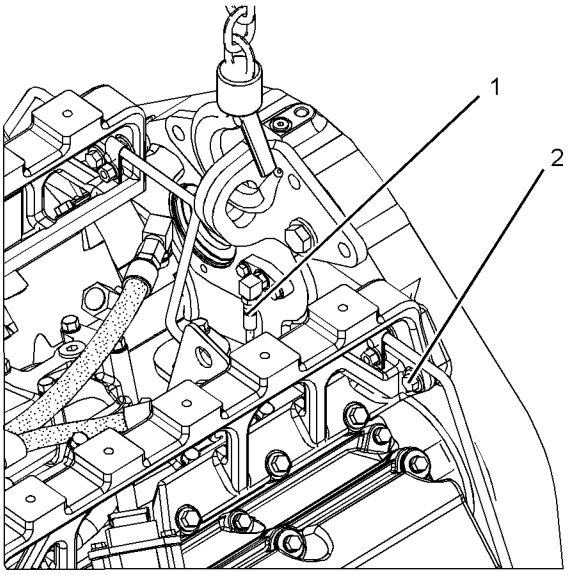


Illustration 303 g01147132

8. Install bolts (2).

9. Connect hose assembly (1).

10. Install the bolts that hold the engine oil pan to the rear housing.

11. Tighten all the bolts that hold the engine oil pan evenly to raise the engine oil pan into position.

End By:

a. Install the rear gear group.

i07607176

Housing (Rear) - Install

SMCS Code: 1157-012

Installation Procedure

Table 61

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 598™	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Apply Tooling (A) to the bottom of the rear housing at the junction of the cylinder block and the engine oil pan.

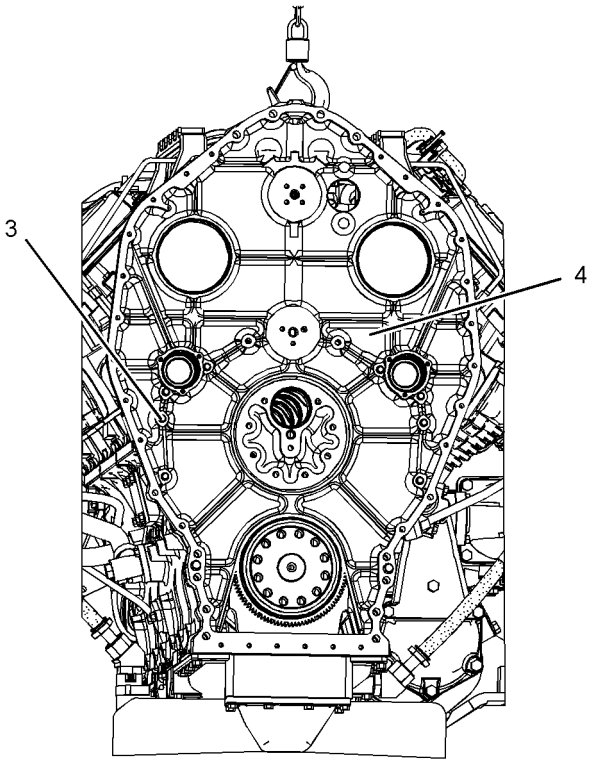


Illustration 304 g01147138

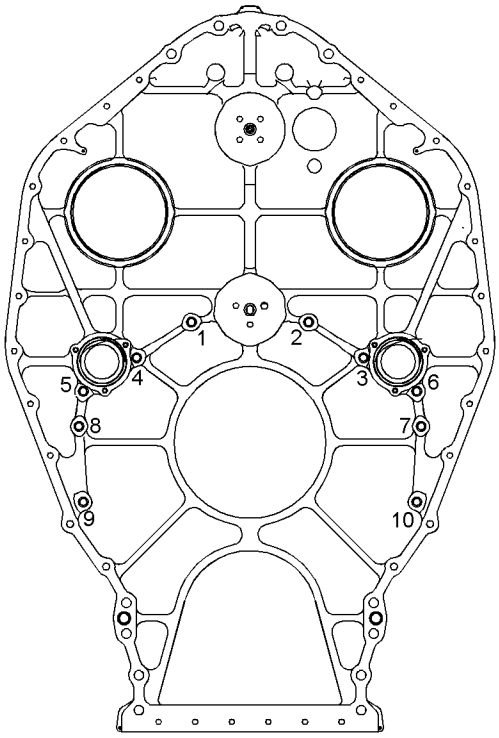


Illustration 305 g01147149

2. Attach a suitable lifting device to rear housing (4). The weight of rear housing (4) is approximately 84 kg (185 lb).

3. Position the gasket on rear housing (4).

4. Position rear housing (4) on the cylinder block. Install bolts (3). Tighten bolts (3) in a numerical sequence to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

5. Trim the gasket between the rear housing and the cylinder block even with the bottom of the rear housing.

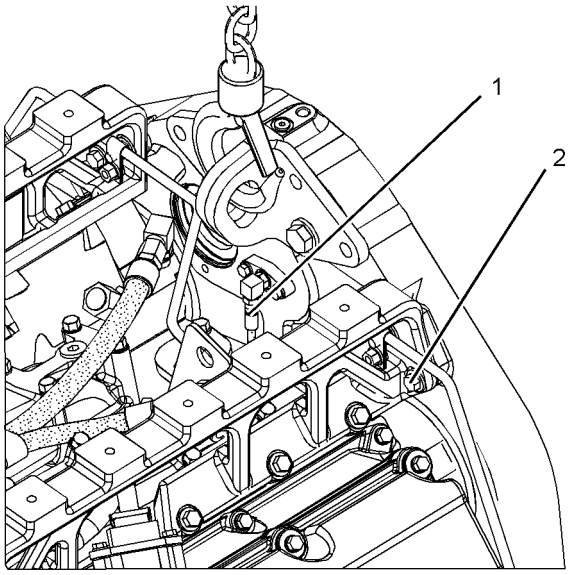


Illustration 306 g01147132

6. Install bolts (2).

7. Connect hose assembly (1).

8. Install the bolts that hold the engine oil pan to the rear housing.

9. Tighten all the bolts that hold the engine oil pan evenly to raise the engine oil pan into position.

End By:

a. Install the rear gear group. Refer to Disassembly and Assembly, “Gear Group (Rear) - Install”.

i06691975

Valve Mechanism Cover - Remove and Install (C32)

SMCS Code: 1107-010

S/N: PZB1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: EHX1–99999

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

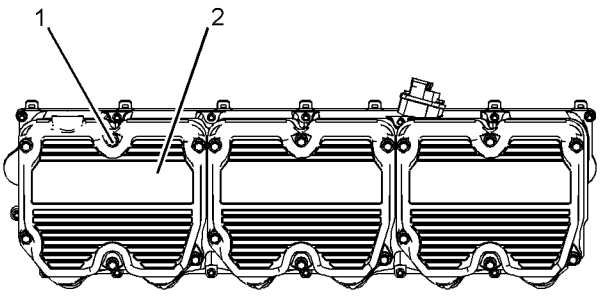


Illustration 307 g01147941

1. Remove bolts (1), valve mechanism covers (2) and the seals.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 308 g06078165

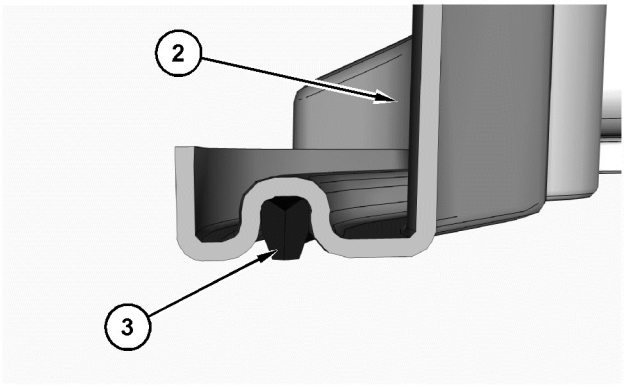


Illustration 309 g06078161

Note: Be sure that the seal is seated correctly into the valve mechanism cover. The narrow side of the seal should face out away from the valve mechanism cover.

1. Install seals (3) into valve mechanism covers (2).

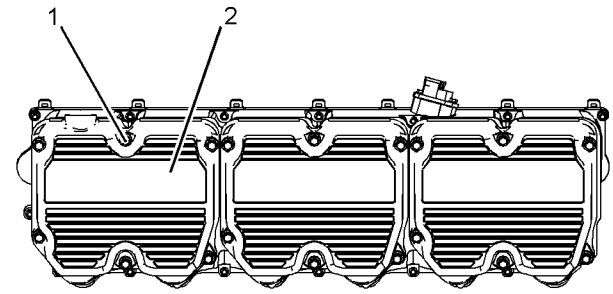


Illustration 310 g01147941

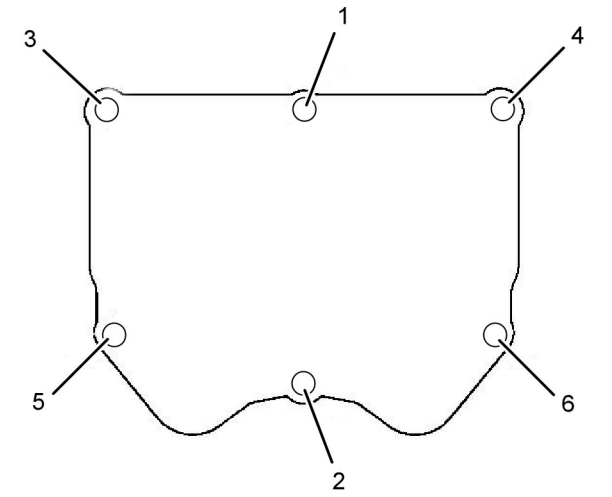


Illustration 311 g03225827

2. Position valve mechanism covers (2) on the valve mechanism cover base. Install bolts (1). Tighten bolts (1) in the sequence shown in illustration 311 .

i06692001

Valve Mechanism Cover - Remove and Install
(C27)

SMCS Code: 1107-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

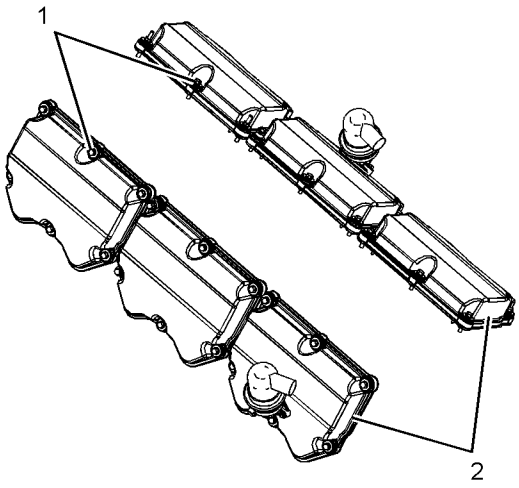


Illustration 312 g01265909

1. Remove bolts (1) and valve mechanism covers (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 313 g06078165

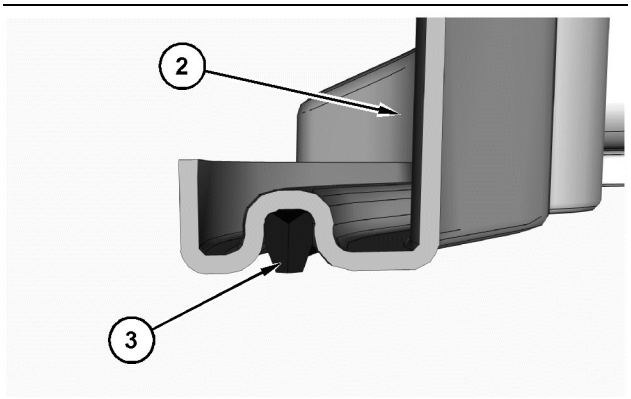


Illustration 314 g06078161

Note: Be sure that the seal is seated correctly into the valve mechanism cover. The narrow side of the seal should face out away from the valve mechanism cover.

1. Install seals (3) into valve mechanism covers (2).

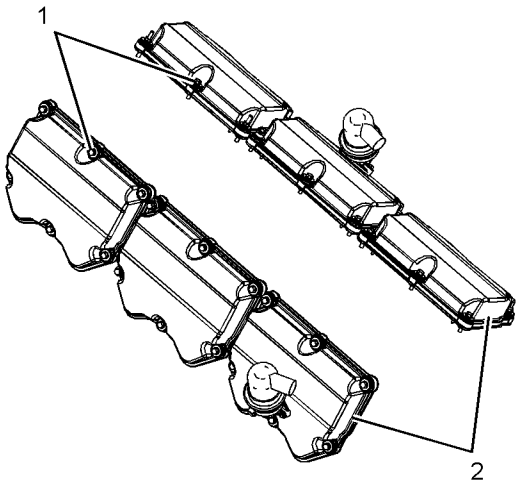


Illustration 315 g01265909

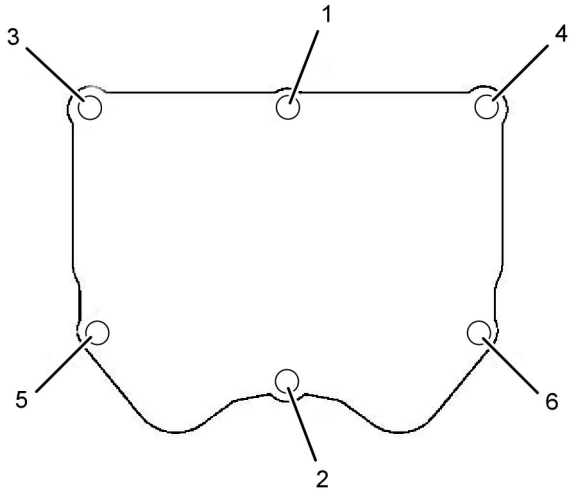


Illustration 316 g03225827

2. Position valve mechanism covers (2) on the valve mechanism cover base. Install bolts (1). Tighten bolts (1) in the sequence shown in illustration 316 .

i03424280

Valve Mechanism Cover Base - Remove and Install

SMCS Code: 1120-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Start By:

a. Remove the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

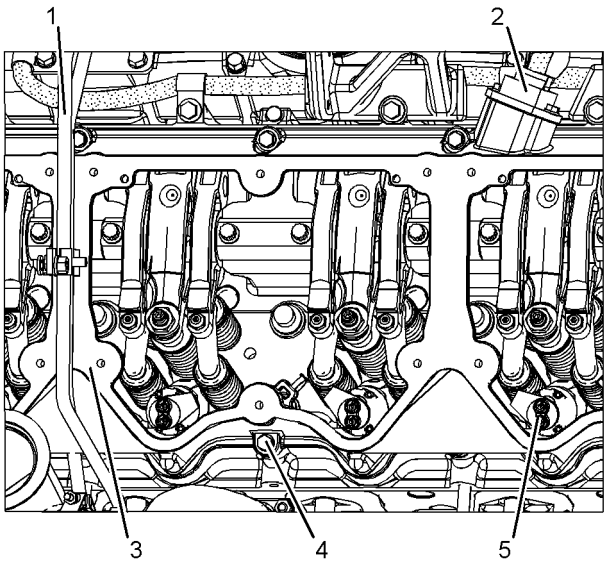


Illustration 317 g01147965

1. Remove tube assemblies (1).

2. Disconnect harness assemblies (5) and harness assembly (2).

3. Remove bolts (4).

4. Remove valve mechanism cover base (3) and the seal from the cylinder head.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

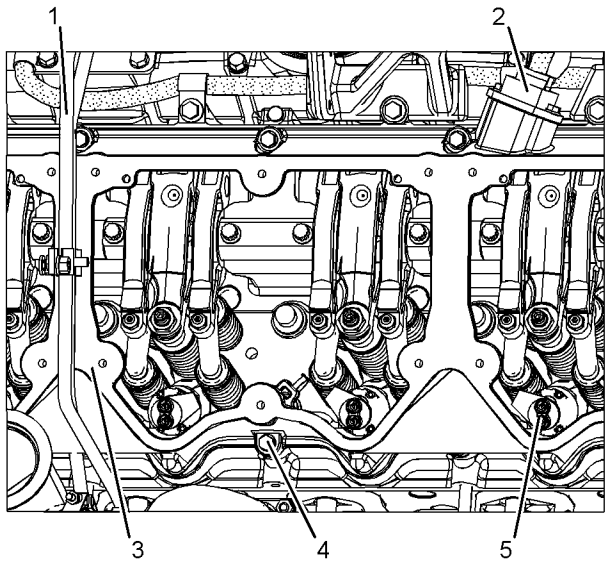


Illustration 318 g01147965

1. Install the seal on valve mechanism cover base (3).

2. Position valve mechanism cover base (3) on the cylinder head and install bolts (4).

3. Position harness assemblies (5) on the electronic unit injectors. Tighten the cap nuts to a torque of 2.5 ± 0.25 N·m (22 ± 2 lb in).

4. Connect harness assembly (2).

5. Install tube assemblies (1).

End By:

a. Install the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”.

i02882814

Valve Actuator (Variable) - Remove

SMCS Code: 1105-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Start By:

a. Remove the valve mechanism cover. Refer to the Disassembly and Assembly Manual, "Valve Mechanisim Cover - Remove and Install".

Note: Do not disassemble the variable valve actuator after the component has been removed. Any attempt to disassemble the variable valve actuator will void the warranty of the component.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

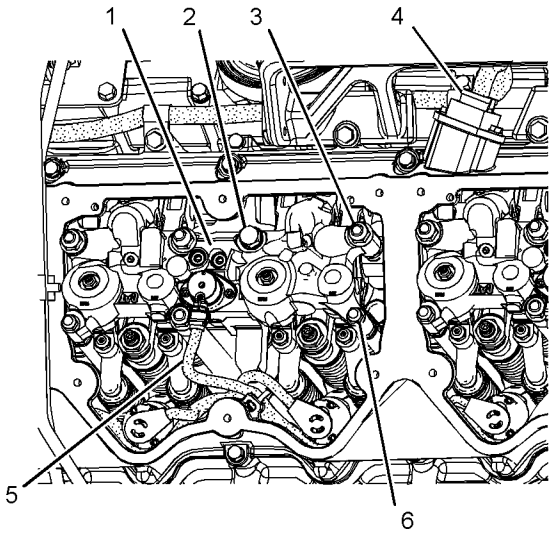


Illustration 319 g01435057

1. Disconnect harness assembly (4). Disconnect harness assembly (5).

2. Remove bolt (2). Remove four nuts (3) and two nuts (6).

3. Remove variable valve actuator (1).

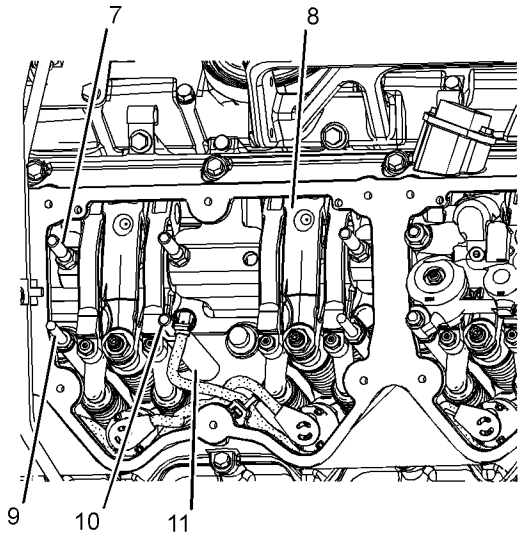


Illustration 320 g01435059

4. Remove support (11) and stud (10).

5. Remove two studs (9) and three studs (7).

6. Remove rocker arm (8).

i07681008

Valve Actuator (Variable) - Install

SMCS Code: 1105-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 62

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite Graphite 50	-
	-	Loctite LB 8009 (1)	-

(1) For use in EAME

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

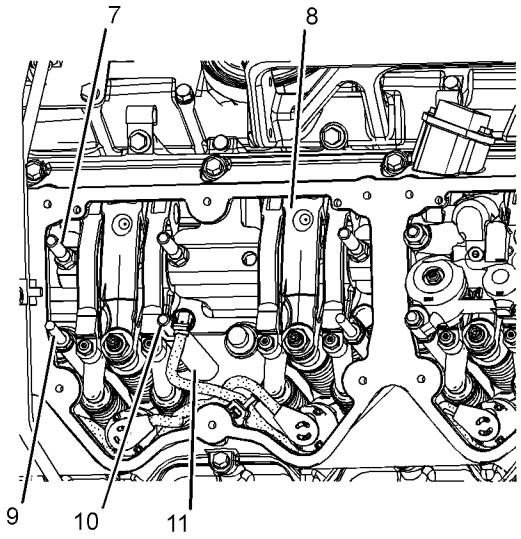
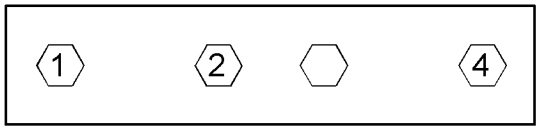
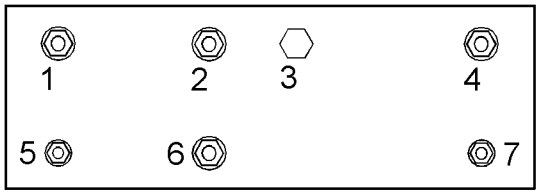


Illustration 321 g01435059



Rocker Arm Shaft Detail
Torque Sequence 2, 4, 1, 2



Actuator Valve Detail
Torque Sequence 3, 6, 2, 4, 1, 7, 5, 3

Illustration 322 g01435470

1. Install two studs (9) at location 5 and location 7. Tighten studs (9) to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

2. Install stud (10) at location 6. Tighten stud (10) to a torque of 65 ± 10 N·m (48 ± 7 lb ft). Install support (11).

3. Position rocker arm (8). Apply Tooling (A) to the threads and under head of studs (7). Install three studs (7) at location 1, location 2, and location 4. Tighten studs (7) to a torque of 55 ± 5 N·m (41 ± 4 lb ft). Tighten studs (7) again to a torque of 55 ± 5 N·m (41 ± 4 lb ft). Tighten studs (7) an additional 60° ± 5°.

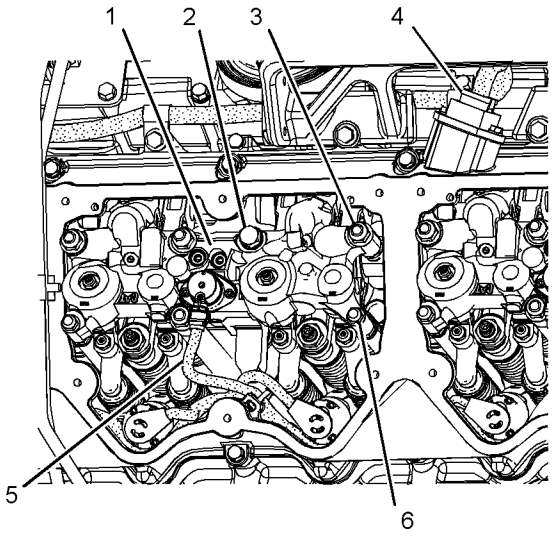


Illustration 323 g01435057

4. Install variable valve actuator (1).

5. Install bolt (2). Tighten bolt (2) to a torque of 105 ± 20 N·m (77 ± 15 lb ft). Install four nuts (3). Tighten nuts (3) to a torque of 105 ± 20 N·m (77 ± 15 lb ft). Refer to the tightening sequence.

6. Install two nuts (6). Tighten nuts (6) to a torque of 47 ± 9 N·m (35 ± 7 lb ft). Refer to the tightening sequence.

7. Connect harness assembly (5). Connect harness assembly (4) to variable valve actuator (1).

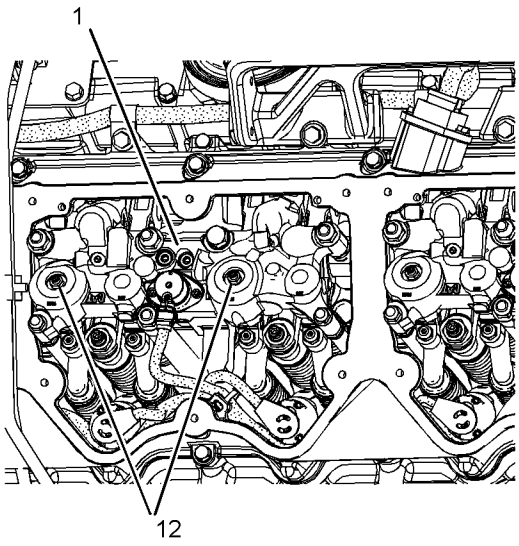


Illustration 324 g01446175

8. First adjust the lash on the exhaust and then adjust the compression brake on variable valve actuator (1). Refer to Testing and Adjusting, “Slave Piston Lash - Adjust” for more information on adjusting the lash for the compression brake. Tighten jam nut (12) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).

End By:

a. Install the valve mechanism cover. Refer to the Disassembly and Assembly Manual, “Valve Mechanism Cover - Remove and Install”.

i08192799

Rocker Arm and Shaft - Remove

SMCS Code: 1102-011

Removal Procedure

Table 63

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	387-8004	Lifting Bracket	1

Start By:

a. Remove the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the crankshaft to top center compression stroke for the No. 1 piston. Install the timing bolt in the flywheel. Refer to Testing and Adjusting, “Finding Top Center Piston for No. 1 Piston” for more information.

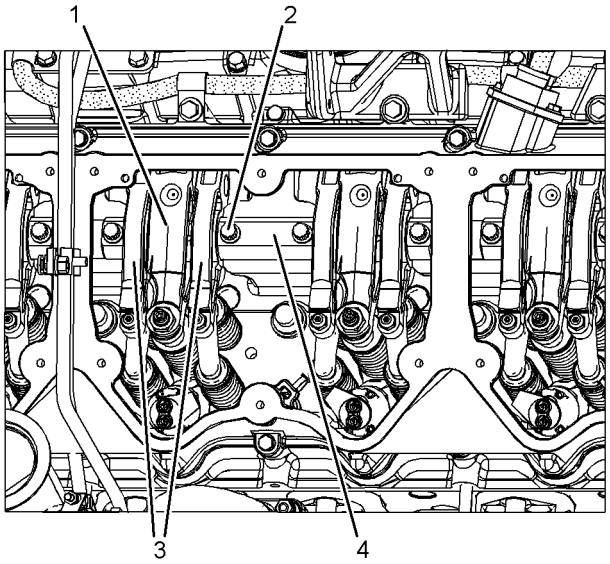


Illustration 325 g01148045

2. Remove bolts (2) and discard them.

3. Use Tooling (A) to remove rocker arm shaft assembly (4), valve rocker arms (3), and electronic unit injector rocker arms (1) as a unit.

i04997049

Rocker Arm - Disassemble

SMCS Code: 1123-015

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Disassembly Procedure

Start By:

a. Remove the rocker arms and the rocker shaft. Refer to Disassembly and Assembly, “Rocker Arm and Shaft - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

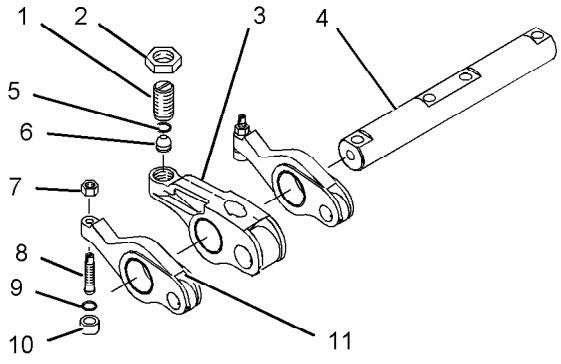


Illustration 326 g01047557

1. Remove valve rocker arms (11) and electronic unit injector rocker arm (3) from rocker shaft assembly (4).

2. Remove jam nut (7) from adjustment screw (8).

3. Remove adjustment screw (8) from valve rocker arms (11).

4. Remove button (10) from adjustment screw (8). Remove O-ring seal (9) from the adjustment screw.

5. Remove jam nut (2) from unit injector adjustment screw (1).

6. Remove unit injector adjustment screw (1) from electronic unit injector rocker arm (3).

7. Remove button (6) from unit injector adjustment screw (1). Remove O-ring seal (5) from the unit injector adjustment screw.

i04998150

Rocker Arm - Assemble

SMCS Code: 1123-016

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

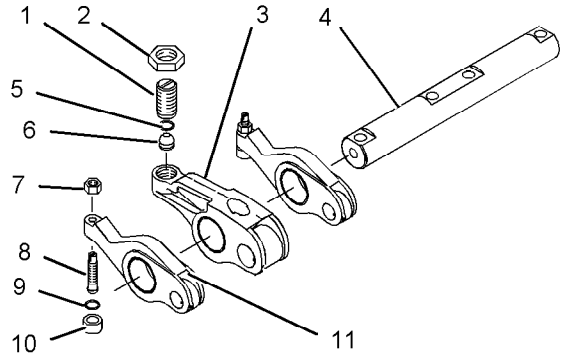


Illustration 327 g01047557

Note: Do not reuse the O-ring seal on the adjustment screw if the button is removed from the adjustment screw.

1. Install O-ring seal (9) in button (10).

2. Use a soft hammer to seat button (10) on adjustment screw (8).

3. Install adjustment screw (8) in valve rocker arms (11). Install jam nut (7) on the adjustment screw.

4. Install O-ring seal (5) in button (6).

5. Use a soft hammer to seat button (6) on unit injector adjustment screw (1).

6. Install unit injector adjustment screw (1) in electronic unit injector rocker arm (3). Install jam nut (2) on the unit injector adjustment screw.

7. Lubricate rocker shaft assembly (4) with clean engine oil.

8. Install valve rocker arms (11) and electronic unit injector rocker arm (3) on rocker shaft assembly (4).

End By:

a. Install the rocker arms and the rocker shaft. Refer to Disassembly and Assembly, “Rocker Arm and Shaft - Install”.

i08192802

Rocker Arm and Shaft - Install

SMCS Code: 1102-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 64

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	387-8004	Lifting Bracket	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

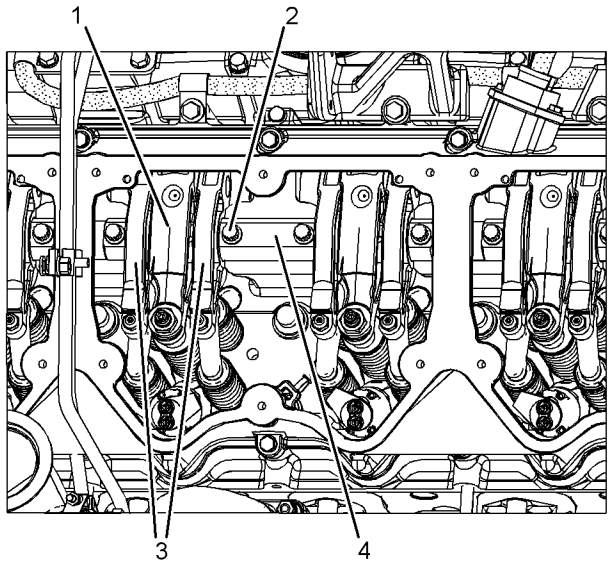


Illustration 328 g01148045

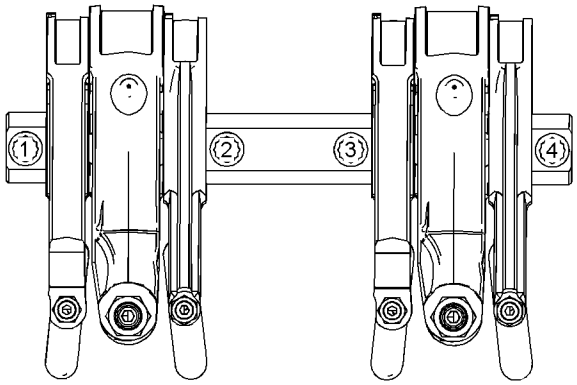


Illustration 329 g01325993

1. Position rocker arm shaft assembly (4), valve rocker arms (3), and electronic unit injector rocker arms (1) as a unit with Tooling (A) on the cylinder head.

Note: Apply clean engine oil to the underside of the bolt heads and the threads prior to installation.

2. Install new bolts (2) and tighten to a torque of 55 ± 5 N·m (41 ± 4 lb ft). Tighten bolts (2) again to a torque of 55 ± 5 N·m (41 ± 4 lb ft). Turn bolts (2) for an additional 60 ± 5 degrees. Tighten the bolts in the following sequence: 2, 3, 1, 4.

Note: The additional 60 degrees can be attained by turning the bolt two points.

3. Adjust the valve lash for the inlet valves and the exhaust valves. Refer to Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust”.

4. Adjust the electronic unit injectors. Refer to Testing and Adjusting, “Electronic Unit Injector - Adjust”.

End By:

a. Install the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”.

i04303629

Cylinder Head - Remove (C32)

SMCS Code: 1100-011

S/N: TZC1–Up

S/N: NZK1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

Table 65

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	3
B	1U-9200	Lever Puller Hoist	1

Start By:

a. Remove the accessory pump drive adapter, if equipped. Refer to Disassembly and Assembly, Engine Supplement, “Pump Drive - Remove - Accesory Drive (Right Hand Side)”.

b. Remove the electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”.

c. Remove the valve mechanism cover base. Refer to Disassembly and Assembly, “Valve Mechanism Cover Base - Remove and Install”.

d. Remove the fuel transfer pump. Refer to Disassembly and Assembly, “Fuel Transfer Pump - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

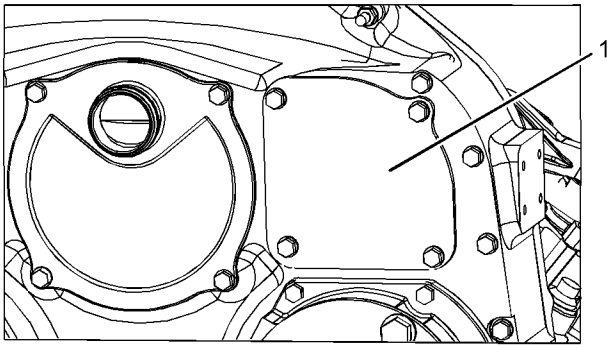


Illustration 330 g01148233

2. Remove cover (1).

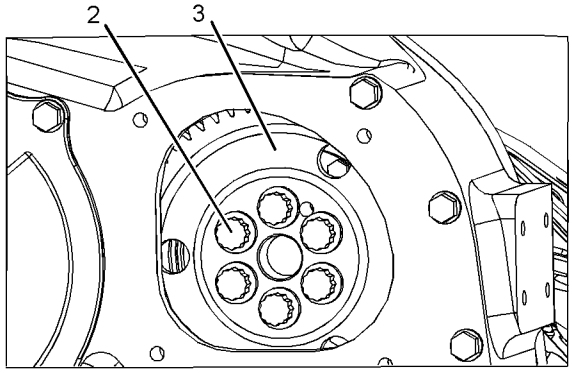


Illustration 331 g01148237

3. Remove bolts (2). Reposition gear (3) inside the flywheel housing.

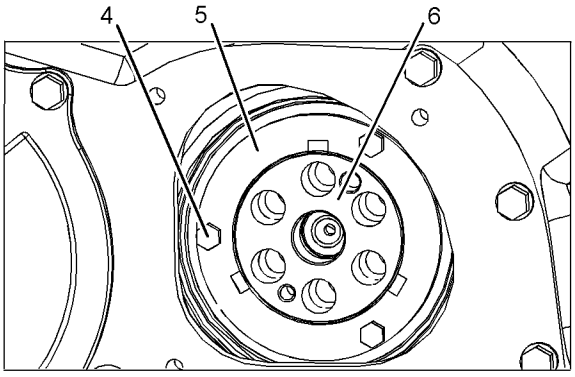


Illustration 332 g01148238

4. Remove bolts (4), thrust plate (5), and adapter assembly (6).

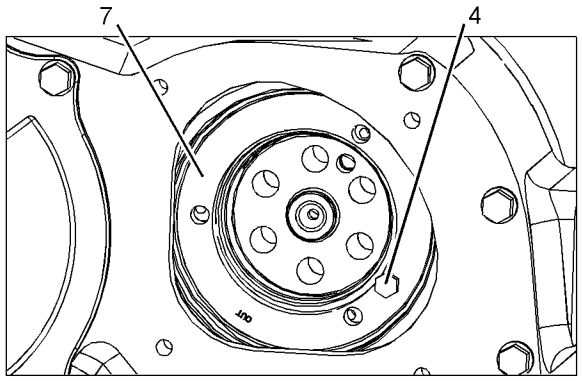


Illustration 333 g01148241

5. Use bolt (4) in order to remove sealing plate (7). Remove the O-ring seals.

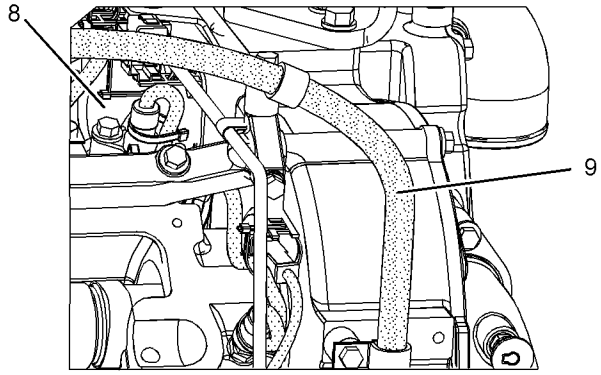


Illustration 334 g01148246

6. Remove elbow (8). Disconnect hose assembly (9).

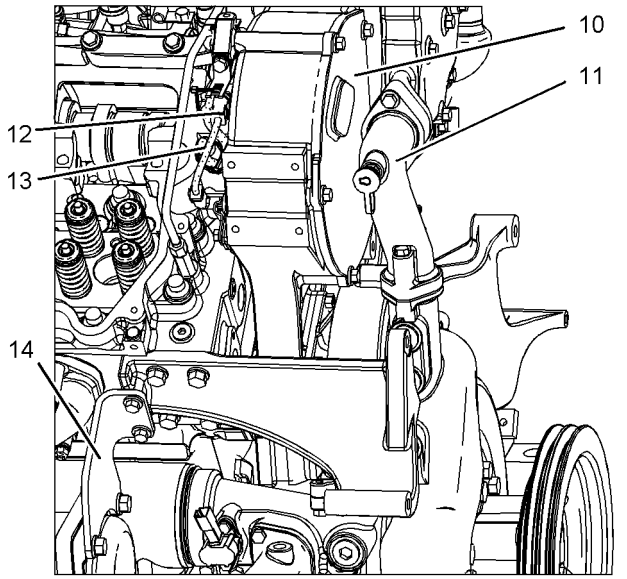


Illustration 335 g01148489

7. Remove elbow (11) and cover (10).

8. Disconnect harness assembly (12) and harness assembly (13).

9. Remove bracket (14).

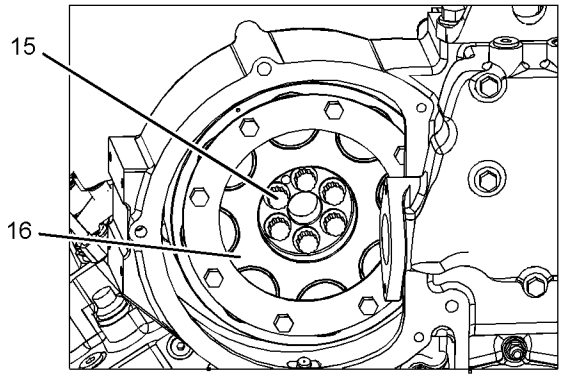


Illustration 336 g01148492

10. Remove bolts (15) and damper (16).

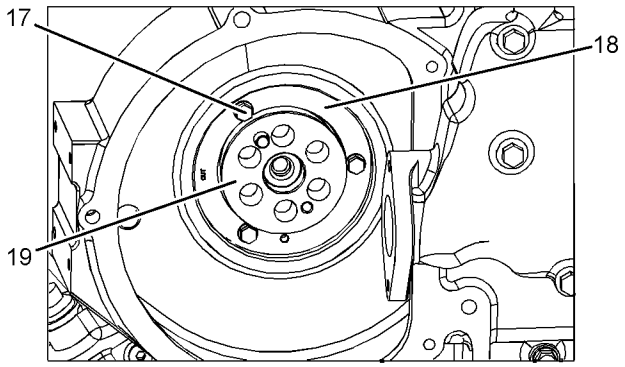


Illustration 337 g01148516

11. Remove bolts (17). Remove sealing plate (18) and adapter assembly (19).

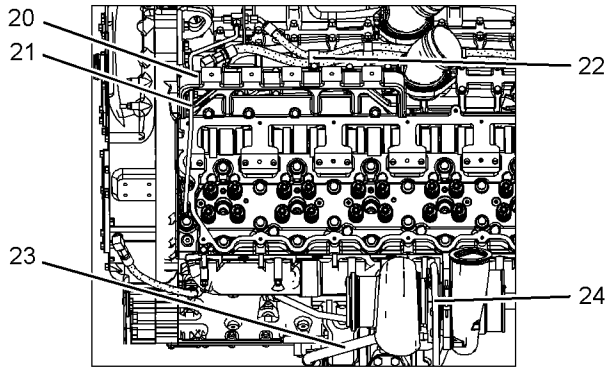


Illustration 338 g01148522

12. Disconnect clip assembly (22) from the cylinder head. Remove tube assemblies (21).

13. Remove bracket (20).

14. Disconnect tube assembly (23) and remove tube assembly (24).

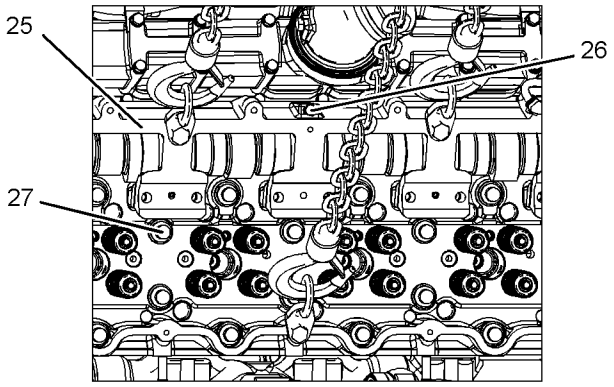


Illustration 339 g01148568

15. Attach Tooling (A) and a suitable lifting device to cylinder head (25). Attach Tooling (B) to the side of cylinder head (25) that is near the turbocharger. The weight of cylinder head (25) is approximately 365 kg (800 lb).

16. Remove bolts (26) and bolts (27).

17. Remove cylinder head (25). Remove the gaskets, O-ring seals, and the spacer plate.

i08107049

Cylinder Head - Remove (C27)

SMCS Code: 1100-011

Removal Procedure

Table 66

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	477-3192	Lifting Eye	3
B	1U-9200	Lever Puller Hoist	1

Start By:

a. Remove the accessory pump drive adapter, if equipped. Refer to Disassembly and Assembly, Engine Supplement, "Pump Drive - Remove - Accesory Drive (Right-Hand Side)".

b. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".

c. Remove the valve mechanism cover base. Refer to Disassembly and Assembly, "Valve Mechanism Cover Base - Remove and Install".

d. Remove the fuel transfer pump. Refer to Disassembly and Assembly, "Fuel Transfer Pump - Remove".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

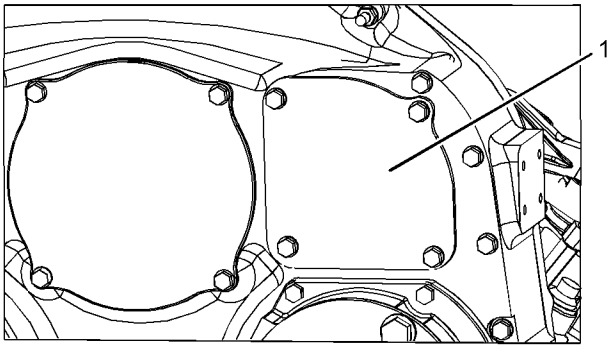


Illustration 340 g01265926

2. Remove cover (1).

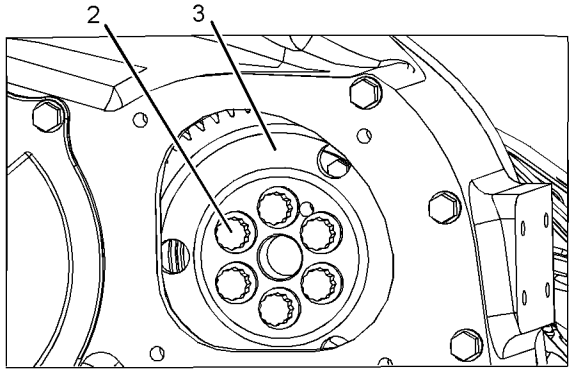


Illustration 341 g01148237

3. Remove bolts (2). Reposition gear (3) inside the flywheel housing.

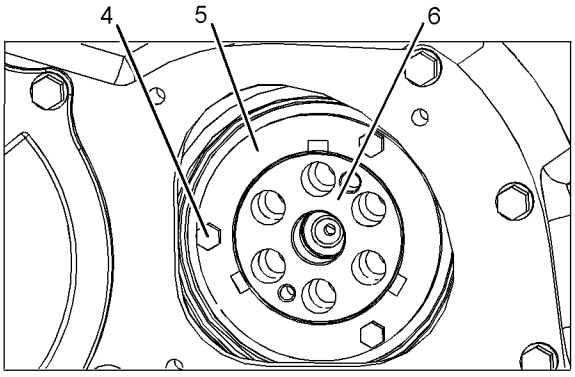


Illustration 342 g01148238

4. Remove bolts (4), thrust plate (5), and adapter assembly (6).

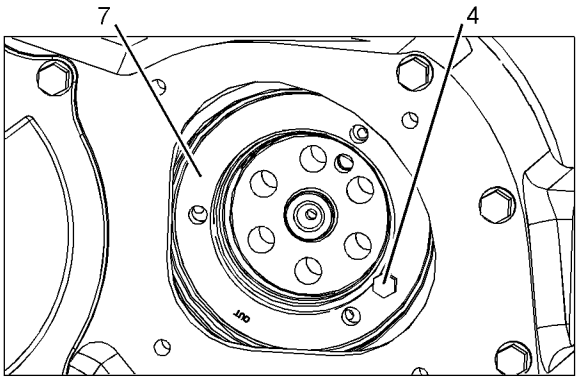


Illustration 343 g01148241

5. Use bolt (4) to remove sealing plate (7). Remove the O-ring seals.

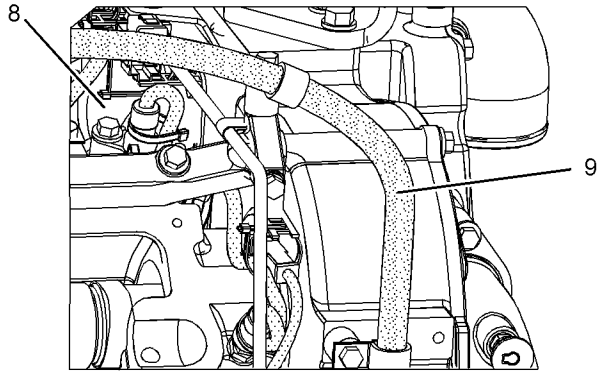


Illustration 344 g01148246

6. Remove elbow (8). Disconnect hose assembly (9).

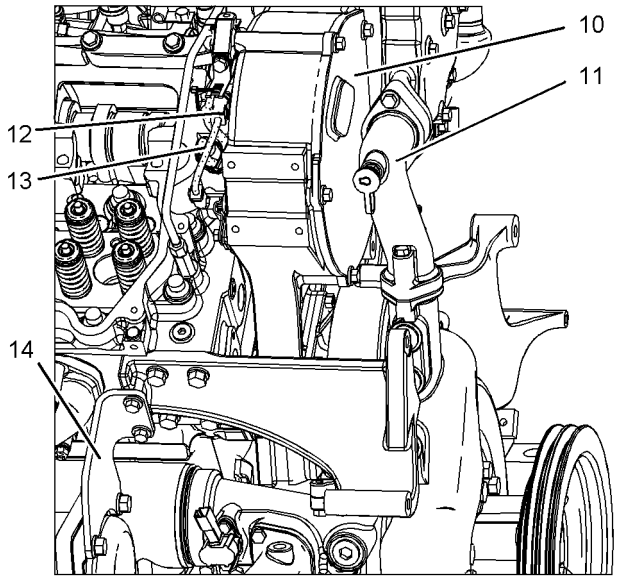


Illustration 345 g01148489

7. Remove elbow (11) and cover (10).

8. Disconnect harness assembly (12) and harness assembly (13).

9. Remove bracket (14).

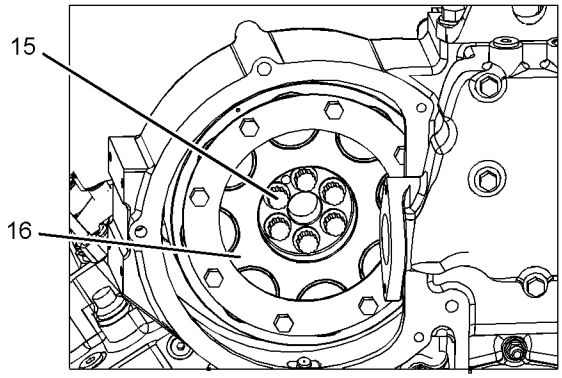


Illustration 346 g01148492

10. Remove bolts (15) and damper (16).

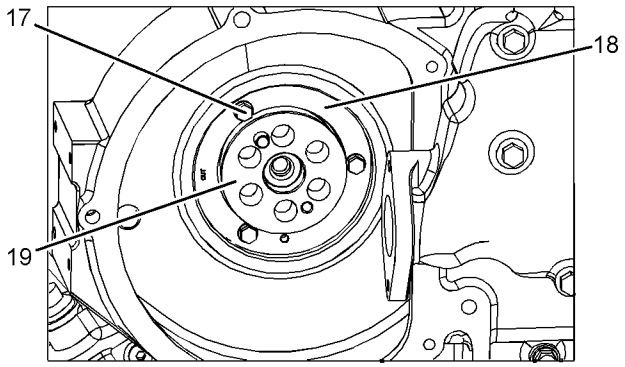


Illustration 347 g01148516

11. Remove bolts (17). Remove sealing plate (18) and adapter assembly (19).

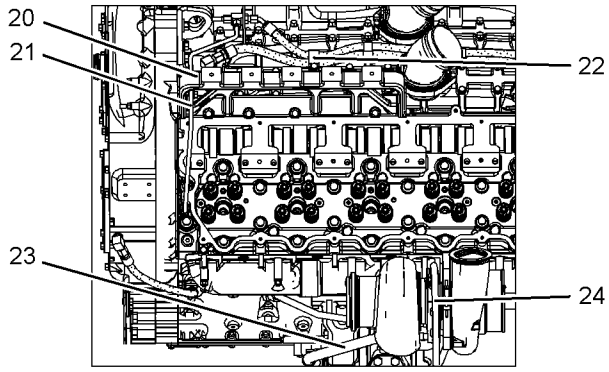


Illustration 348 g01148522

12. Disconnect clip assembly (22) from the cylinder head. Remove tube assemblies (21).

13. Remove bracket (20).

14. Disconnect tube assembly (23) and remove tube assembly (24).

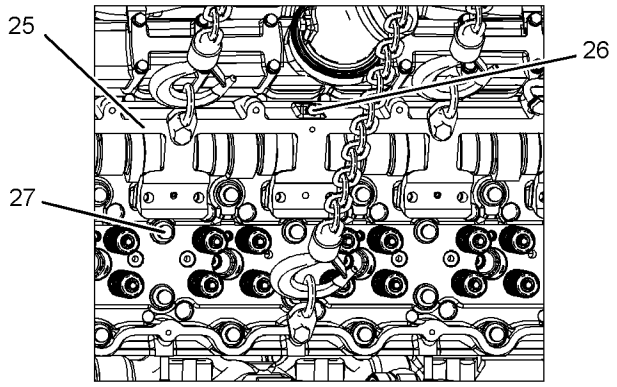


Illustration 349 g01148568

15. Attach Tooling (A) and a suitable lifting device to cylinder head (25). Attach Tooling (B) to the side of cylinder head (25) that is near the turbocharger. The weight of cylinder head (25) is approximately 365 kg (800 lb).

16. Remove bolts (26) and bolts (27).

17. Remove cylinder head (25). Remove the gaskets, O-ring seals, and the spacer plate.

i04303691

Cylinder Head - Install (C32)

SMCS Code: 1100-012

S/N: TZC1–Up

S/N: NZK1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Installation Procedure

Table 67

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	3
B	1U-9200	Lever Puller Hoist	1
C	-	Loctite Aviation Gasket Sealant	-
E	-	Loctite Graphite-50 Anti-Seize	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 350 g06059010

1. Lay out the shim plate gasket in a clean dry area.

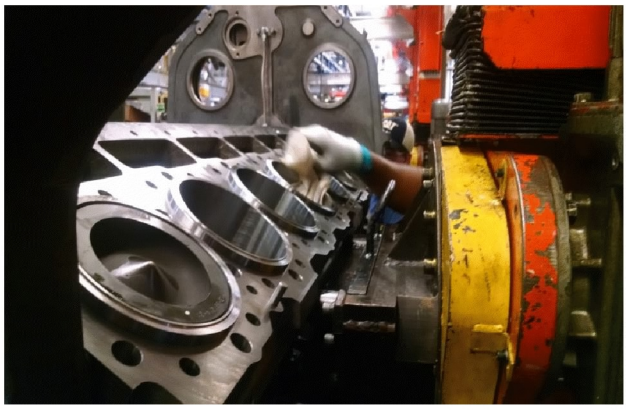


Illustration 351 g06059004

2. Using a clean, dry, cotton towel with Isopropyl Alcohol, clean the surfaces of any oil, fuel, or debris prior to gasket installation.



Illustration 352 g06059015

3. Apply Tooling (C) to the block side of the gasket-plate only. Do not allow Tooling (C) to contact the opposite side of the gasket.

Note: Tooling (C) should be applied as an even, minimal coat (skim coat). Minimal to zero material should squeeze out of joint after the head assembly has been torqued. No adhesive should contact water ferrule and or liner lip.

4. Install the gasket-plate.

5. Install the spacer plate, O-ring seals, and the gaskets on the engine.

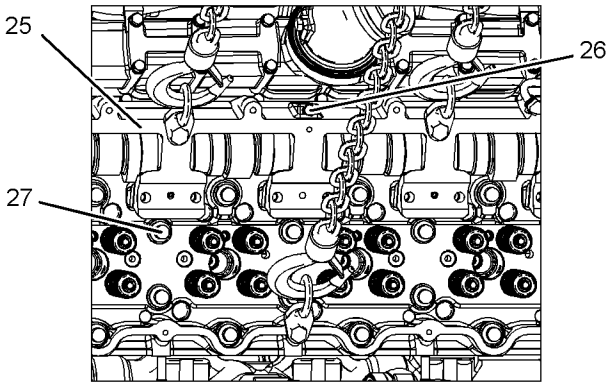


Illustration 353 g01148568

6. Attach Tooling (A) and a suitable lifting device to cylinder head (25). Attach Tooling (B) to the side of cylinder head (25) that is near the turbocharger. The weight of cylinder head (25) is approximately 365 kg (800 lb).

7. Position cylinder head (25) on the dowel pins in the cylinder block.

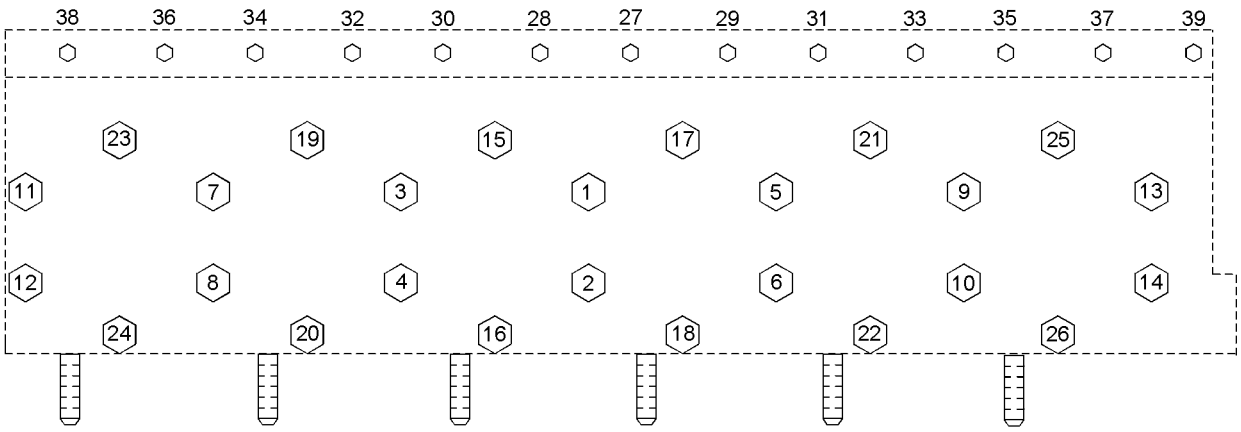


Illustration 354 g01148791

Note: Apply Tooling (E) to the bolts and both sides of the washers. Tighten the bolts in the following step sequence:

8. Install bolts (26) and bolts (27) according to the following procedure.

a. In a numerical sequence, tighten Bolt (1) through Bolt (26) to a torque of 270 ± 15 N·m (199 ± 11 lb ft).

b. In a numerical sequence, tighten Bolt (1) through Bolt (26) to a torque of 450 ± 15 N·m (332 ± 11 lb ft).

c. In a numerical sequence, again tighten Bolt (1) through Bolt (26) to a torque of 450 ± 15 N·m (332 ± 11 lb ft).

d. In a numerical sequence, tighten Bolt (27) through Bolt (39) to a torque of 45 ± 7 N·m (33 ± 5 lb ft).

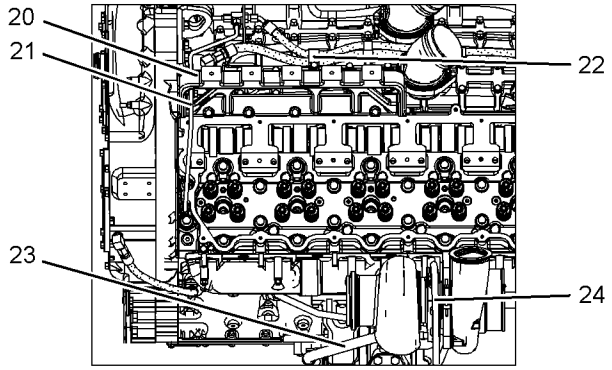


Illustration 355 g01148522

9. Connect tube assembly (23) and install tube assembly (24).

10. Install bracket (20).

11. Connect clip assembly (22). Install tube assemblies (21).

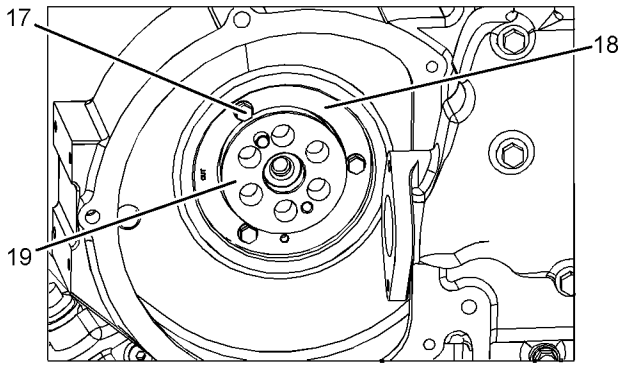


Illustration 356 g01148516

12. Install sealing plate (18) and adapter assembly (19). Install bolts (17).

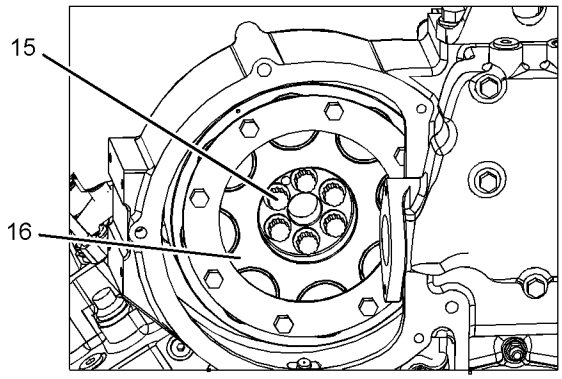


Illustration 357 g01148492

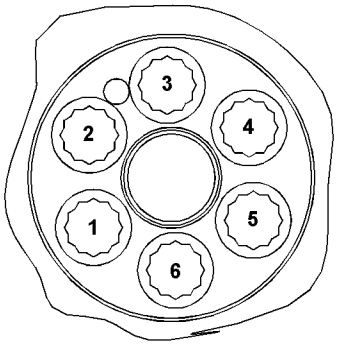


Illustration 358 g01151441

13. Install damper (16) and bolts (15).

14. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

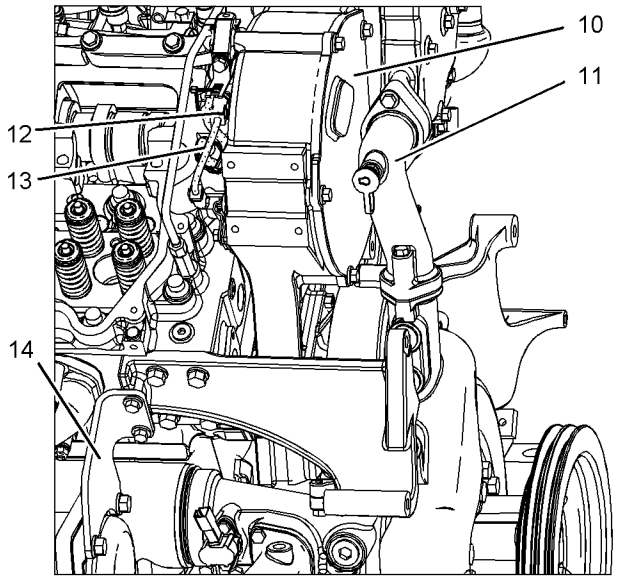


Illustration 359 g01148489

15. Install bracket (14).

16. Connect harness assembly (13) and harness assembly (12).

17. Install cover (10) and elbow (11).

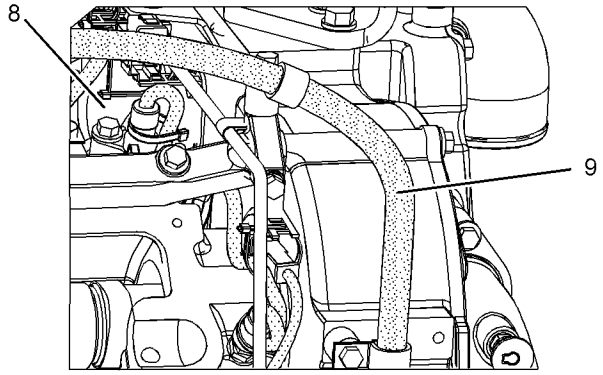


Illustration 360 g01148246

18. Connect hose assembly (9). Install elbow (8).

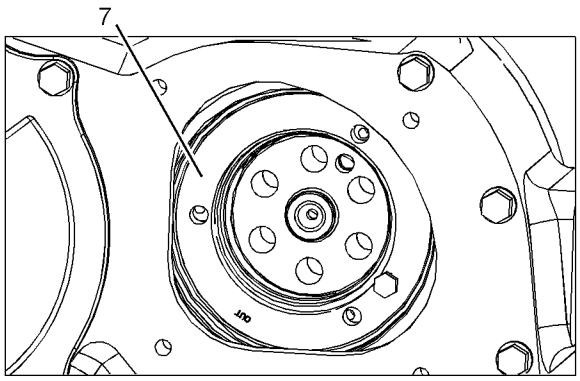


Illustration 361 g01148835

19. Install new O-ring seals and sealing plate (7).

Note: Ensure that the O-ring seals remain in position on sealing plate (7) during installation.

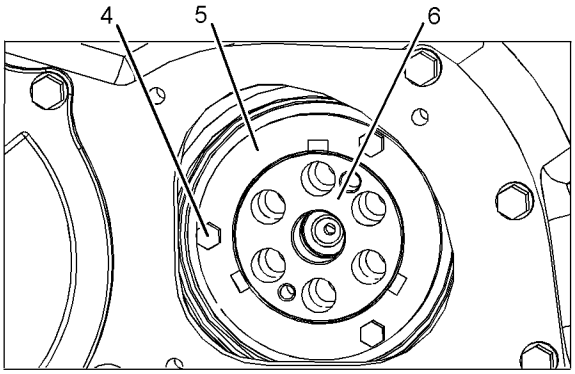


Illustration 362 g01148238

20. Install adapter assembly (6), thrust plate (5), and bolts (4).

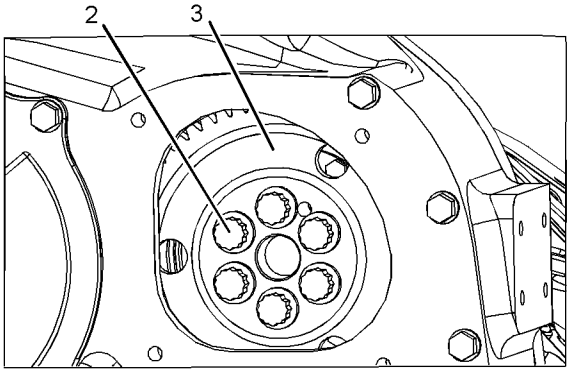


Illustration 363 g01148237

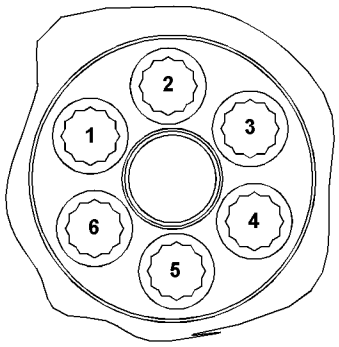


Illustration 364 g01151468

21. Reposition gear (3). Install bolts (2).

22. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

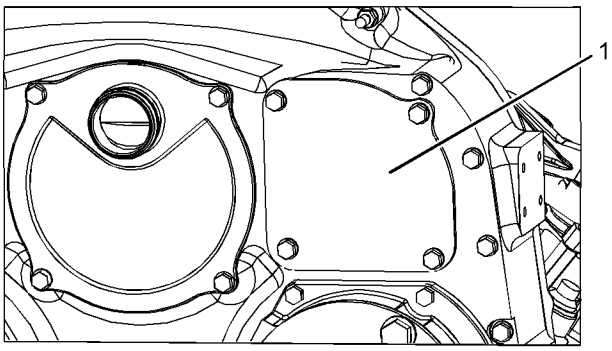


Illustration 365 g01148233

23. Install cover (1).

24. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the fuel transfer pump. Refer to Disassembly and Assembly, “Fuel Transfer Pump - Install”.

b. Install the valve mechanism cover base. Refer to Disassembly and Assembly, “Valve Mechanism Cover Base - Remove and Install”.

c. Install the electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.

d. If equipped, install the piston pump for the fan drive. Refer to Disassembly and Assembly, Engine Supplement, “Pump Drive - Install - Accessory Drive (Right-Hand Side)”.

i08138712

Cylinder Head - Install (C27)

SMCS Code: 1100-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 68

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	477-3192	Lifting Eye	3
B	1U-9200	Lever Puller Hoist	1
C	-	Loctite Aviation Gasket Sealant	-
E	-	Loctite Graphite- 50 Anti-Sieze	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 366 g06059010

1. In a clean dry area, lay out the shim plate gasket for the application of adhesive.

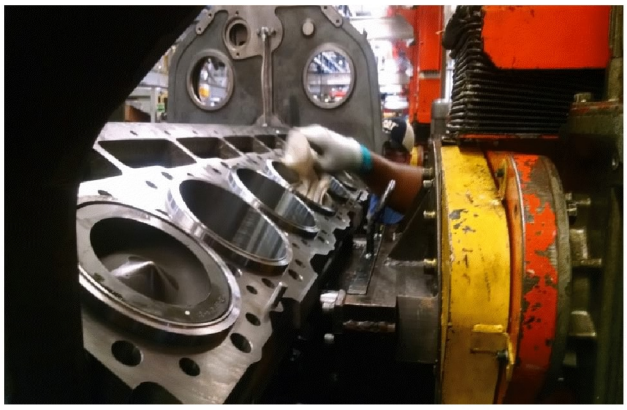


Illustration 367 g06059004

2. Wipe the surfaces using a clean dry cotton towel with Isopropyl Alcohol to remove any oil, fuel, or debris prior to installation of the gasket.



Illustration 368 g06059015

3. Apply Tooling (C) to the block side of the gasket-plate only. Do not allow Tooling (C) to contact the opposite side of the gasket.

Note: Tooling (C) should be applied as an even, minimal coat (skim coat). Minimal to zero material should squeeze out of joint after the head assembly has been torqued. No adhesive should contact water ferrule and or liner lip.

4. Install the gasket-plate.

5. Install the spacer plate, O-ring seals, and the gaskets on the engine.

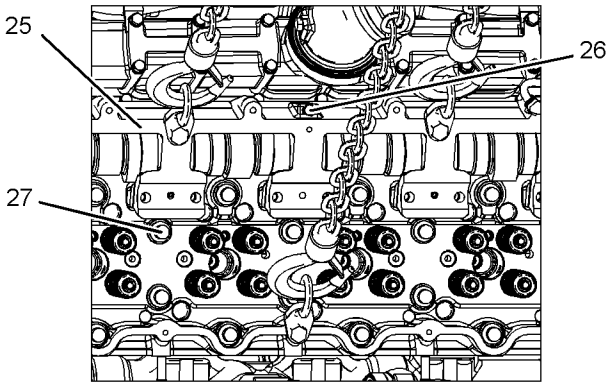


Illustration 369 g01148568

6. Attach Tooling (A) and a suitable lifting device to cylinder head (25). Attach Tooling (B) to the side of cylinder head (25) that is near the turbocharger. The weight of cylinder head (25) is approximately 365 kg (800 lb).

7. Position cylinder head (25) on the dowel pins in the cylinder block.

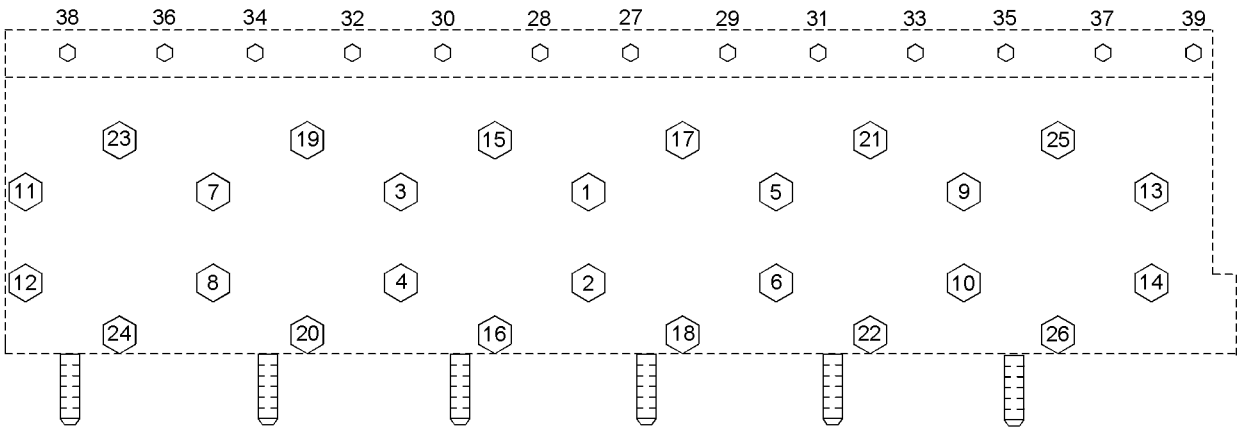


Illustration 370 g01148791

Note: Apply Tooling (E) to the bolts and both sides of the washers. Tighten the bolts in the following step sequence:

Note: The bolts at locations (11), (12), (13), (14), (16), (18), (20), (22), (24), and (26) are longer bolts.

8. Install bolts (26) and bolts (27) according to the following procedure.

a. In a numerical sequence, tighten Bolt (1) through Bolt (26) to a torque of 270 ± 15 N·m (199 ± 11 lb ft).

b. In a numerical sequence, tighten Bolt (1) through Bolt (26) to a torque of 450 ± 15 N·m (332 ± 11 lb ft).

c. In a numerical sequence, again tighten Bolt (1) through Bolt (26) to a torque of 450 ± 15 N·m (332 ± 11 lb ft).

d. In a numerical sequence, tighten Bolt (27) through Bolt (39) to a torque of 45 ± 7 N·m (33 ± 5 lb ft).

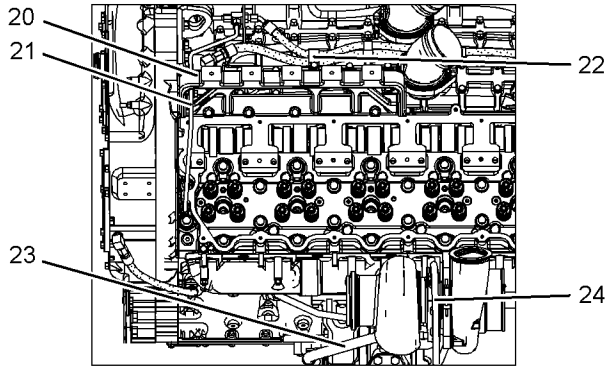


Illustration 371 g01148522

9. Connect tube assembly (23) and install tube assembly (24).

10. Install bracket (20).

11. Connect clip assembly (22). Install tube assemblies (21).

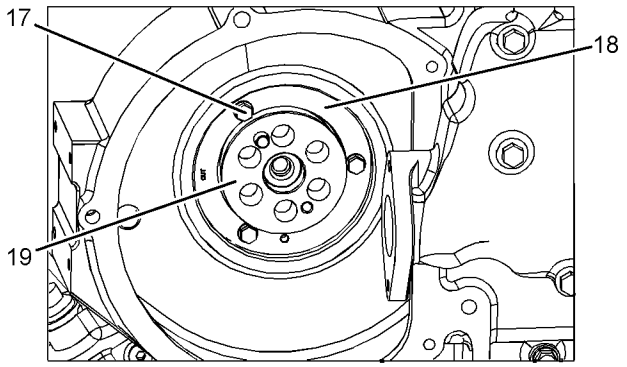


Illustration 372 g01148516

12. Install sealing plate (18) and adapter assembly (19). Install bolts (17).

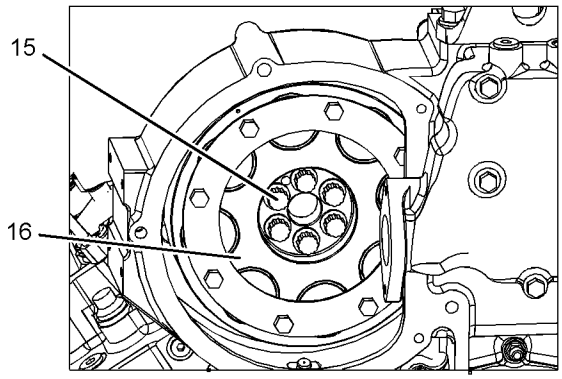


Illustration 373 g01148492

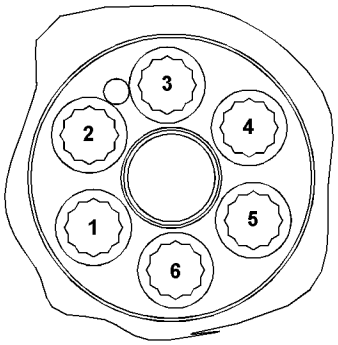


Illustration 374 g01151441

13. Install damper (16) and bolts (15).

14. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

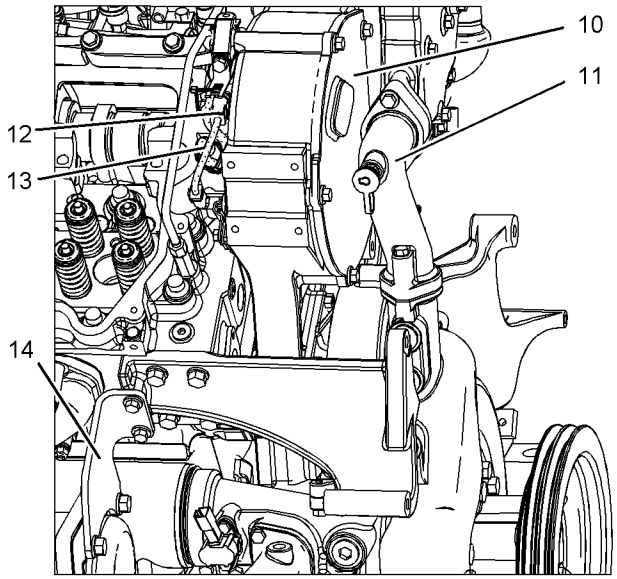


Illustration 375 g01148489

15. Install bracket (14).

16. Connect harness assembly (13) and harness assembly (12).

17. Install cover (10) and elbow (11).

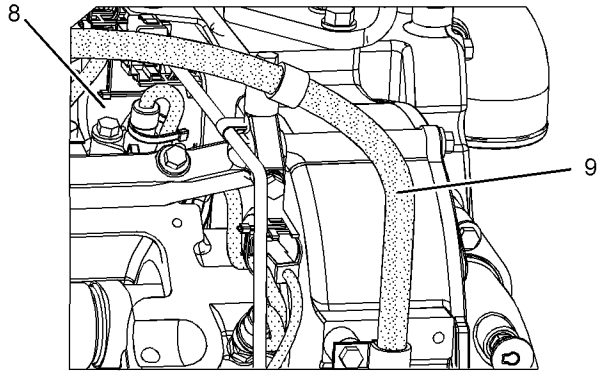


Illustration 376 g01148246

18. Connect hose assembly (9). Install elbow (8).

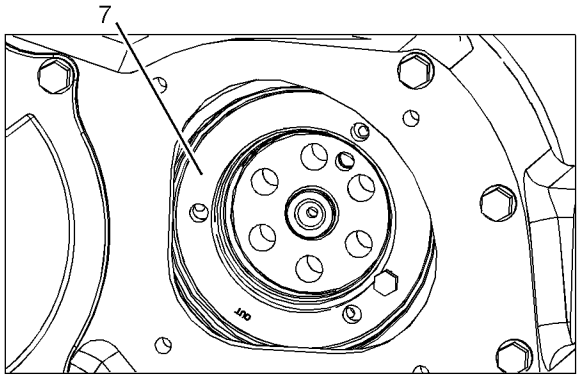


Illustration 377 g01148835

19. Install new O-ring seals and sealing plate (7).

Note: Ensure that the O-ring seals remain in position on sealing plate (7) during installation.

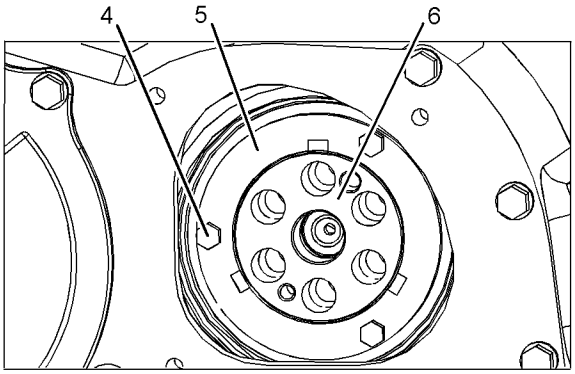


Illustration 378 g01148238

20. Install adapter assembly (6), thrust plate (5), and bolts (4).

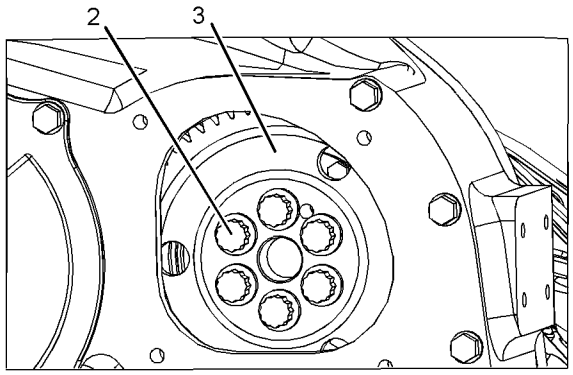


Illustration 379 g01148237

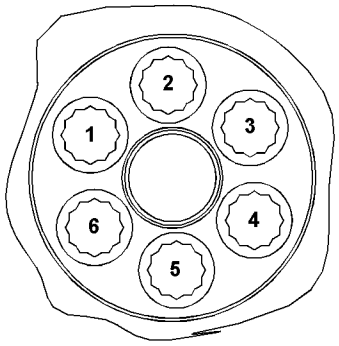


Illustration 380 g01151468

21. Reposition gear (3). Install bolts (2).

22. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

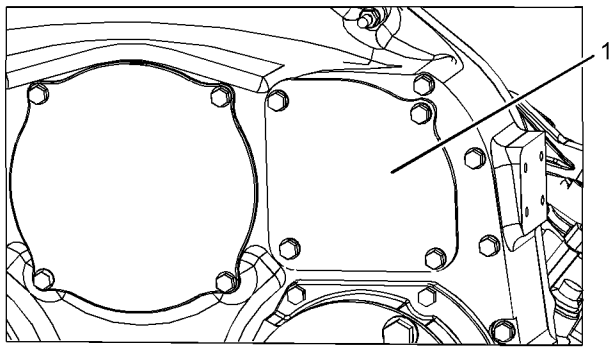


Illustration 381 g01265926

23. Install cover (1).

24. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the fuel transfer pump. Refer to Disassembly and Assembly, “Fuel Transfer Pump - Install”.

b. Install the valve mechanism cover base. Refer to Disassembly and Assembly, “Valve Mechanism Cover Base - Remove and Install”.

c. Install the electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.

d. If equipped, install the accessory pump drive adapter. Refer to Disassembly and Assembly, Engine Supplement, “Pump Drive - Install - Accessory Drive (Right-Hand Side)”.

i07897504

Camshaft - Remove

SMCS Code: 1210-011

C27 Removal Procedure

Table 69

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	177-8001	Pilot Sleeve	2
B	249-2936	Adapter	1
C	274-7932(1) or 274-7933(2)	Guide	1

(1) Rear Removal
(2) Front Removal

Start By:

a. Remove the rocker arms and the rocker shafts.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE
Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

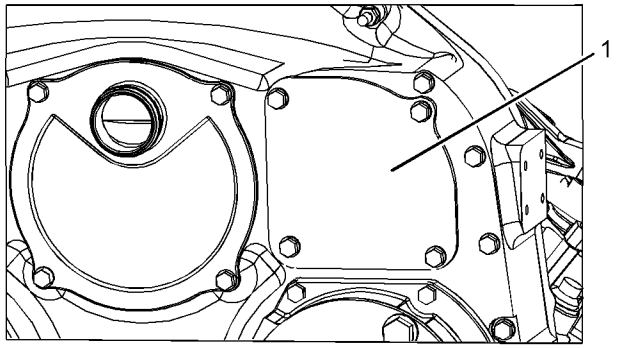


Illustration 382 g01148233

2. Remove cover (1).

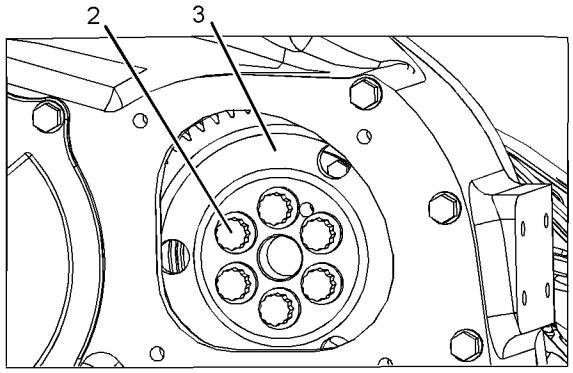


Illustration 383 g01148237

3. Line up timing marks on gear (3) for reassembly purposes.

4. Remove bolts (2). Reposition gear (3) inside the flywheel housing.

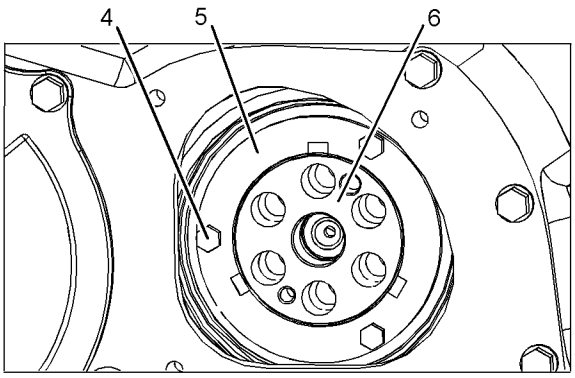


Illustration 384 g01148238

5. Remove bolts (4), thrust plate (5), and adapter assembly (6).

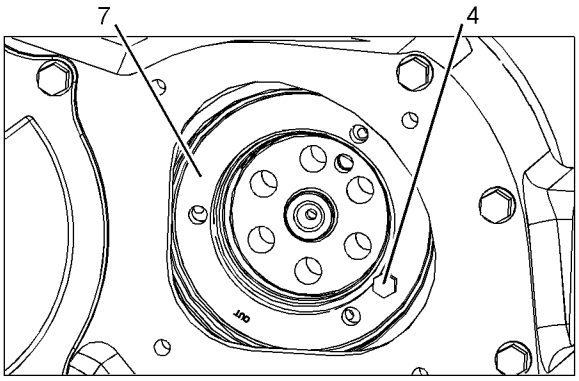


Illustration 385 g01148241

6. Use bolt (4) in order to remove sealing plate (7). Remove the O-ring seals.

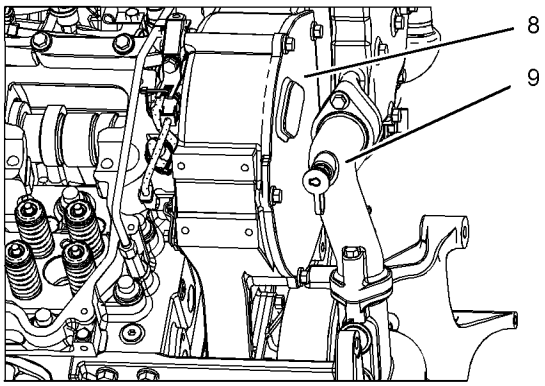


Illustration 386 g01160256

7. Remove elbow (9) and cover (8).

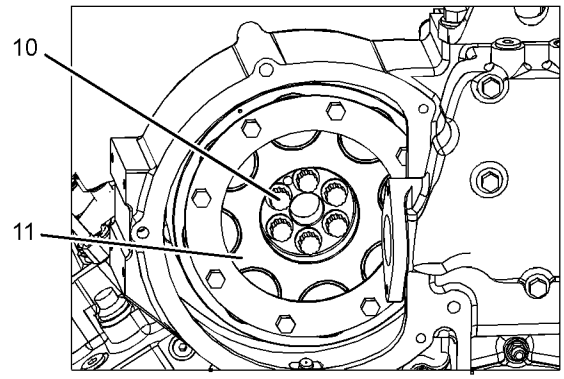


Illustration 387 g01160259

8. Remove bolts (10) and damper (11).

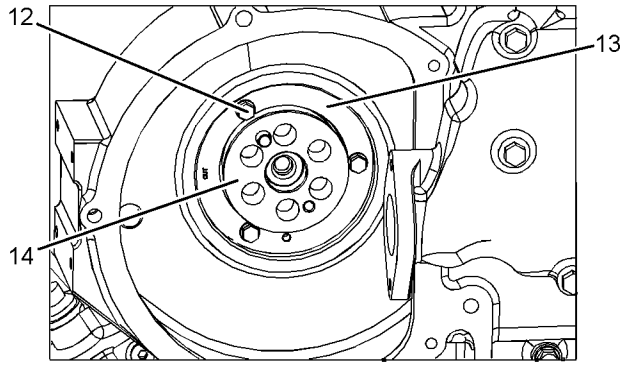


Illustration 388 g01160261

9. Remove bolts (12). Remove sealing plate (13) and adapter assembly (14).

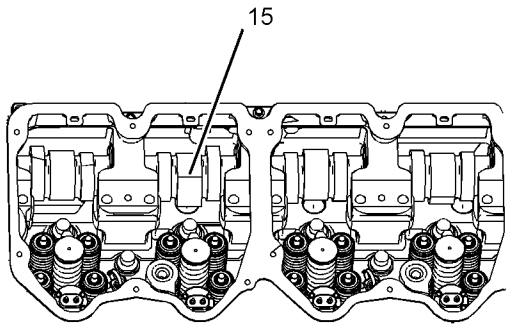


Illustration 389 g01160265

10. Install Tooling (A) and Tooling (B) on the rear of camshaft (15). Install Tooling (A) on the front of camshaft (15).

11. Install Tooling (C) on the front housing or the rear housing. Tooling (C) is used to support the camshaft.

Note: It is necessary to install Tooling (A) and Tooling (B) on the camshaft. Tooling (A) and Tooling (B) will support the camshaft as the camshaft is moved out of the cylinder head and into Tooling (C). Align the camshaft with the bore of Tooling (C).

Note: Avoid lifting the camshaft. The camshaft should rest on Tooling (A) and Tooling (B). Lifting of the camshaft can cause misalignment as the camshaft is removed, resulting in damage to the camshaft bearings.

12. Carefully slide the camshaft out of the cylinder head for removal. Use two technicians to remove the camshaft. Keep the camshaft level while the camshaft is being removed from the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

Note: Rotate the camshaft during removal. This will prevent the camshaft from binding in the camshaft bearings.

C32 Removal Procedure

Table 70

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7257	Cradle As	3
B	9U-7240	Camshaft Hook	2

Start By:

a. Remove the rocker arms and the rocker shafts.

b. Remove the valve cover base.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE
Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

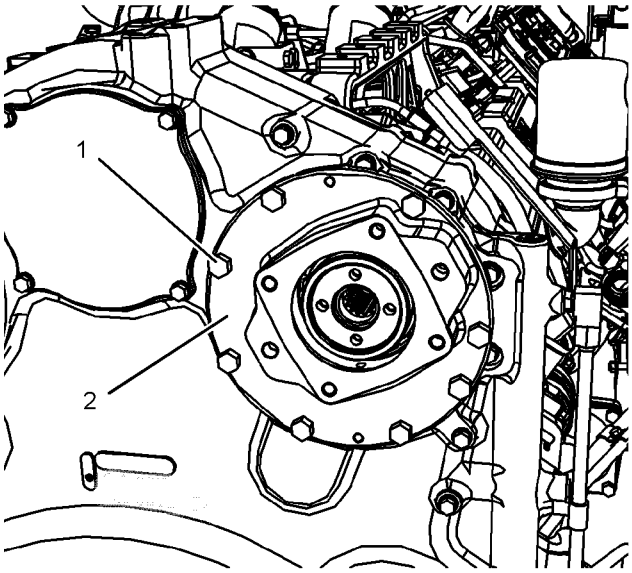


Illustration 390 g03427215

2. Remove bolts (1) and pump drive (2).

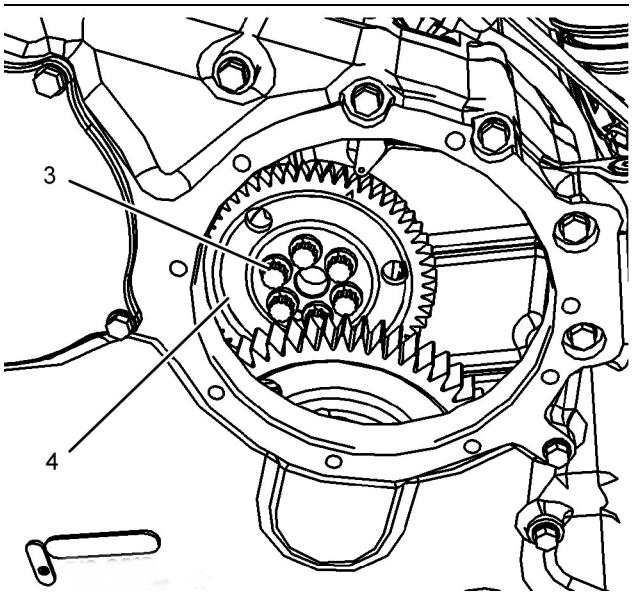


Illustration 391 g03427216

3. Line up timing marks on gear (4) for reassembly purposes.

4. Remove bolts (3). Remove gear (4) from the flywheel housing.

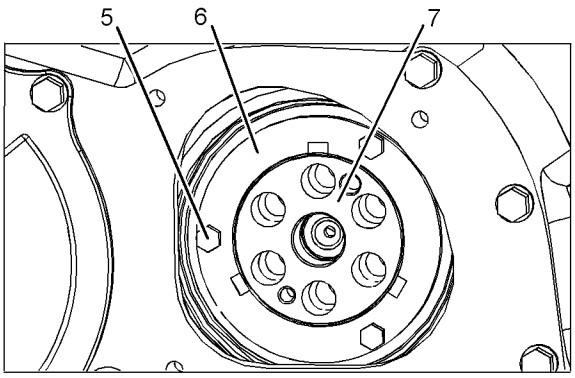


Illustration 392 g03427220

5. Remove bolts (5), thrust plate (6), and adapter assembly (7).

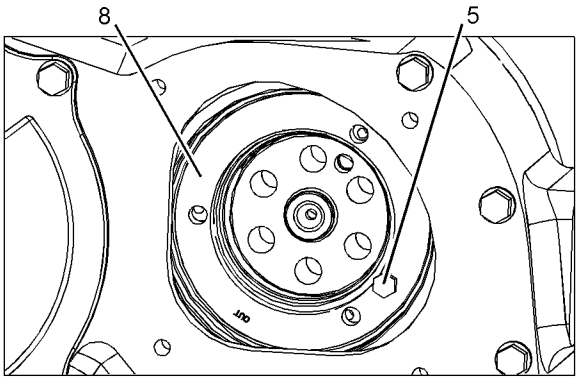


Illustration 393 g03427221

6. Use bolt (5) in order to remove sealing plate (8). Remove the O-ring seals.

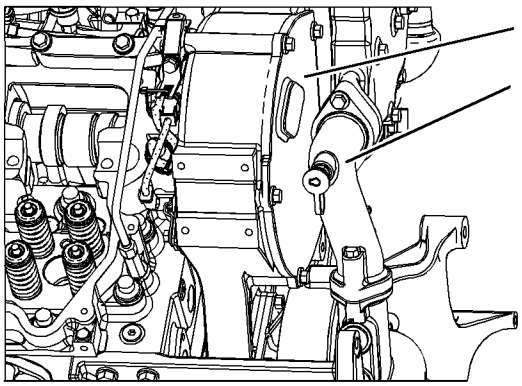


Illustration 394 g03427223

7. Remove elbow (10) and cover (9).

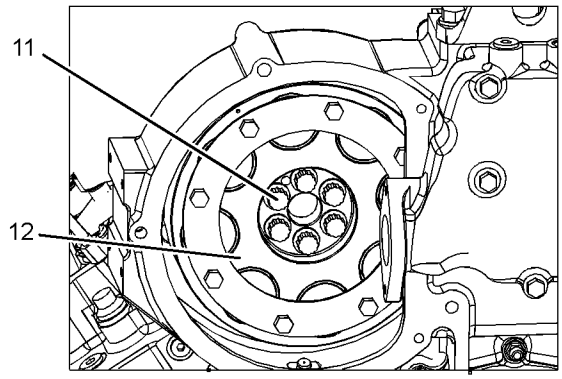


Illustration 395 g03427226

8. Remove bolts (11) and damper (12).

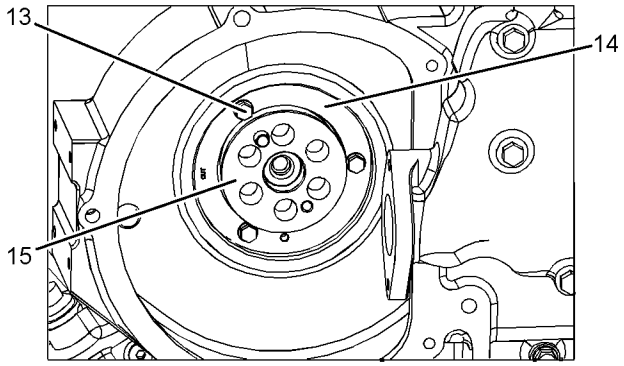


Illustration 396 g03427227

9. Remove bolts (13). Remove sealing plate (14), adapter assembly (15), and the O-ring seals.

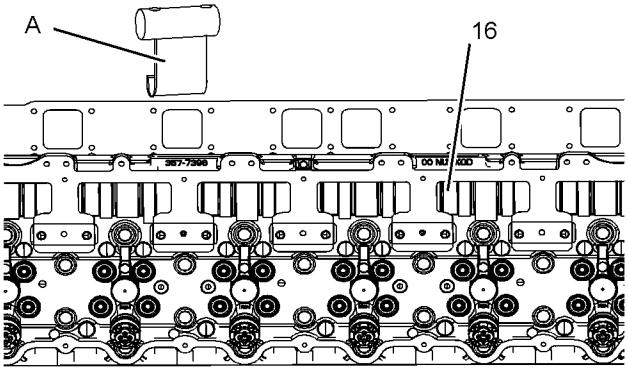


Illustration 397 g03588176

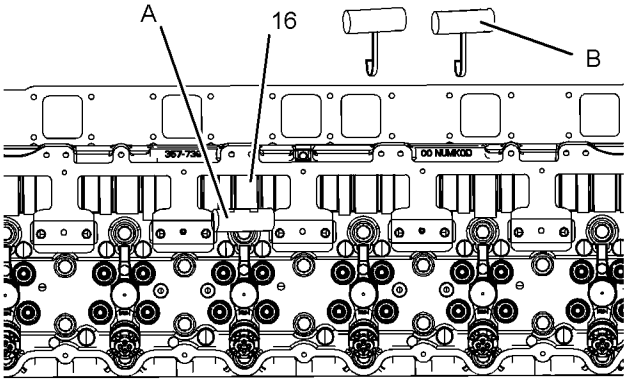


Illustration 398 g03588178

10. Install Tooling (A) on the cylinder head at three locations.

11. Carefully slide camshaft (16) out of the cylinder head for removal. Use Tooling (B) and two technicians to remove the camshaft. Keep the camshaft level while the camshaft is being removed from the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

i07897465

Camshaft - Install (C27)

SMCS Code: 1210-012

Installation Procedure

Table 71

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	177-8001	Pilot Sleeve	2
B	249-2936	Adapter	1
C	274-7932[1] or 274-7933[2]	Guide	1
D		Loctite LB 8028	1

(1) Rear Removal
(2) Front Removal

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE
Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

1. Ensure that the camshaft and camshaft bearings are thoroughly clean. Lubricate the camshaft lobes with a 50/50 mixture of Tooling (D) and clean engine oil. Apply a thin coat of clean engine oil on the camshaft bearings.

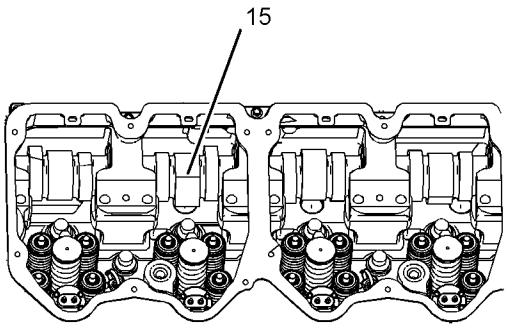


Illustration 399 g01160265

2. Install Tooling (A) and Tooling (B) on the rear of camshaft (15). Install Tooling (A) on the front of camshaft (15).

3. Install Tooling (C) on the front housing or the rear housing. Tooling (C) is used to support the camshaft.

4. Use two people to install the camshaft. Use Tooling (C) to assist in aligning the camshaft with the camshaft bearings. Carefully slide the camshaft into the cylinder head. Keep the camshaft level while the camshaft is being installed in the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

Note: Rotate the camshaft during installation. This will prevent the camshaft from binding in the camshaft bearings.

5. Remove Tooling (A) and Tooling (B) from the camshaft.

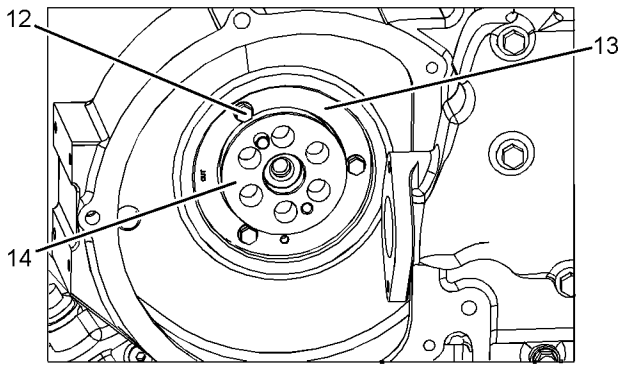


Illustration 400 g01160261

6. Install sealing plate (13) and adapter assembly (14). Install bolts (12).

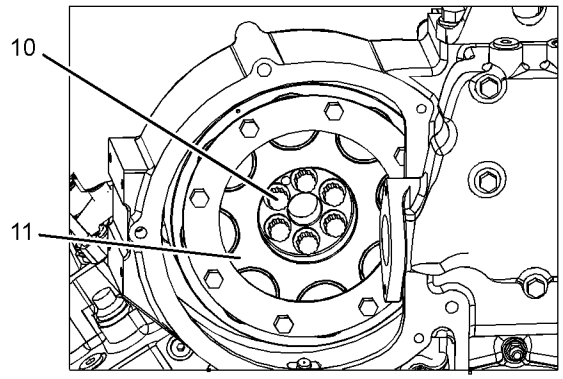


Illustration 401 g01160259

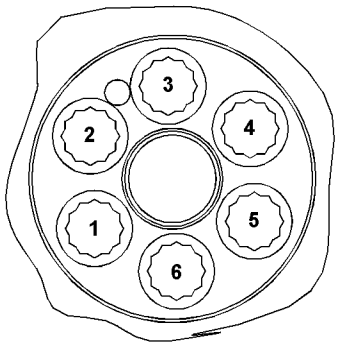


Illustration 402 g01151441

7. Install damper (11) and bolts (10).

8. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

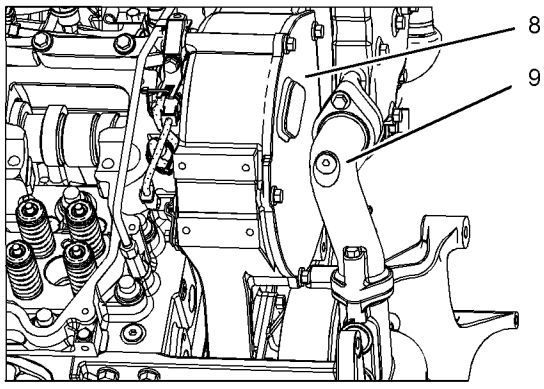


Illustration 403 g01265946

9. Install cover (8) and elbow (9).

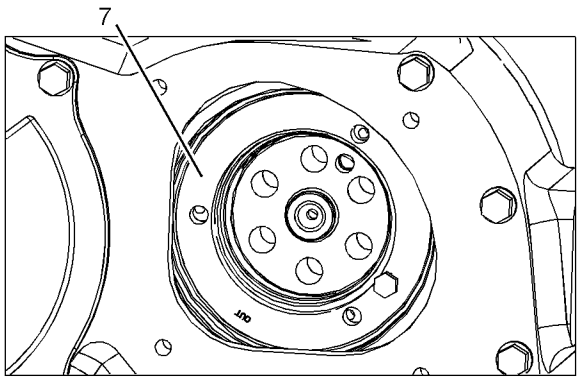


Illustration 404 g01148835

10. Install new O-ring seals and sealing plate (7).

Note: Ensure that the O-ring seals remain in position on sealing plate (7) during installation.

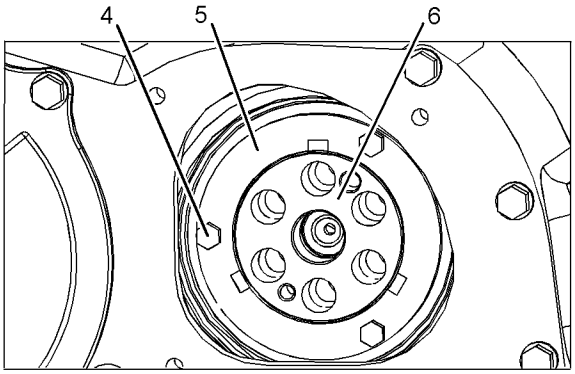


Illustration 405 g01148238

11. Install adapter assembly (6), thrust plate (5), and bolts (4).

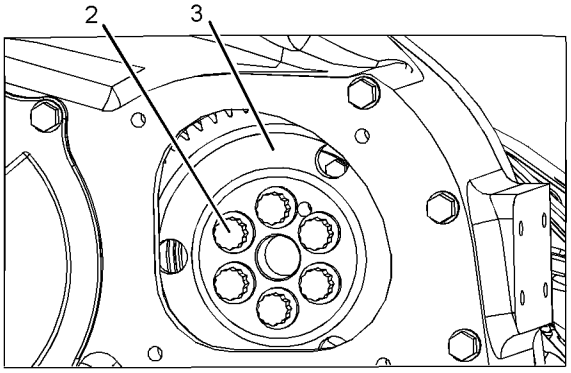


Illustration 406 g01148237

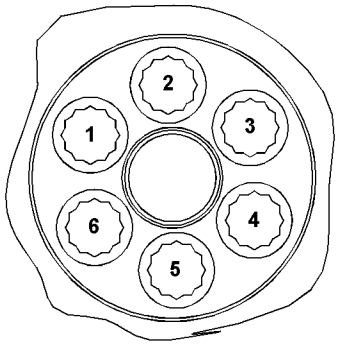


Illustration 407 g01151468

12. Reposition gear (3). Install bolts (2).

13. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

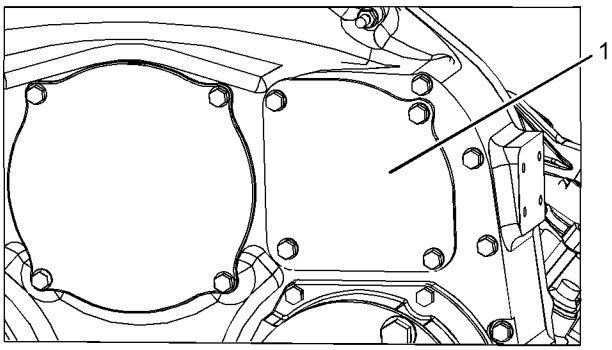


Illustration 408 g01265926

14. Install cover (1).

15. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, “Rocker Arms and Shaft - Install”.

i07898010

Camshaft - Install

SMCS Code: 1210-012

C27 Installation Procedure

Table 72

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	177-8001	Pilot Sleeve	2
B	249-2936	Adapter	1
C	274-7932(1) or 274-7933(2)	Guide	1
D		Loctite LB 8028	1

(1) Rear Removal
(2) Front Removal

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE
Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

1. Ensure that the camshaft and camshaft bearings are thoroughly clean. Lubricate the camshaft lobes with a 50/50 mixture of Tooling (D) and clean engine oil. Apply a thin coat of clean engine oil on the camshaft bearings.

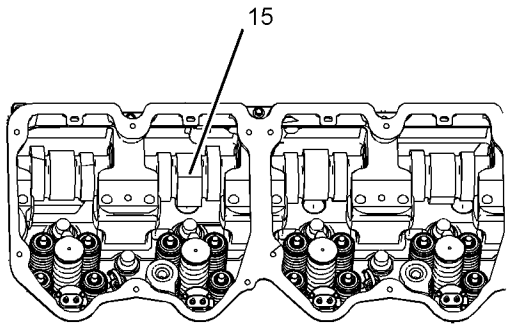


Illustration 409 g01160265

2. Install Tooling (A) and Tooling (B) on the rear of camshaft (15). Install Tooling (A) on the front of camshaft (15).

3. Install Tooling (C) on the front housing or the rear housing. Tooling (C) is used to support the camshaft.

4. Use two technicians to install the camshaft. Use Tooling (C) to assist in aligning the camshaft with the camshaft bearings. Carefully slide the camshaft into the cylinder head. Keep the camshaft level while the camshaft is being installed in the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

Note: Rotate the camshaft during installation. This will prevent the camshaft from binding in the camshaft bearings.

5. Remove Tooling (A) and Tooling (B) from the camshaft.

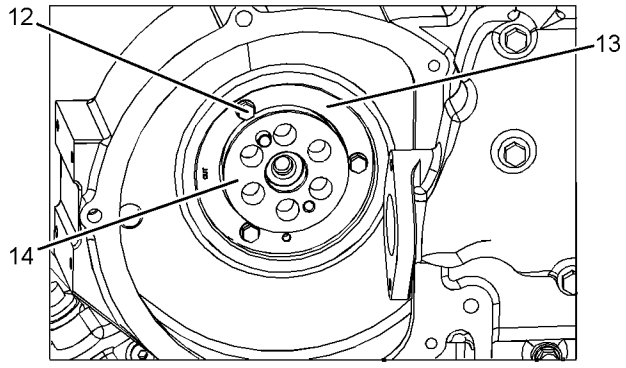


Illustration 410 g01160261

6. Install sealing plate (13) and adapter assembly (14). Install bolts (12).

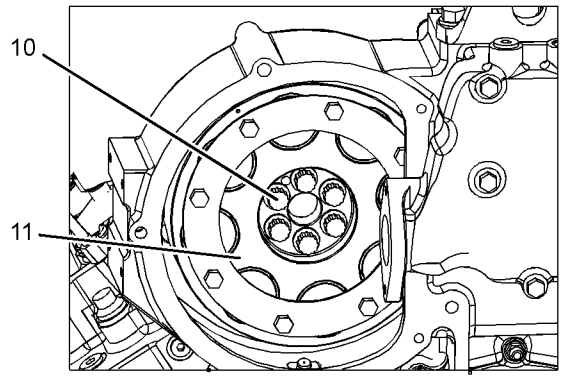


Illustration 411 g01160259

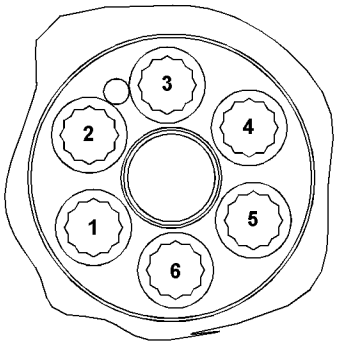


Illustration 412 g01151441

7. Install damper (11) and bolts (10).

8. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

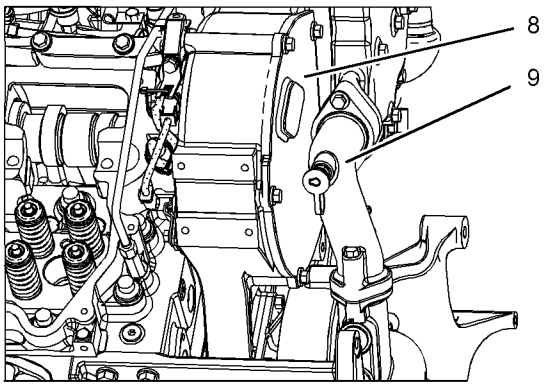


Illustration 413 g01160256

9. Install cover (8) and elbow (9).

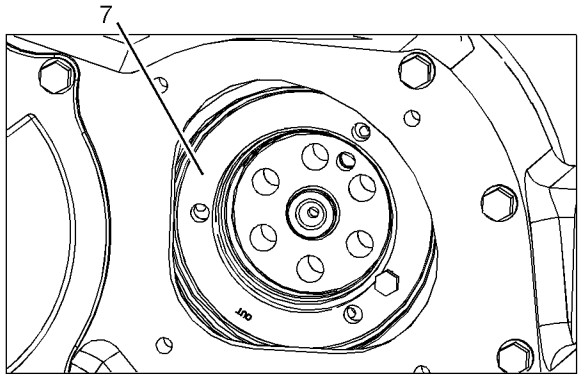


Illustration 414 g01148835

10. Install new O-ring seals and sealing plate (7).

Note: Ensure that the O-ring seals remain in position on sealing plate (7) during installation.

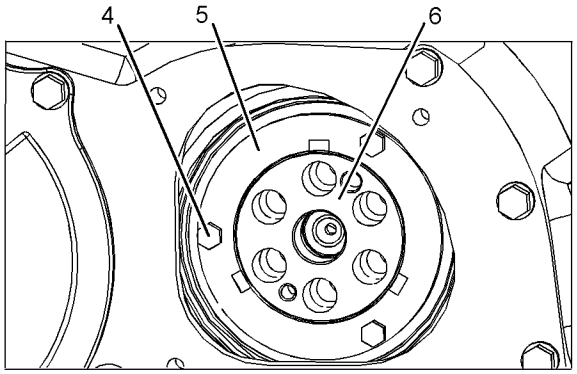


Illustration 415 g01148238

11. Install adapter assembly (6), thrust plate (5), and bolts (4).

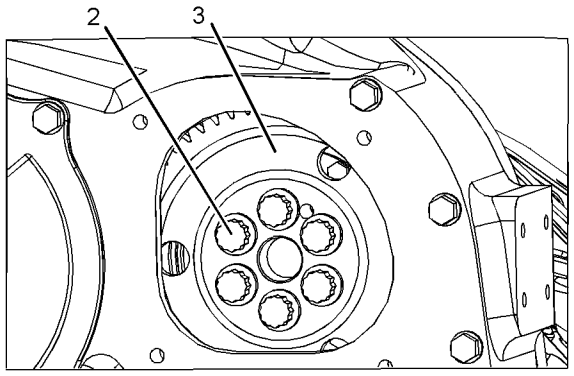


Illustration 416 g01148237

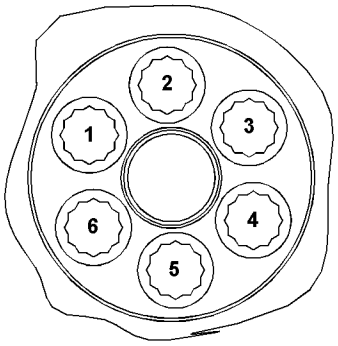


Illustration 417 g01151468

12. Reposition gear (3). Install bolts (2).

13. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

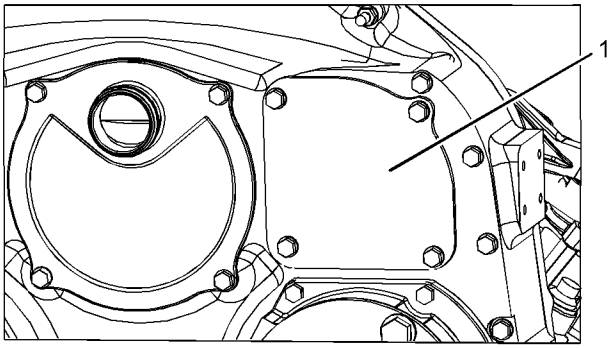


Illustration 418 g01148233

14. Install cover (1).

15. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the rocker arms and the rocker shafts.

C32 Installation Procedure

Table 73

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7257	Cradle As	3
B	9U-7240	Camshaft Hook	2
D		Loctite LB 8028	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE
Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

1. Ensure that the camshaft and camshaft bearings are thoroughly clean. Lubricate the camshaft lobes with a 50/50 mixture of Tooling (C) and clean engine oil. Apply a thin coat of clean engine oil on the camshaft bearings.

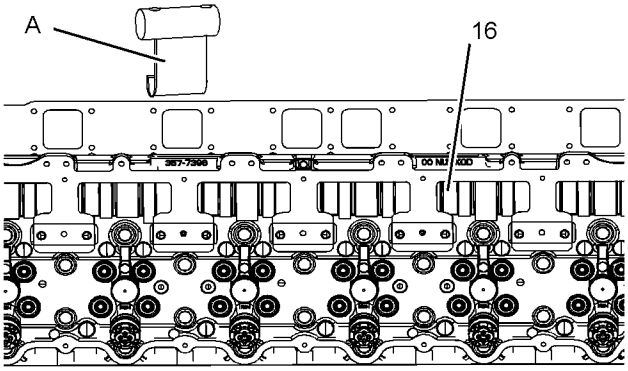


Illustration 419 g03588176

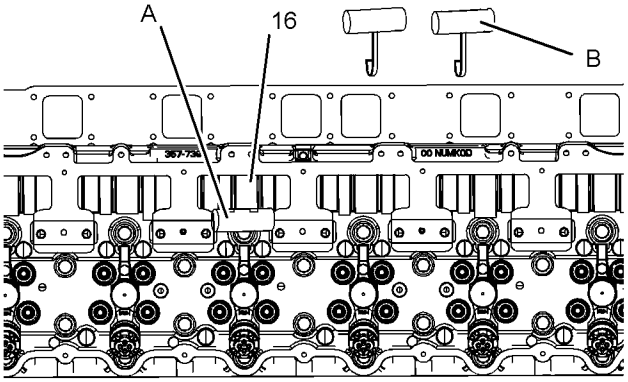


Illustration 420 g03588178

2. Install Tooling (A) on the cylinder head (16) at three locations.

3. Use two technicians to install the camshaft. Use Tooling (B) to assist in aligning the camshaft with the camshaft bearings. Carefully slide the camshaft into the cylinder head. Keep the camshaft level while the camshaft is being installed in the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

4. Remove Tooling (A) from the cylinder head.

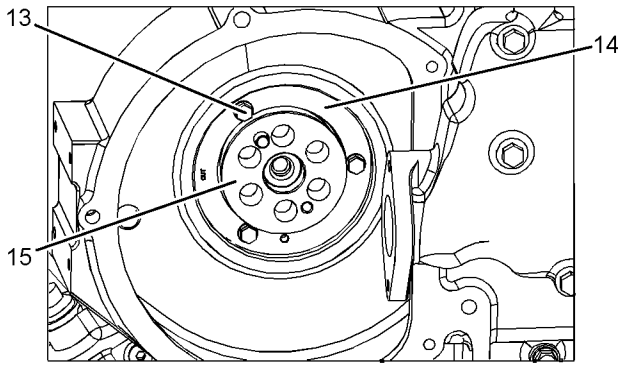


Illustration 421 g03427227

5. Install sealing plate (14), adapter assembly (15), and new O-ring seals. Install bolts (13).

Note: Ensure that the O-ring seals remain in position on sealing plate (14) during installation.

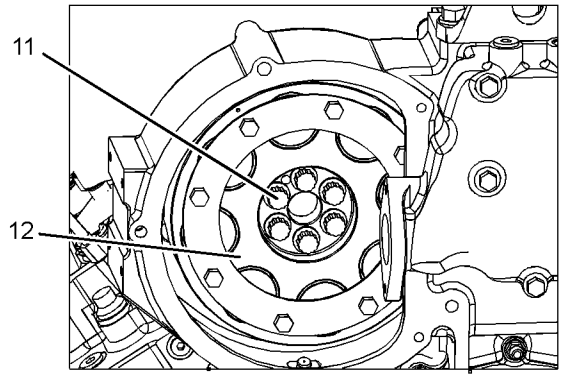


Illustration 422 g03427226

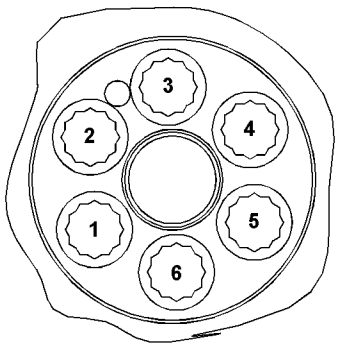


Illustration 423 g01151441

6. Install damper (12) and bolts (11).

7. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

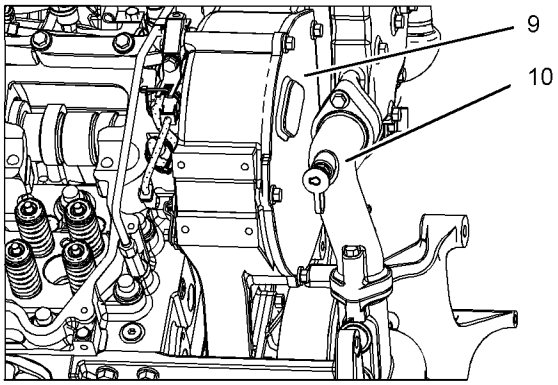


Illustration 424 g03427223

8. Install cover (9) and elbow (10).

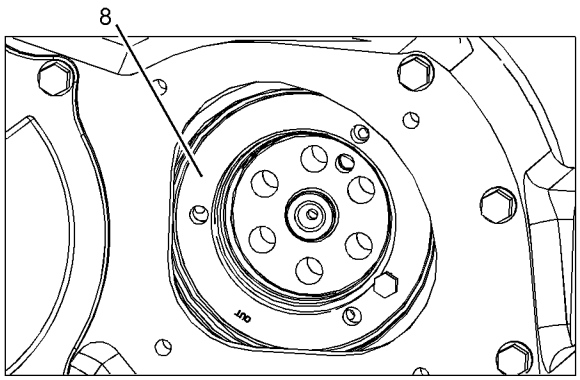


Illustration 425 g03427276

9. Install new O-ring seals and sealing plate (8).

Note: Ensure that the O-ring seals remain in position on sealing plate (8) during installation.

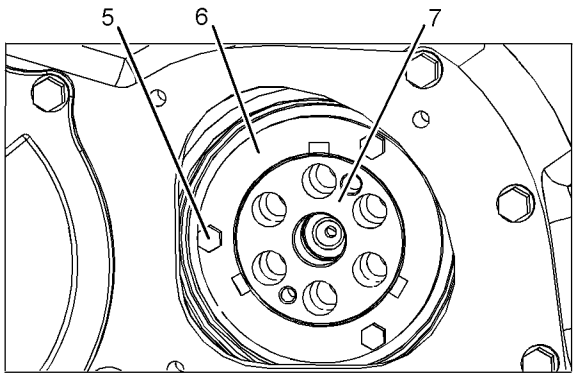


Illustration 426 g03427220

10. Install adapter assembly (7), thrust plate (6), and bolts (5).

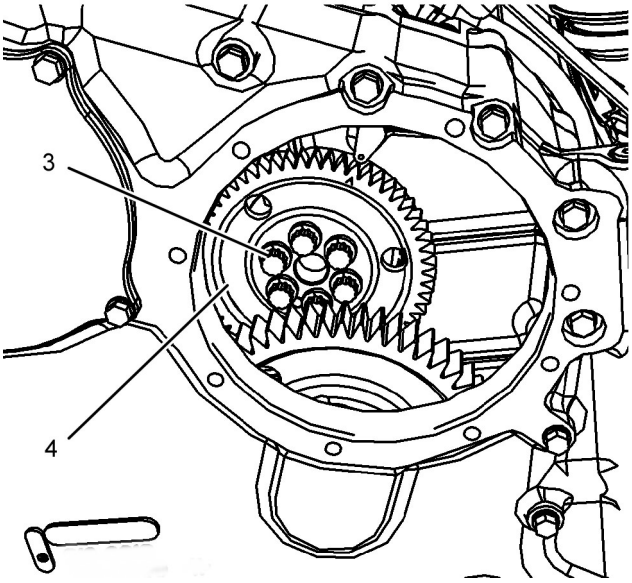


Illustration 427 g03427216

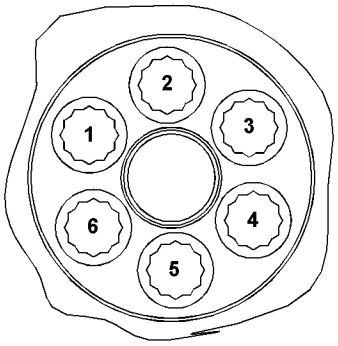


Illustration 428 g01151468

11. Install gear (4). Install bolts (3).

12. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

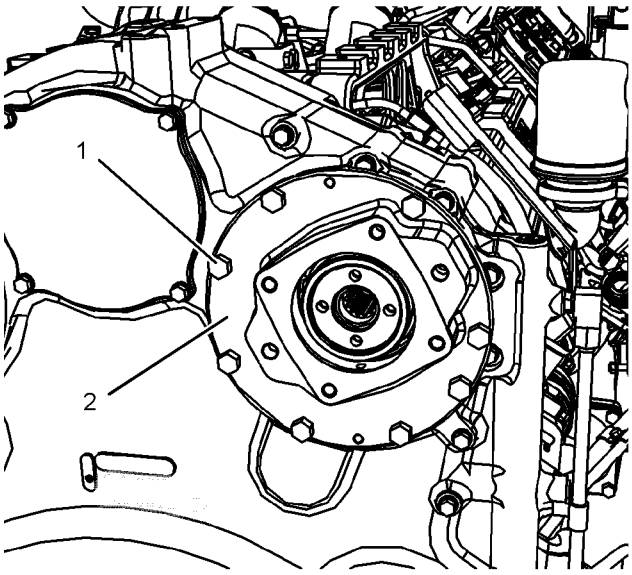


Illustration 429 g03427215

13. Install pump drive (2) and bolts (1).

14. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the valve cover base.

b. Install the rocker arms and the rocker shafts.

i02451045

Camshaft Bearings - Remove

SMCS Code: 1211-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 74

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
B	9U-7222	Camshaft Bearing Pilot	1
	8M-8778	Taperlock Stud 1/2 - 13 by 1 9/16 inch	1
C	9U-7210	Puller Plate	1

Start By:

a. Remove the camshaft. Refer to Disassembly and Assembly, “Camshaft - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

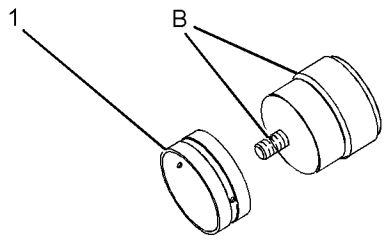


Illustration 430 g01159745

1. Remove the No. 7 camshaft bearing (rear). Work from the rear of the engine to the front of the engine.

2. Install the small end of Tooling (B) in camshaft bearing (1).

3. Position Tooling (C) over Tooling (A). Install Tooling (A) through the cylinder head on Tooling (B).

Note: Tooling (C) is installed on the outside of the cylinder head. Tooling (C) is required in order to remove all the camshaft bearings from the cylinder head.

4. Use Tooling (A) to remove camshaft bearing (1) from the cylinder head.

5. Remove Tooling (B) from Tooling (A) and remove the camshaft bearing.

i02451063

Camshaft Bearings - Install

SMCS Code: 1211-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 75

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
B	9U-7222	Camshaft Bearing Pilot	1
	8M-8778	Taperlock Stud 1/2 - 13 by 1 9/16 inch	1
C	9U-7210	Puller Plate	1
D	9U-7223	Alignment Bushing	1
E	9U-7213	Backup Plate	1
	0S-1621	Bolt 1/2 - 13 by 1 inch	1
F	9U-7214	Spacer Plate	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

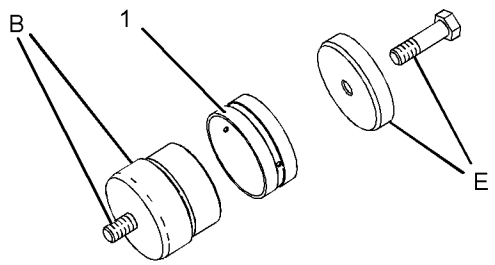


Illustration 431 g01159754

1. Install the No. 7 camshaft bearing (rear), as follows:

a. Insert the large end of Tooling (B) into the No. 7 camshaft bore.

b. Position Tooling (C) over Tooling (A). Install Tooling (A) through the cylinder head on Tooling (B).

c. Position camshaft bearing (1) on Tooling (B). Install Tooling (E) on Tooling (B).

Note: Refer to Specifications, “Cylinder Head” for appropriate information for the orientation of the camshaft bearings in the cylinder head.

d. Use Tooling (A) in order to pull camshaft bearing (1) into the camshaft bore.

Note: When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

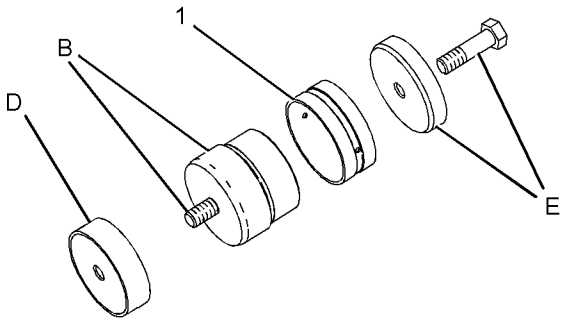


Illustration 432 g01159756

2. Install the No. 6 through No. 2 camshaft bearings, as follows:

a. Insert the large end of Tooling (B) into the camshaft bore.

Note: Use Tooling (D) to align Tooling (A) and Tooling (B) with the camshaft bearing bores. Install Tooling (D) in the inside diameter of any installed camshaft bearing between Tooling (A) and Tooling (B).

b. Install Tooling (A) on Tooling (B). Position camshaft bearing (1) on Tooling (B). Install Tooling (E) on Tooling (B).

Note: Refer to Specifications, “Cylinder Head” for appropriate information for the location and the orientation of the camshaft bearings in the cylinder head.

c. Use Tooling (A) in order to pull camshaft bearing (1) into the camshaft bore.

Note: When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

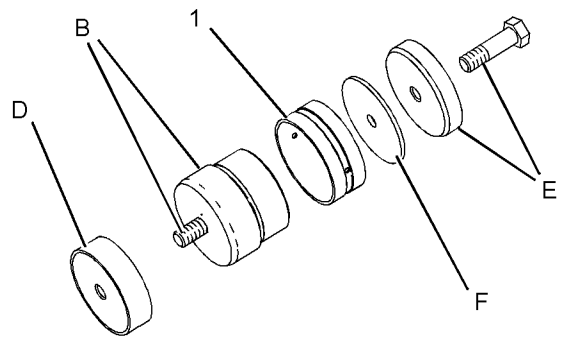


Illustration 433 g01159758

3. Install the No. 1 camshaft bearing (front), as follows:

a. Insert the large end of Tooling (B) into the No. 1 camshaft bore. Assemble Tooling (A) and Tooling (D) on Tooling (B).

b. Position camshaft bearing (1) on Tooling (B). Install Tooling (E) and Tooling (F) on Tooling (B).

Note: Refer to Specifications, “Cylinder Head” for appropriate information for the location and the orientation of the camshaft bearings in the cylinder head.

Note: Tooling (F) is used to seat the No. 1 camshaft bearing to the correct depth in the camshaft bore.

c. Use Tooling (A) in order to pull the No. 1 camshaft bearing into the No. 1 camshaft bore. When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

End By:

a. Install the camshaft. Refer to Disassembly and Assembly, “Camshaft - Install”.

i05645512

Engine Oil Pan - Remove and Install
(Multiple Oil Pan)

SMCS Code: 1302-010

S/N: TZC1–Up

S/N: HPE1–Up

S/N: JHM1–Up

S/N: TZR1–Up

Removal Procedure

Table 76

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	LOCTITE 5900 Flange Sealant	1

1. Refer to Operation and Maintenance Manual, “Engine Oil and Filter - Change” for the correct draining and filling procedures.

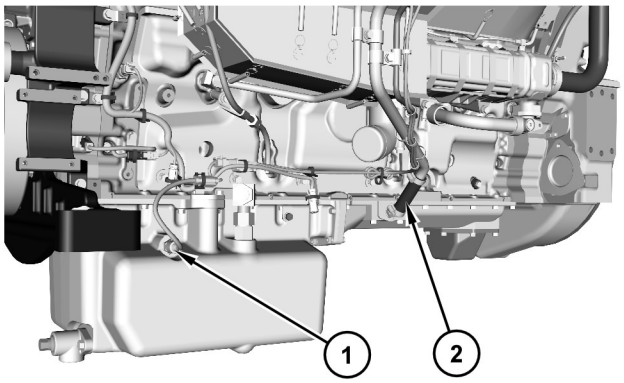


Illustration 434 g03582586

2. Remove engine oil level sensor (1) and disconnect hose (2).

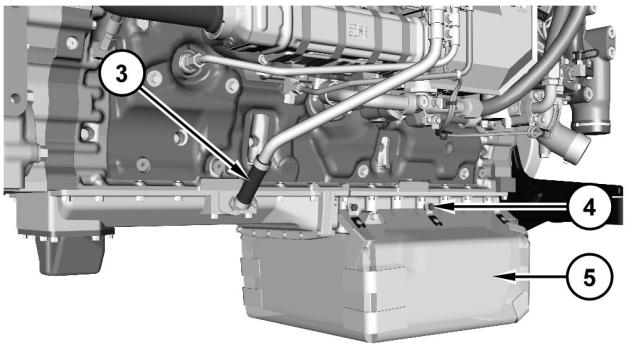


Illustration 435 g03582646

3. Disconnect hose (3).

4. Remove bolts (4) and oil pan cover (5).

Note: Note the position of oil pan cover (5) for reinstallation.

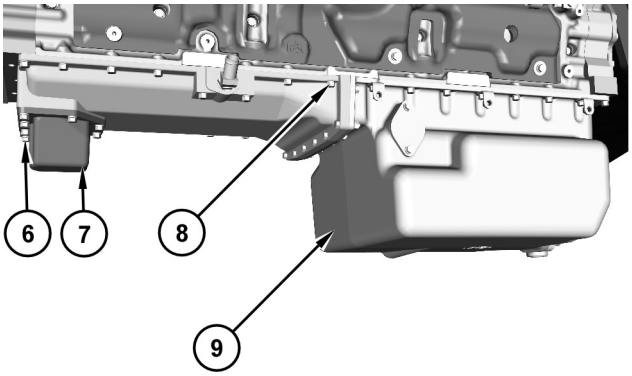


Illustration 436 g03583108

5. Remove bolts (6) and oil pan section (7)

6. Position a suitable lifting device under engine oil pan assembly (9). The weight of engine oil pan assembly is approximately 58 kg (128 lb).

7. Remove bolts (8), engine oil pan assembly (9) and the gasket.

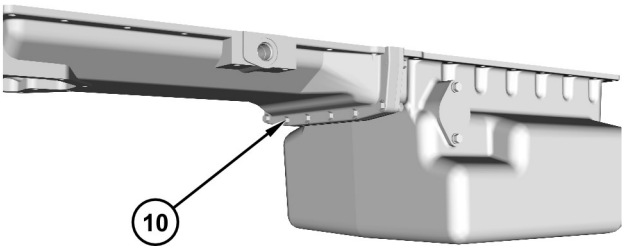


Illustration 437 g03587360

8. Remove bolts (10) and separate engine oil pan assembly (9).

Installation Procedure

1. Install engine oil pan assembly (9) in the reverse order of removal.

Note: Make sure that all surfaces are free of containments. Trim excess gasket material from the gasket engine oil pan assembly (9).

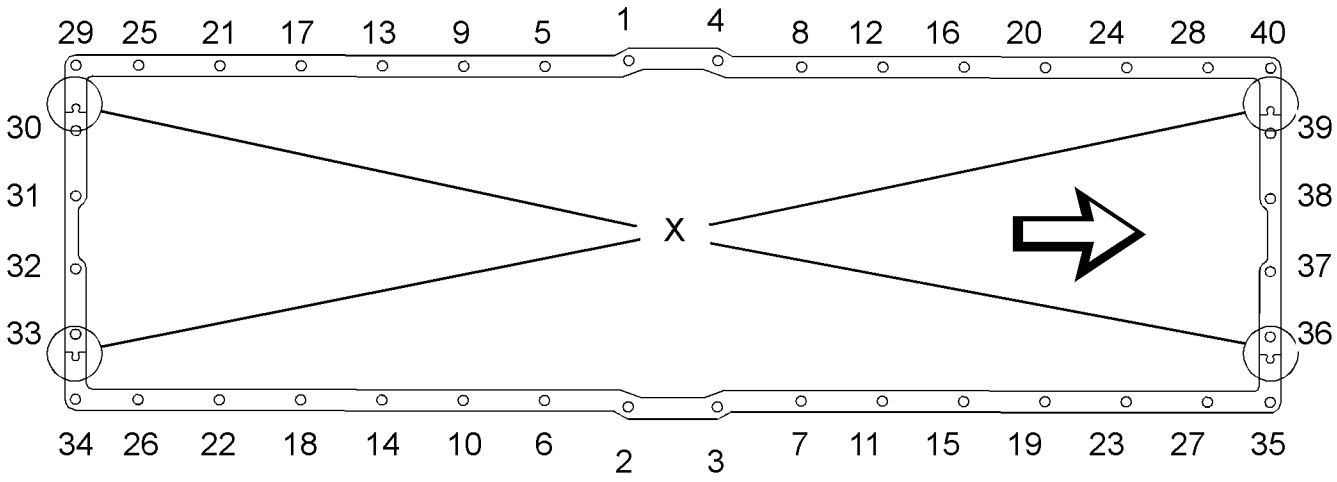


Illustration 438 g02750956

a. Apply Tooling (A) to Locations (X) and over the ball and socket joints of gasket (11).

Note: Illustration 438 shows the tightening sequence for bolts (8). The directional arrow is pointing towards the front housing.

b. Tighten bolts (8) using the above sequence to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

c. Tighten bolts (8) again using the above sequence to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

d. Tighten engine oil level sensor (1) to a torque of 25 ± 1 N·m (221 ± 9 lb in).

i05827094

Engine Oil Pan - Remove and Install

SMCS Code: 1302-010

S/N: TZC1–Up

S/N: HPE1–Up

S/N: JHM1–Up

S/N: TZR1–Up

Removal Procedure

Table 77

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	LOCTITE 5900 Flange Sealant	1

1. Refer to Operation and Maintenance Manual, “Engine Oil and Filter - Change” for the correct draining and filling procedures.

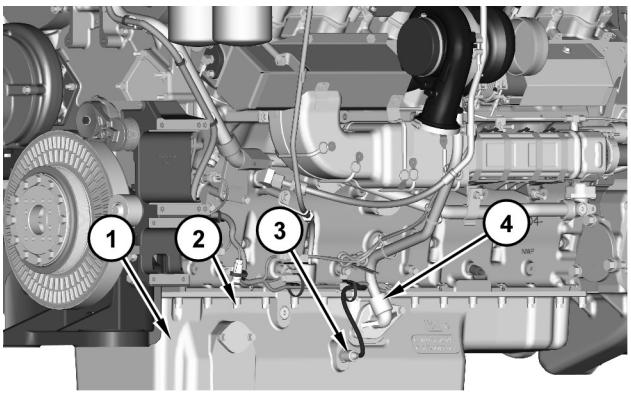


Illustration 439 g03687833

2. Remove engine oil level sensor (3). Remove tube assembly (4).

3. Remove bolts (2). Remove engine oil pan (1).

Note: Note the position of engine oil pan cover (1) for reinstallation.

Installation Procedure

1. Install engine oil pan (1) in the reverse order of removal.

Note: Make sure that all surfaces are free of containments. Trim excess gasket material from the gasket engine oil pan assembly (1).

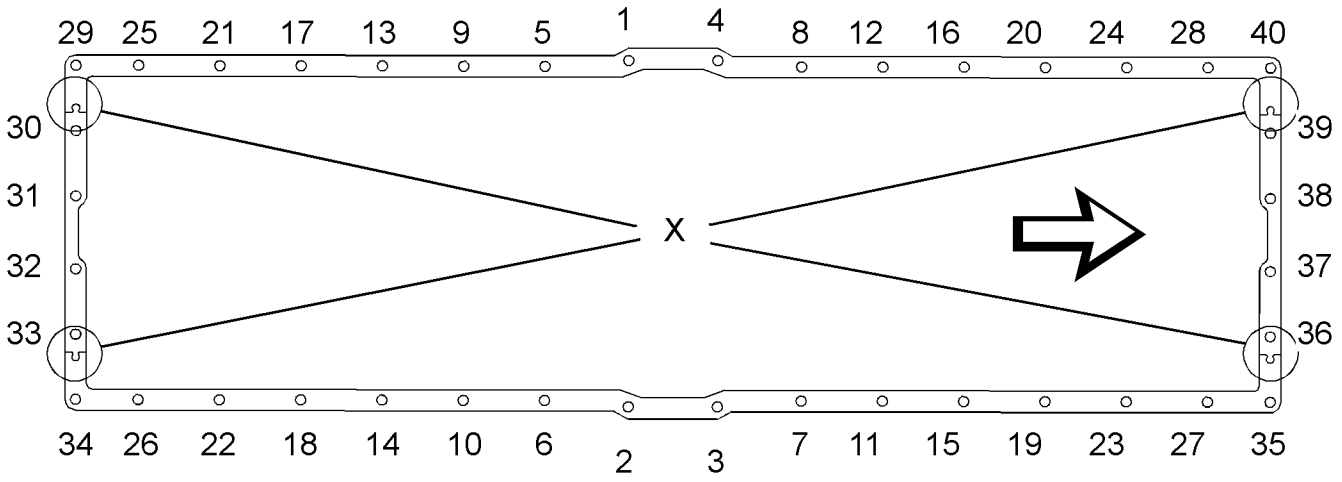


Illustration 440 g02750956

a. Apply Tooling (A) to Locations (X) and over the ball and socket joints of gasket (4).

Note: Illustration 440 shows the tightening sequence for bolts (2). The directional arrow is pointing towards the front housing.

b. Tighten bolts (2) using the above sequence to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

c. Tighten bolts (2) again using the above sequence to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

d. Tighten engine oil level sensor (3) to a torque of 25 ± 1 N·m (221 ± 9 lb in).

i07420820

Engine Oil Pan - Remove and Install

SMCS Code: 1302-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 78

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7505	Hydraulic Jack	1
B	-	Loctite 5900 Flange Sealant	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the engine oil into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Engine Oil and Filter - Change”.

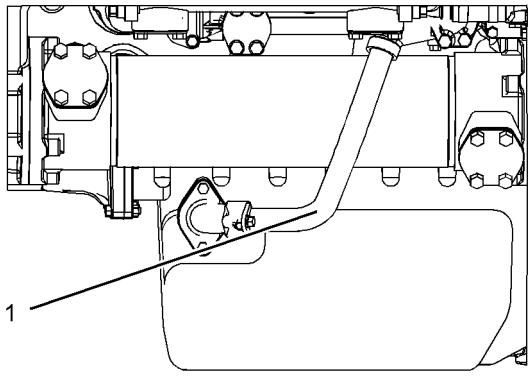


Illustration 441 g01149000

2. Remove tube assembly (1).

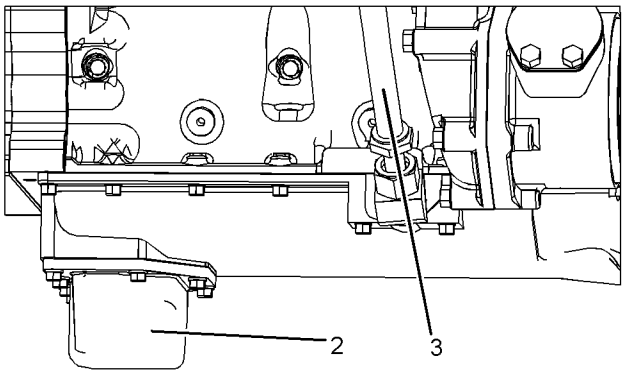


Illustration 442 g01149001

3. Disconnect hose assemblies (3).

4. Remove engine oil pan (2) and the gasket.

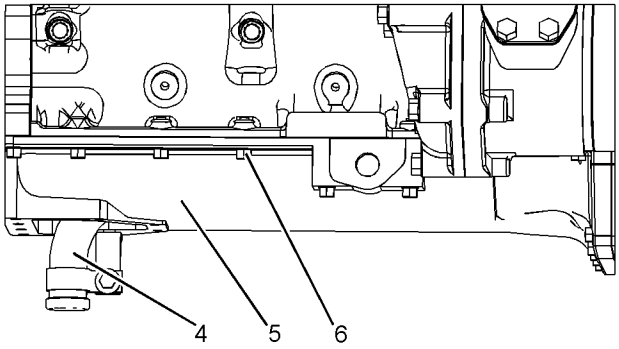


Illustration 443 g01149003

5. Disconnect tube assembly (4) from engine oil pan (5).

6. Use Tooling (A) to support engine oil pan (5). The weight of engine oil pan (5) is approximately 105 kg (235 lb).

7. Remove bolts (6). Remove engine oil pan (5) and the gasket.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Install engine oil pan (7) in reverse order of removal.

a. Apply Tooling (B) on the four socket joints of the oil pan gasket and the four T-joints on the bottom of the block where the front and rear

housings meet the block.

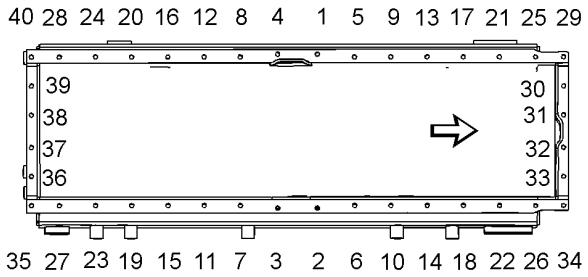


Illustration 444 g02226333

Tightening Sequence

The directional arrow is towards the front housing of the engine.

b. Tighten bolts (6) in sequence to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

c. Tighten bolts (6) again in sequence to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

d. If the oil drain plug was removed, install the oil drain plug. Tighten the oil drain plug to a torque of 70 ± 10 N·m (52 ± 7 lb ft).

i07538710

Cylinder Liner - Remove

SMCS Code: 1216-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 79

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-8665	Cylinder Liner Puller Gp	1
B(1)	6V-9448	Cylinder Liner Puller Gp (C27)	1
	373-1438	Cylinder Liner Puller Gp (C32)	1

(1) Optional Tool used to remove liner, piston, and connecting rod as an assembly.

Start By:

a. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, “Pistons and Connecting Rods - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

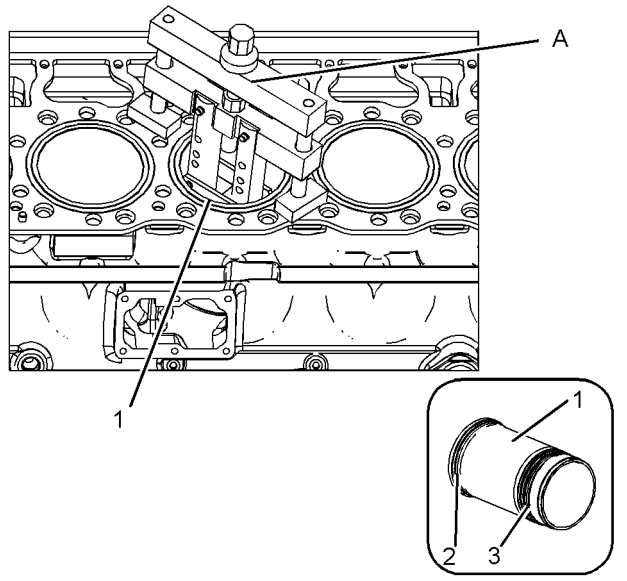


Illustration 445 g01149417

1. Use Tooling (A) to remove cylinder liner (1).

2. Remove liner seals (3) and filler band (2) from cylinder liner (1).

i08320689

Cylinder Liner - Install

SMCS Code: 1216-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 80

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	2P-8260	Cylinder Liner Installer	1
C	486-1525	Lubricant(1)	1

(1) If this product is not available, refer to Engine News, “Alternative Assembly Lubricant Used in Repair Processes Is Now Available for All C27, C32, and 3400 Engines” M0114593 for alternate lubricants.

Regional alternatives of Tooling (C) are available at the following website:

https://www.ipcol.com/assembly-lubricants/p80-emulsion

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the cylinder liner projection. Refer to Testing and Adjusting, “Cylinder Liner Projection - Inspect”.

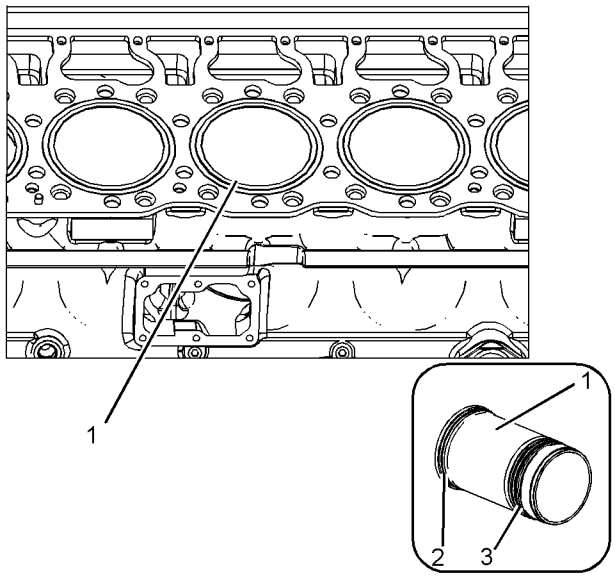


Illustration 446 g01149469

2. Install liner seals (3) on cylinder liner (1).

3. Apply Tooling (C) on the cylinder block liner bore surfaces and liner seals (3).

4. Dip filler band (2) in clean engine oil for a moment. Install the filler band on the cylinder liner immediately.

5. Use Tooling (B) to install cylinder liner (1) in the cylinder block. Ensure that any marks in relation to the cylinder liner projection are in alignment.

End By:

a. Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Install".

i02295020

Piston Cooling Jets - Remove and Install

SMCS Code: 1331-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 81

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9S-9082	Engine Turning Tool	1

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

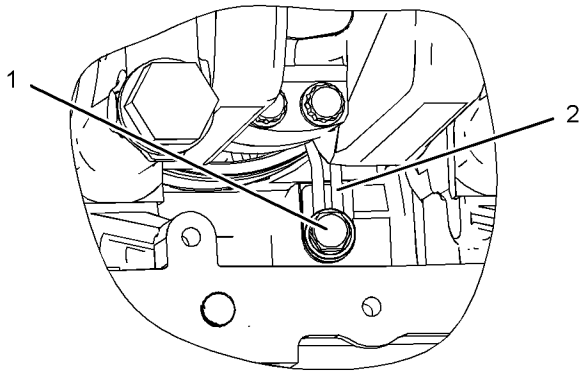


Illustration 447 g01149484

1. Use Tooling (A) to rotate the crankshaft in order to gain access to the piston cooling jet.

2. Remove bolt (1) and piston cooling jet (2).

Installation Procedure

Table 82

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9S-9082	Engine Turning Tool	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

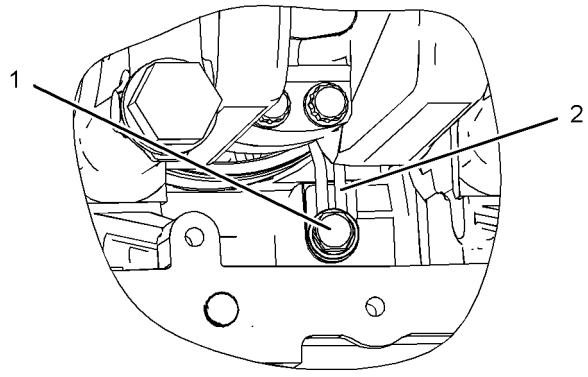


Illustration 448 g01149484

1. Use Tooling (A) to rotate the crankshaft in order to gain access to the piston cooling jet.

2. Position piston cooling jet (2) in the cylinder block. Install bolt (1). Tighten the bolt to a torque of 25 ± 6 N·m (18 ± 4 lb ft).

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, “Engine Oil Pump - Install”.

i02295112

Pistons and Connecting Rods - Remove

SMCS Code: 1225-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 83

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9S-9082	Engine Turning Tool	1

Start By:

a. Remove the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Remove”.

b. Remove the piston cooling jets. Refer to Disassembly and Assembly, “Piston Cooling Jets - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

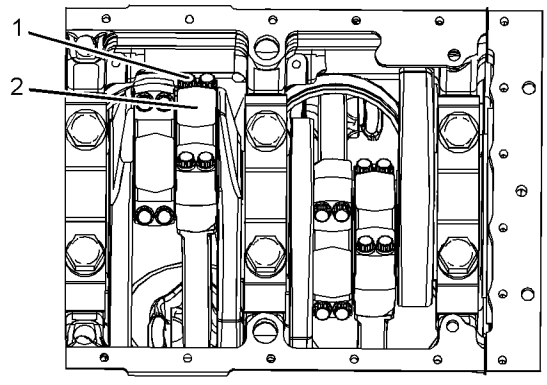


Illustration 449 g01149594

1. Use Tooling (A) to rotate the crankshaft until the piston is at the bottom center.

2. Remove the carbon ridge from the top inside surface of the cylinder liner.

3. Inspect the connecting rod and connecting rod cap for the proper identification mark. The connecting rod and the connecting rod cap should have an etched number on the side. The number should match the cylinder number. Mark the connecting rod and the connecting rod cap, if necessary.

Note: Do not stamp the connecting rod assembly. Stamping or punching the connecting rod assembly could cause the connecting rod to fracture.

4. Remove bolts (1) and connecting rod bearing cap (2).

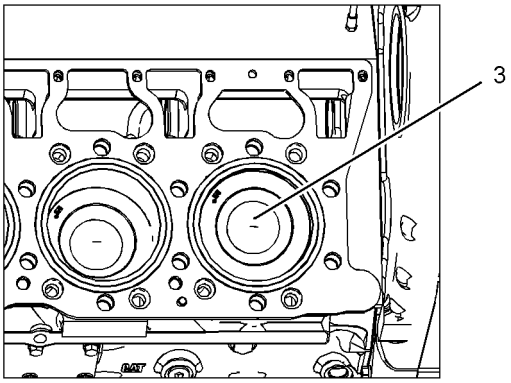


Illustration 450 g01149595

5. Remove piston (3) and the connecting rod from the cylinder liner.

i04168531

Pistons and Connecting Rods - Disassemble

SMCS Code: 1225-015

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Disassembly Procedure

Table 84

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-6192	Pliers	1
B	7M-3978(1)	Piston Ring Expander Gp	1
	7B-7974(2)	Piston Ring Expander Gp	1

(1) For use with 137 mm (5.4 inch) bores.
(2) For use with 145 mm (5.7 inch) bores.

Start By:

a. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, “Pistons and Connecting Rods - Remove”.

Note: Mark the components of each piston and connecting rod assembly. The components must be reinstalled in the original location. Do not interchange components.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

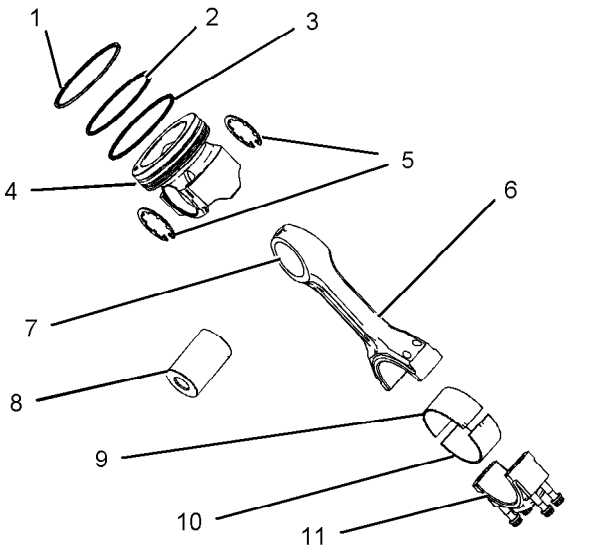


Illustration 451 g01048512

1. Remove lower connecting rod bearing (10) from connecting rod bearing cap (11).

2. Remove upper connecting rod bearing (9) from connecting rod (6).

3. Use Tooling (A) to remove pin retainer (5) from piston body assembly (4).

4. Remove connecting rod pin (8) and connecting rod (6) from the piston body assembly.

5. Use Tooling (B) to remove piston rings (1), (2), and (3) from the piston body assembly.

6. Do not remove bearing (7) at this time.

Note: The bearing will be removed from the connecting rod when a new bearing is installed in the connecting rod.

i04168565

Pistons and Connecting Rods - Assemble

SMCS Code: 1225-016

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Assembly Procedure

Table 85

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-6192	Pliers	1
B	7M-3978(1)	Piston Ring Expander Gp	1
	7B-7974(2)	Piston Ring Expander Gp	1
C	5P-8639	Hydraulic Press (Connecting Rod Bearing)	1
	8F-0024	Hose Assembly	1
	1P-2375	Connecting Coupler	1
	1P-2376	Connecting Coupler	1
	5P-8651	Spacer	1
	5P-8649	Adapter	1
	5P-8650	Bushing Adapter	1
	9U-6600	Hand Hydraulic Pump	1

(1) For use with 137 mm (5.4 inch) bores.
(2) For use with 145 mm (5.7 inch) bores.

Note: Prior to removal from the engine, the pistons and connecting rod assemblies were marked. The components must be reassembled together. The components must be installed in the original location in the engine. Do not interchange any of the components.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

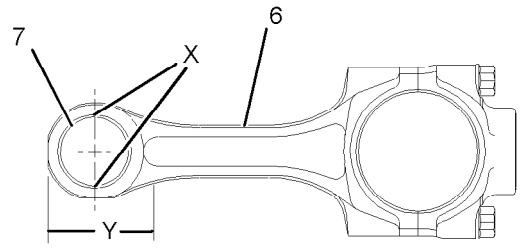


Illustration 452 g01017742

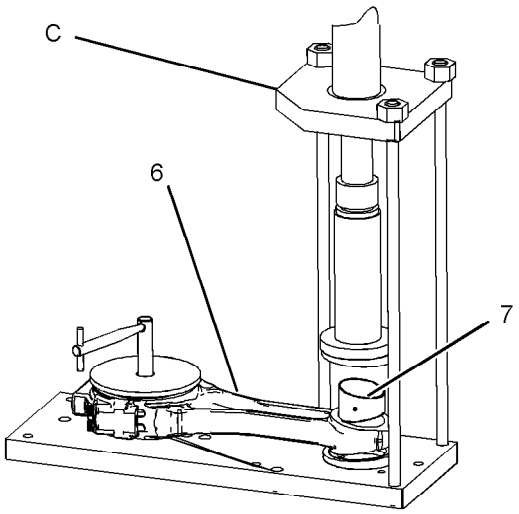


Illustration 453 g01018268

NOTICE
The connecting rod must be heated for the installation of the piston pin bearing. Do not use a torch.

1. Raise heat of connecting rod (6) along Length (Y).

(Y) Maximum Length for heating the connecting rod . . . . . 95 mm ((3.7 inch))

2. Allow the connecting rod and the bearing to cool to room temperature.

3. Use Tooling (C) to remove the old bearing and install new bearing (7) at the same time. The adapter of Tooling (C) should make full contact with the surfaces of connecting rod (6).

Note: Orient the bearing joint within ± 5 degrees of either Location (X).

4. Use a pin boring machine to machine the bore of bearing (7) to the correct diameter.

Diameter of bearing bore . . . . . 60.035 ± 0.008 mm ((2.3636 ± 0.0003 inch))

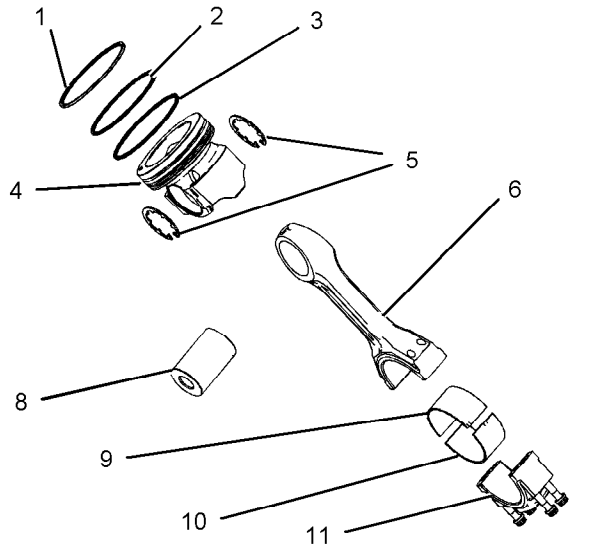


Illustration 454 g01056145

5. Position the spring for the oil control piston ring in the oil ring groove in the piston body assembly.

6. Position oil control piston ring (3) over the spring. Position the oil control piston ring so that the gap is 180 degrees from the joint in the spring. Install the oil control piston ring on the piston with Tooling (B).

7. Use Tooling (B) to install intermediate piston ring (2) with the side that has the identification “UP-2” toward the top of the piston.

8. Use Tooling (B) to install top piston ring (1) with the side that has the identification “UP-1” toward the top of the piston.

9. Position piston rings (1), (2), and (3) so the gaps are 120 degrees from each other.

10. Check the clearance between the ends of piston rings (1), (2), and (3). Refer to Specifications, “Pistons And Rings”.

11. Position piston body assembly (4) on connecting rod (6). Apply clean engine oil to connecting rod pin (8) and install the connecting rod pin. Install pin retainer (5) with Tooling (A).

12. Install upper connecting rod bearing (9) in connecting rod (6).

Note: Ensure that the bearing locking tab is located in the notch of the connecting rod.

13. Install lower connecting rod bearing (10) in connecting rod bearing cap (11).

Note: Ensure that the bearing locking tab is located in the notch of the connecting rod bearing cap.

14. Ensure that the dowels are installed in the connecting rod bearing cap.

End By:

a. Install the pistons and connecting rods. Refer to Disassembly and Assembly, “Pistons and Connecting Rods - Install”.

i06552242

Pistons and Connecting Rods - Install

SMCS Code: 1225-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 86

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9S-9082	Engine Turning Tool	1
B	5P-3526(1)	Piston Ring Compressor	1
	200-3914(2)	Piston Ring Compressor	1
C	8T-3052	Degree Wheel	1

(1) For use with 137 mm (5.4 inch) bores.
(2) For use with 145 mm (5.7 inch) bores.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, “Bearing Clearance - Check”. Apply clean engine oil on the connecting rod bearings for final assembly.

1. Apply clean engine oil to the cylinder liner bore, to the piston rings, and to the outer surface of the piston.

Note: Ensure that the connecting rod and pistons are installed in the correct cylinder.

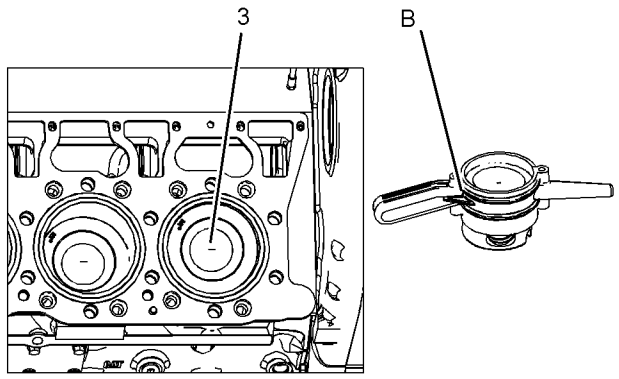


Illustration 455 g01149650

2. Use Tooling (A) to rotate the crankshaft until the connecting rod journal is at the bottom center.

3. Use Tooling (B) to install piston (3) and the connecting rod in the cylinder liner.

Note: Install the connecting rod so that the bearing tab is located on the opposite side of the piston cooling jet.

4. Install the upper connecting rod bearing in the connecting rod.

Note: Ensure that the connecting rod bearing is installed so that the bearing tab fits into the notch in the connecting rod.

5. Pull the connecting rod onto the crankshaft journal.

6. Install the lower connecting rod bearing in the connecting rod bearing cap.

Note: Ensure that the connecting rod bearing is installed so that the bearing tab fits into the notch in the connecting rod.

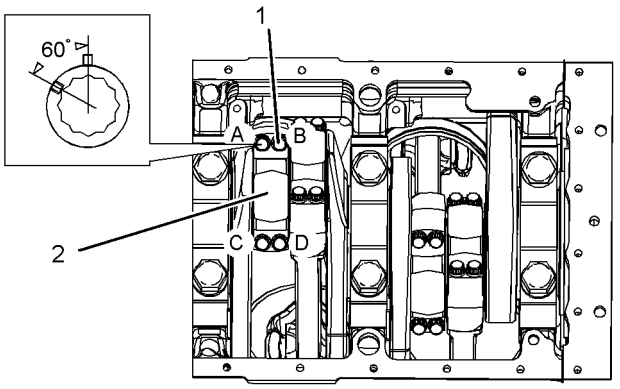


Illustration 456 g01149651

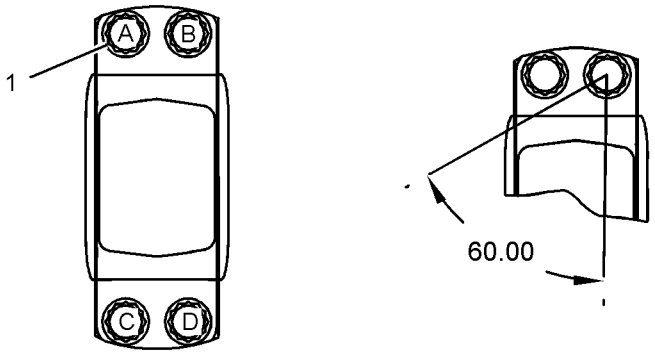


Illustration 457 g06020346

7. Position connecting rod bearing cap (2) on the connecting rod.

Note: Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod. The bearing tabs of the connecting rod bearing cap and the connecting rod are located on the side opposite of the piston cooling jet.

8. Lubricate the threads of bolts (1) with clean engine oil. Install the bolts.

9. Tighten bolts (1), as follows:

a. Tighten Bolt (A) and Bolt (C) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

b. Tighten Bolt (B) and Bolt (D) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

c. Turn Bolt (B) and Bolt (D) for an additional 60 ± 5 degrees (1/6 turn).

Note: If Tooling (C) is not used, place an index mark on each bolt.

d. Tighten Bolt (A) and Bolt (C) again to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

e. Turn Bolt (A) and Bolt (C) for an additional 60 ± 5 degrees (1/6 turn).

Note: If Tooling (C) is not used, place an index mark on each bolt.

f. Rotate the crankshaft to ensure that the crankshaft turns freely.

End By:

a. Install the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

i02295567

Connecting Rod Bearings - Remove

SMCS Code: 1219-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

Table 87

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9S-9082	Engine Turning Tool	1

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

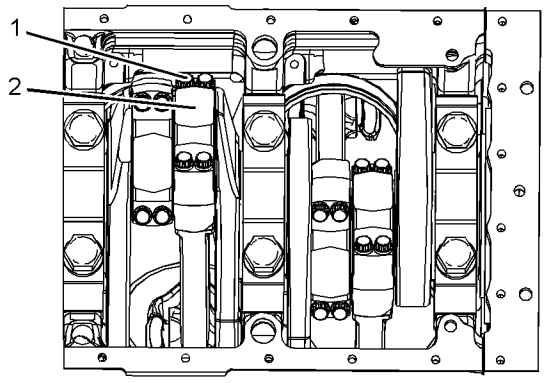


Illustration 458 g01149594

1. Use Tooling (A) to rotate the crankshaft until the connecting rod is at the bottom center.

2. Inspect the connecting rod and connecting rod cap for the proper identification mark. The connecting rod and the connecting rod cap should have an etched number on the side. The number should match the cylinder number. Mark the connecting rod and the connecting rod cap, if necessary.

Note: Do not stamp the connecting rod assembly. Stamping or punching the connecting rod assembly could cause the connecting rod to fracture.

3. Remove bolts (1) and connecting rod bearing cap (2) from the connecting rod.

4. Remove the lower half of the connecting rod bearing from the connecting rod bearing cap.

5. Push the connecting rod away from the crankshaft. Remove the upper half of the connecting rod bearing from the connecting rod.

i02295910

Connecting Rod Bearings - Install

SMCS Code: 1219-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 88

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9S-9082	Engine Turning Tool	1
B	8T-3052	Degree Wheel	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, “Bearing Clearance - Check”. Apply clean engine oil on the connecting rod bearings for final assembly.

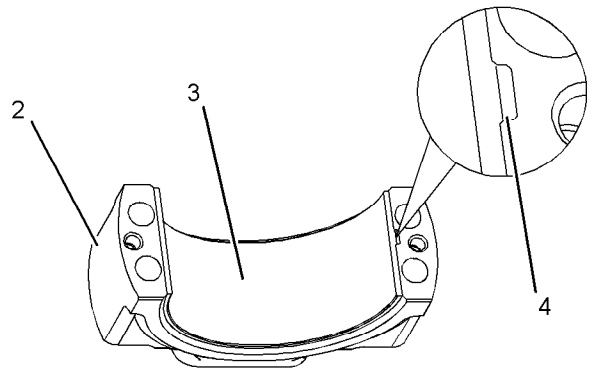


Illustration 459 g00998730

1. Use Tooling (A) to rotate the crankshaft until the connecting rod journal is at the bottom center.

2. Install a new lower half connecting rod bearing (3) in connecting rod bearing cap (2).

Note: Ensure that bearing locking tab (4) is located in the notch of the connecting rod bearing cap.

3. Install a new upper half connecting rod bearing in the connecting rod.

Note: Ensure that the bearing locking tab is located in the notch of the connecting rod.

4. Pull the connecting rod onto the crankshaft.

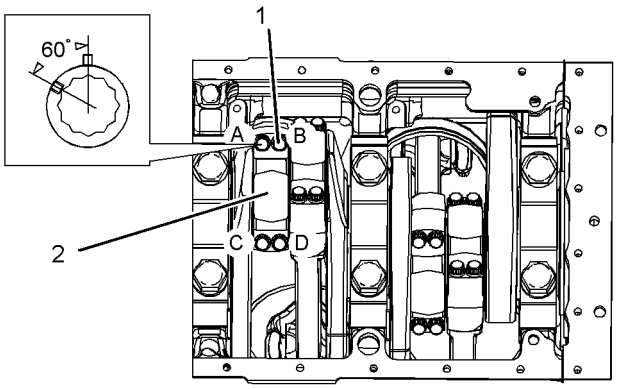


Illustration 460 g01149651

5. Position connecting rod bearing cap (2) on the connecting rod.

Note: Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod. The bearing tabs of the connecting rod bearing cap and the connecting rod are located on the side opposite of the piston cooling jet.

6. Lubricate the threads of bolts (1) with clean engine oil. Install the bolts.

7. Tighten bolts (1), as follows:

a. Tighten Bolt (A) and Bolt (C) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

b. Tighten Bolt (B) and Bolt (D) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

c. Turn Bolt (B) and Bolt (D) for an additional 60 ± 5 degrees (1/6 turn).

Note: If Tooling (B) is not used, place an index mark on each bolt.

d. Tighten Bolt (A) and Bolt (C) again to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

e. Tighten Bolt (A) and Bolt (C) for an additional 60 ± 5 degrees (1/6 turn).

Note: If Tooling (B) is not used, place an index mark on each bolt.

f. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i02296017

Crankshaft Main Bearings - Remove

SMCS Code: 1203-011

Removal Procedure

Table 89

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	2P-5518	Bearing Tool	1

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the main bearing caps for identification of the location and check the direction of the main bearing caps in relation to the cylinder block. The main bearing caps must be installed in the original location and the original direction.

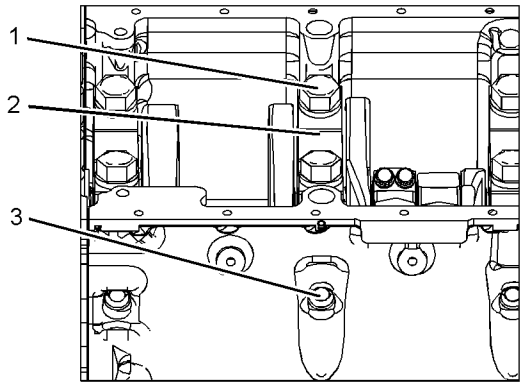


Illustration 461 g01149949

2. Remove bolts (1) and bolts (3) from No. 2 through No. 6 main bearing caps (2).

Note: Remove No. 1 and No. 7 main bearing caps (2) after No. 2 through No. 6 main bearing caps have been installed.

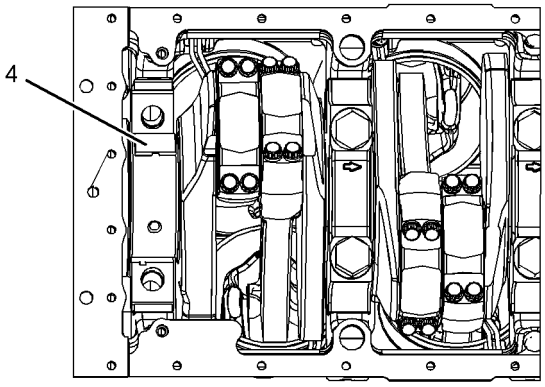


Illustration 462 g01149952

3. Install Tooling (A) in the oil hole of the crankshaft. Carefully rotate the crankshaft in order to remove upper main bearing (4) from the cylinder block.

Note: Push the upper main bearing from the opposite side of the bearing tab with Tooling (A). If the crankshaft is turned in the wrong direction, the tab on the bearing will be pushed between the crankshaft and the bearing area of the cylinder block. This can result in damage to the cylinder block and/or the crankshaft.

4. Remove the thrust plates from each side of the No. 4 main bearing.

5. Remove the lower halves of the main bearings from the main bearing caps.

i07322000

Crankshaft Main Bearings - Install

SMCS Code: 1203-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 90

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	2P-5518	Bearing Tool	1
B	8T-5096	Dial Indicator	1
C	8T-3052	Degree Wheel	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install the main bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, “Bearing Clearance - Check”. Apply clean engine oil on the main bearings for final assembly.

Note: Ensure that the main bearings are installed so that bearing tabs fit into the notch in the cylinder block. The upper halves of the main bearings have the oil groove and the oil hole.

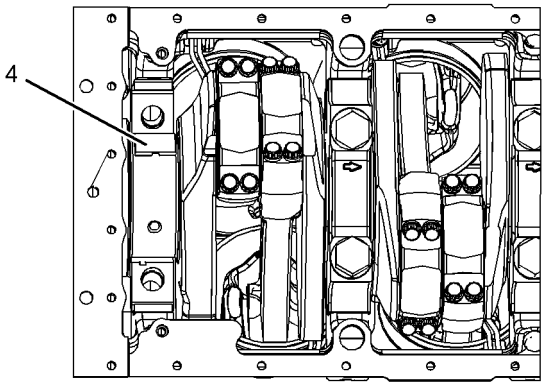


Illustration 463 g01149952

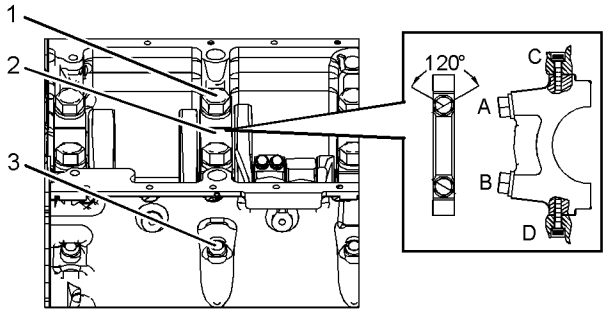


Illustration 464 g01149987

1. Position new upper main bearing (4) on the crankshaft. Insert the end of the upper main bearing that does not have the tab into the cylinder block. Install Tooling (A) in the oil hole of the crankshaft. Carefully rotate the crankshaft to push the upper main bearing into the cylinder block.

Note: Push the upper main bearing from the side of the bearing tab with Tooling (A). If the crankshaft is turned in the wrong direction, the tab on the bearing will be pushed between the crankshaft and the bearing area of the cylinder block. This can result in damage to the cylinder block and/or the crankshaft.

2. Install the thrust plates on each side of the No. 4 main bearing.

Note: Install the thrust plates with the words “Block Side” toward the cylinder block.

3. Install the lower halves of the crankshaft main bearings in the main bearing caps.

Note: Ensure that the main bearings are installed so that bearing tabs fit into the notch in the main bearing caps.

4. Position main bearing caps (2) on the crankshaft.

Note: Ensure that the numbers on the main bearing caps match the numbers on the cylinder block. Also ensure that the “FRONT” on the main bearing cap is installed toward the front of the cylinder block.

5. Lubricate the threads of bolts (1) with clean engine oil. Install bolts (1) and the washers.

6. Lubricate the threads of bolts (3) and the seal of the washers with clean engine oil. Install bolts (3) and the washers.

Note: Inspect the washers that go on bolts (3).

7. Tighten bolts (1) and bolts (3) for the main bearing caps, as follows:

a. Tighten Bolt (A) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (A) is on the bearing tab side of the main bearing cap.

b. Tighten Bolt (B) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (B) is on the opposite side of the bearing tab of the main bearing cap.

c. Tighten Bolt (B) for an additional 120 ± 5 degrees (2 flats).

Note: If Tooling (C) is not used, place an index mark on the bolt and the main bearing cap.

d. Tighten Bolt (A) for an additional 120 ± 5 degrees (2 flats).

Note: If Tooling (C) is not used, place an index mark on the bolt and the main bearing cap.

e. Tighten Bolt (D) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (D) is on the opposite side of the bearing tab of the main bearing cap.

f. Tighten Bolt (C) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (C) is on the bearing tab side of the main bearing cap.

g. Rotate the crankshaft to ensure that the crankshaft turns freely.

8. Use Tooling (B) to check the crankshaft end play. Ensure that Tooling (B) is against a machined surface. The end play is controlled by the thrust plates of No. 4 main bearing (center).

Crankshaft end play (new thrust plates)
. . . . . 0.10 to 0.60 mm ((0.004 to 0.024 inch))

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i08186034

Crankshaft - Remove

SMCS Code: 1202-011

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

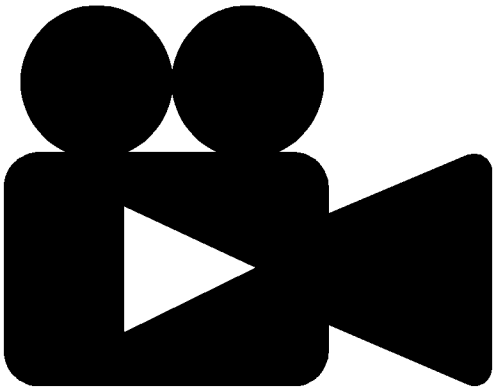


Illustration 465 g06471531

Reference: For more information, refer to supplemental video "Certain C32 Marine Engines Crankshaft - Remove & Install" on Caterpillar Channel1.

Note: Click or copy the following link into a web browser (a CWS login is required to access Caterpillar Channel1), or scan the following QR code using a QR enabled device.

https://channel1.mediaspace.kaltura.com/media/t/1_ajq2tge6



Illustration 466 g06578959

Table 91

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	589-7435	Link Bracket As	2
B	1H-3110	Bearing Puller	1

(continued)

(Table 91, contd)

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
	8B-7560	Step Plate	1
	9U-6600	Hand Hydraulic Pump	1
	1H-3108	Push-Puller Leg	2
	1H-3107	Bearing Puller	1
	3H-0468	Puller Plate	5
	3H-0465	Push-Puller Plate	2
	1P-0820	Hydraulic Puller	1
	5B-0637	Nut	1
	8S-6586	Forcing Screw	1
C	5P-0944	Dowel Puller Group	1
	5P-0939	Dowel Extractor	1

Start By:

a. Remove the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Remove”.

b. Remove the rear housing. Refer to Disassembly and Assembly, “Housing (Rear) - Remove”.

c. Remove the piston cooling jets. Refer to Disassembly and Assembly, “Piston Cooling Jets - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the main bearing caps for identification for the location and the direction in the cylinder block. The identification marks on the main bearing caps must be installed in the same direction prior to removal.

2. Check the connecting rod and the connecting rod bearing caps for identification and the location in the cylinder block.

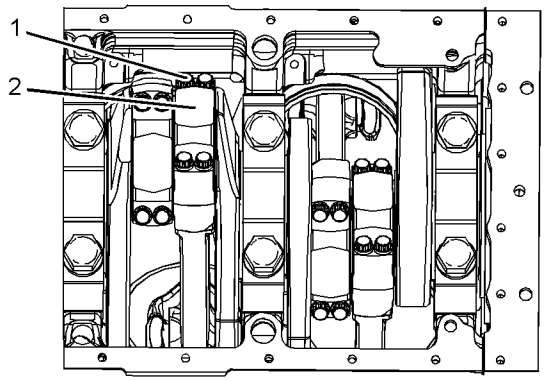


Illustration 467 g01150281

3. Remove bolts (1). Remove connecting rod bearing caps (2).

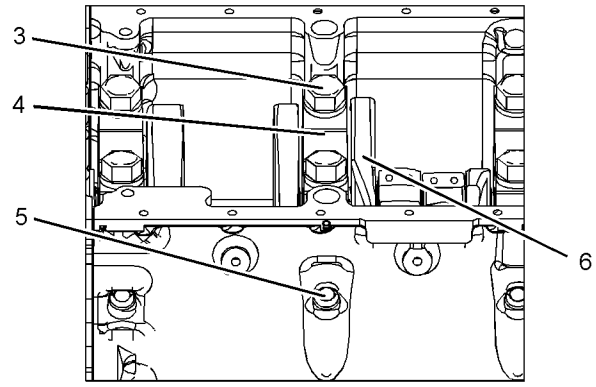


Illustration 468 g01150289

4. Remove bolts (3) and bolts (5). Remove main bearing caps (4).

5. Install Tooling (A) and a suitable lifting device on each end of crankshaft (6). The weight of crankshaft (6) is approximately 188 kg (415 lb).

Note: The counterweights will need to rotate enough to clear the block oil inlet ports from the oil pump. For more information, refer to supplemental video “Certain C32 Marine Engines Crankshaft - Remove & Install” on Caterpillar Channel1. Click or copy the link at the beginning of this procedure into a web browser (a CWS login is required to access Caterpillar Channel1), or scan the QR code using a QR enabled device.

6. Remove crankshaft (6) from the cylinder block.

7. Remove the thrust plates from each side of the No. 4 main bearing.

8. Remove the lower main bearings from main bearing caps (4). Remove the upper main bearings from the cylinder block.

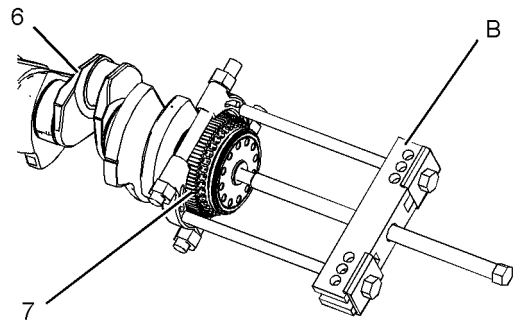


Illustration 469 g01150282

9. Use Tooling (B) to remove crankshaft gear (7) from crankshaft (6).

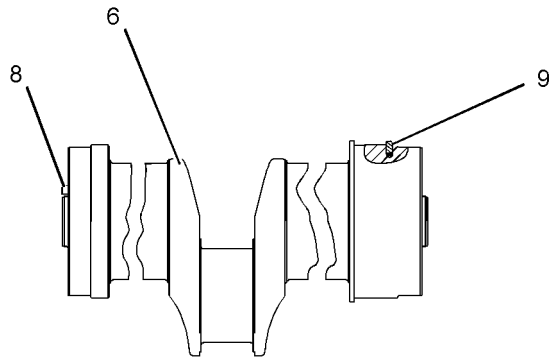


Illustration 470 g01150284

10. If necessary, use Tooling (C) to remove dowel (8) and dowel (9) from crankshaft (6).

i07605761

Crankshaft - Install

SMCS Code: 1202-012

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Installation Procedure

Table 92

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	439-3939	Link Bracket	2
D	8T-5096	Dial Indicator	1
E	8T-3052	Degree Wheel	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

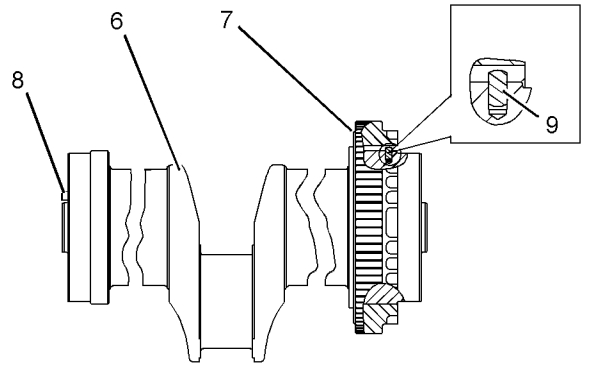


Illustration 471 g01150312

1. Install dowel (8) in the crankshaft.

Protrusion of dowel (8) from the crankshaft face
. . . . . .8.4 mm ((0.33 inch))

2. Install dowel (9) in the crankshaft.

Protrusion of dowel (9) from the crankshaft
. . . . . 4.1 ± 0.5 mm ((0.16 ± 0.02 inch))

3. Install crankshaft gear (7) on the crankshaft with the keyway in alignment with dowel (9). Timing Mark “V” of the gear should face away from crankshaft (6).

Note: Install the main bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, “Bearing Clearance - Check”. Apply clean engine oil on the main bearings for final assembly.

4. Install the upper halves of the main bearings in the cylinder block.

Note: Ensure that the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block. The upper halves of the main bearings have the oil groove and the oil hole.

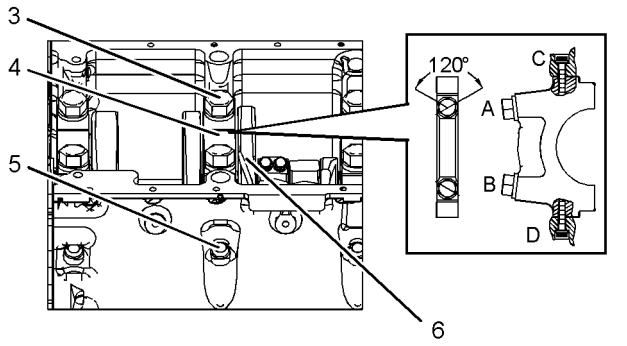


Illustration 472 g01150344

5. Install Tooling (A) and a suitable lifting device on each end of crankshaft (6). The weight of crankshaft (6) is approximately 188 kg (415 lb).

6. Install crankshaft (6) with Timing Mark “V” on the crankshaft gear in alignment with Timing Mark “V” on the cluster gear.

7. Install the thrust plates on each side of the No. 4 main bearing.

Note: Install the thrust plates with the words “Block Side” toward the cylinder block.

8. Install the lower halves of the crankshaft main bearings in the main bearing caps.

Note: Ensure that the main bearings are installed so that the bearing tabs fit into the notch in the main bearing cap.

9. Position main bearing caps (4) on the crankshaft.

Note: Ensure that the numbers on the main bearing caps match the numbers on the cylinder block. Also ensure that the “FRONT” on the main bearing cap is installed toward the front of the cylinder block.

10. Lubricate the threads of bolts (3) with clean engine oil. Install bolts(3) and the washers.

11. Lubricate the threads of bolts (5) and the seal of the washer with clean engine oil. Install bolts (5) and the washers.

Note: Inspect the washers that go on bolts (5).

12. Tighten bolts (3) and bolts (5) for the main bearing caps, as follows:

a. Tighten Bolt (A) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (A) is on the bearing tab side of the main bearing cap.

b. Tighten Bolt (B) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (B) is on the opposite side of the bearing tab of the main bearing cap.

c. Tighten Bolt (B) for an extra 120 ± 5 degrees (2 flats).

Note: If Tooling (E) is not used, place an index mark on the bolt and the main bearing cap.

d. Tighten Bolt (A) for an extra 120 ± 5 degrees (2 flats).

Note: If Tooling (E) is not used, place an index mark on the bolt and the main bearing cap.

e. Tighten Bolt (D) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (D) is on the opposite side of the bearing tab of the main bearing cap.

f. Tighten Bolt (C) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (C) is on the bearing tab side of the main bearing cap.

g. Rotate the crankshaft to ensure that the crankshaft turns freely.

13. Use Tooling (D) to check the crankshaft end play. Ensure that Tooling (D) is against a machined surface. The end play is controlled by the thrust plates of No. 4 main bearing (center).

Crankshaft end play (new thrust plates)
. . . . . 0.10 to 0.60 mm ((0.004 to 0.024 inch))

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, “Bearing Clearance - Check”. Apply clean engine oil on the connecting rod bearings for final assembly.

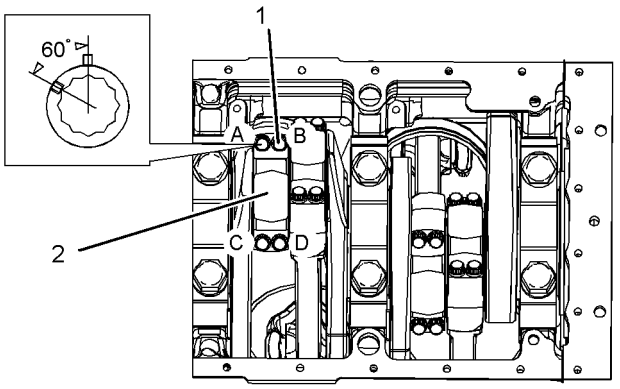


Illustration 473 g01150364

14. Position the connecting rod against the crankshaft. Install connecting rod bearing cap (2) on the connecting rod.

Note: Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod. The bearing tabs of the connecting rod bearing cap and the connecting rod are on the side opposite of the piston cooling jet.

15. Lubricate the threads of bolts (1) with clean engine oil. Install the bolts.

16. Tighten bolts (1), as follows:

a. Tighten Bolt (A) and Bolt (C) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

b. Tighten Bolt (B) and Bolt (D) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

c. Turn Bolt (B) and Bolt (D) for an extra 60 ± 5 degrees (1/6 turn).

Note: If Tooling (E) is not used, place an index mark on each bolt and connecting rod cap.

d. Tighten Bolt (A) and Bolt (C) again to a torque of 70 ± 4 N·m (52 ± 3 lb ft).

e. Turn Bolt (A) and Bolt (C) for an extra 60 ± 5 degrees (1/6 turn).

Note: If Tooling (E) is not used, place an index mark on each bolt and connecting rod cap.

f. Rotate the crankshaft to ensure that the crankshaft turns freely.

End By:

a. Install the piston cooling jets. Refer to Disassembly and Assembly, “Piston Cooling Jets - Remove and Install”.

b. Install the rear housing. Refer to Disassembly and Assembly, “Housing (Rear) - Install”.

c. Install the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Install”.

i05977048

Bearing Clearance - Check

SMCS Code: 1203-535; 1219-535

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Measurement Procedure

Table 93

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**

(continued)

(Table 93, contd)

A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Cat does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Cat engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE
Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A).

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A). Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 474 .

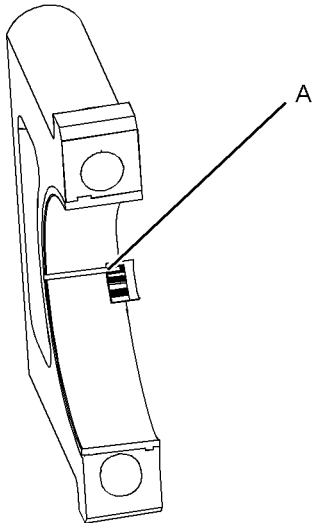


Illustration 474 g01152855
Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, “Connecting Rod Bearing Journal” and Specifications Manual, “Main Bearing Journal” for the correct clearances.

i02297699

Atmospheric Pressure Sensor - Remove and Install

SMCS Code: 1923-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

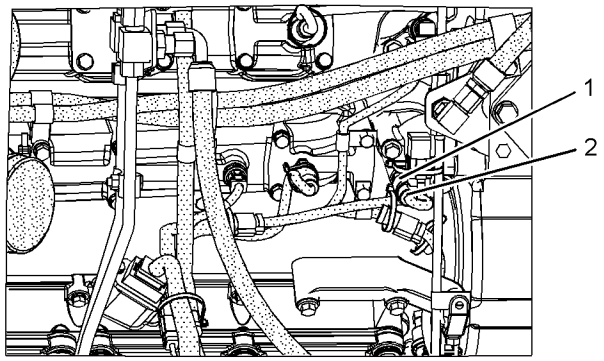


Illustration 475 g01150663

1. Disconnect harness assembly (2).

2. Remove atmospheric pressure sensor (1) from the adapter on the cylinder block.

3. Remove the O-ring seal from atmospheric pressure sensor (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

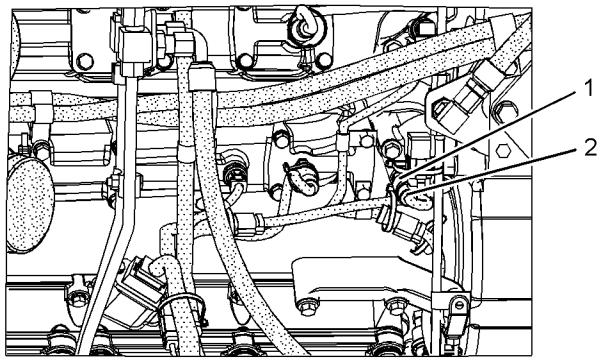


Illustration 476 g01150663

1. Install a new O-ring seal on atmospheric pressure sensor (1).

2. Install atmospheric pressure sensor (1) and tighten to a torque of 10 ± 2 N·m (89 ± 18 lb in).

3. Connect harness assembly (2).

i05721189

Atmospheric Pressure Sensor - Remove and Install

SMCS Code: 1923-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

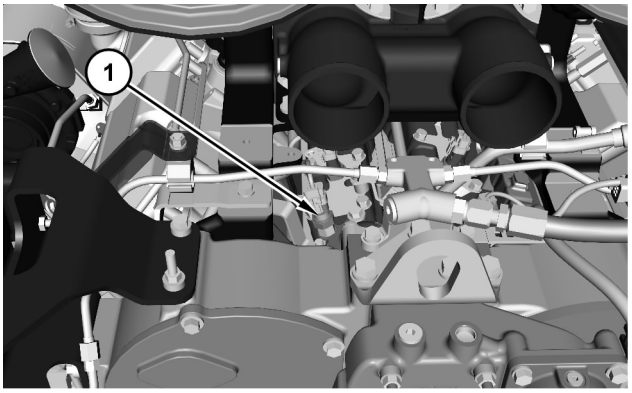


Illustration 477 g03637419

1. Disconnect harness assembly from atmospheric pressure sensor (1). Remove atmospheric pressure sensor (1).

Installation Procedure

1. Install atmospheric pressure sensor (1) in the reverse order of removal.

a. Tighten atmospheric pressure sensor (1) to a torque of 10 ± 2 N·m (89 ± 18 lb in).

i02297743

Camshaft Position Sensor - Remove and Install

SMCS Code: 1912-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

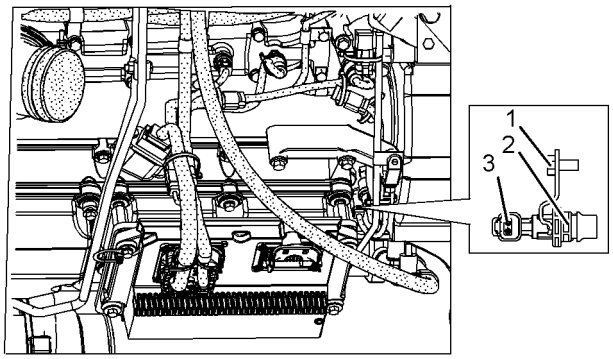


Illustration 478 g01150693

1. Disconnect harness assembly (3).

2. Remove bolt (1) and camshaft position sensor (2).

3. Remove the O-ring seal from camshaft position sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

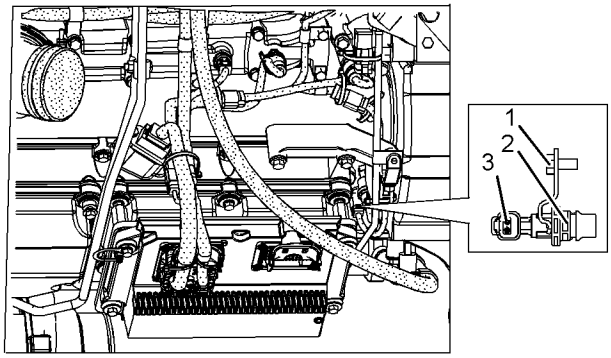


Illustration 479 g01150693

1. Install a new O-ring seal on camshaft position sensor (2). Lubricate the O-ring seal with clean engine oil.

2. Position camshaft position sensor (2) in the front housing and install bolt (1). Tighten bolt (1) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

3. Connect harness assembly (3).

i04598910

Camshaft Position Sensor - Remove and Install

SMCS Code: 1912-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

1. Position the oil filter and base out of the way.

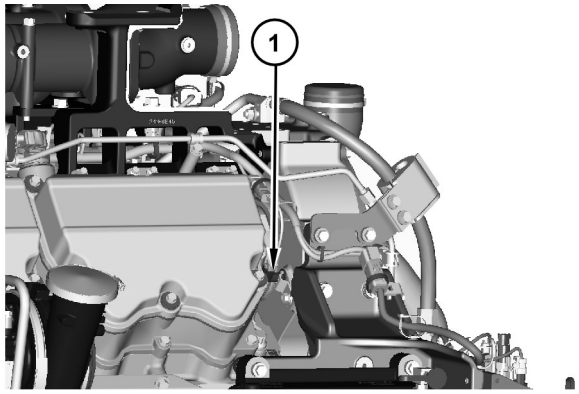


Illustration 480 g02256633

Photo showing the location of the camshaft position sensor.

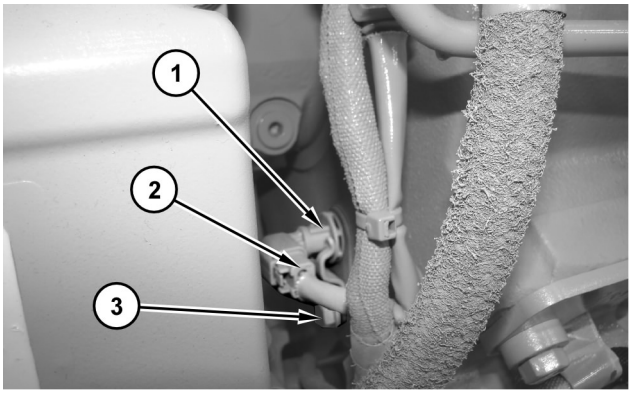


Illustration 481 g02228214

2. Disconnect harness assembly (2).

3. Remove bolt (3) and camshaft position sensor (1).

4. Remove the O-ring seal from camshaft position sensor (1).

Installation Procedure

1. Install camshaft position sensor (1) in reverse order of removal.

2. Install a new O-ring seal on camshaft position sensor (1). Lubricate the O-ring seal with clean engine oil.

a. Tighten bolt (3) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

i02297803

Crankshaft Position Sensor - Remove and Install

SMCS Code: 1912-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

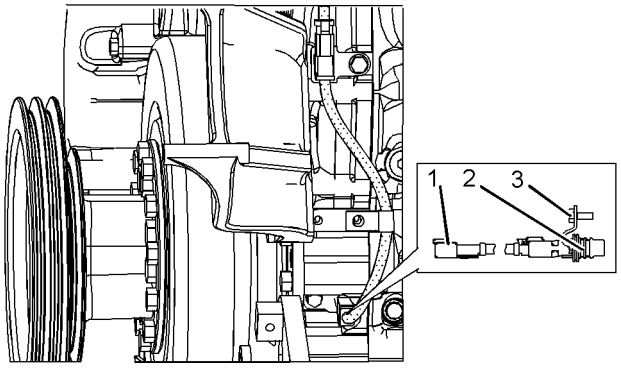


Illustration 482 g01150731

1. Disconnect harness assembly (1).

2. Remove bolt (3) and crankshaft position sensor (2).

3. Remove the O-ring seal from crankshaft position sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

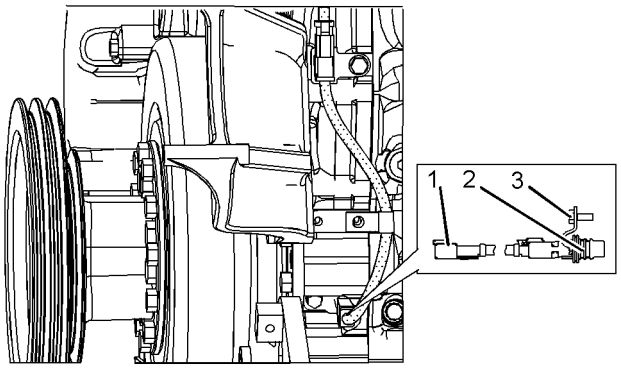


Illustration 483 g01150731

1. Install a new O-ring seal on crankshaft position sensor (2). Lubricate the O-ring seal with clean engine oil.

2. Install crankshaft position sensor (2) in the front housing. Install bolt (3). Tighten bolt (3) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

3. Connect harness assembly (1).

i04035070

Crankshaft Position Sensor - Remove and Install

SMCS Code: 1912-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

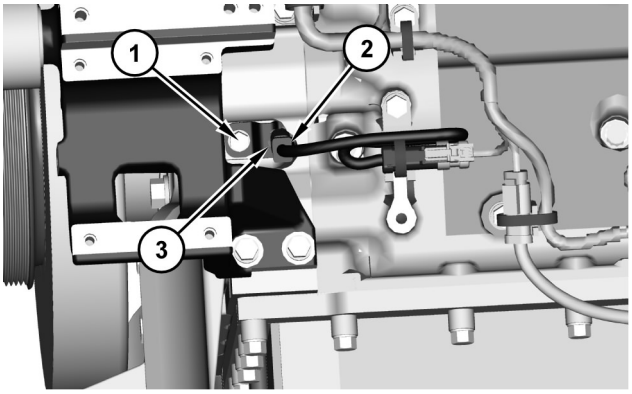


Illustration 484 g02229293

1. Disconnect harness assembly (2).

2. Remove bolt (1) and crankshaft position sensor (3).

3. Remove the O-ring seal from crankshaft position sensor (3).

Installation Procedure

1. Install crankshaft position sensor (3) in reverse order of removal.

2. Install a new O-ring seal on crankshaft position sensor (3). Lubricate the O-ring seal with clean engine oil.

a. Install crankshaft position sensor (3) in the front housing. Install bolt (3). Tighten bolt (3) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

i02297881

Coolant Temperature Sensor - Remove and Install

SMCS Code: 1906-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system to a level below the coolant temperature sensor into a suitable container for storage or disposal.

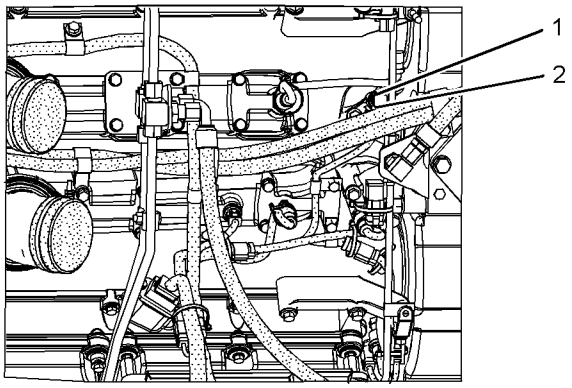


Illustration 485 g01150839

2. Disconnect harness assembly (2).

3. Remove coolant temperature sensor (1).

4. Remove the O-ring seal from coolant temperature sensor (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

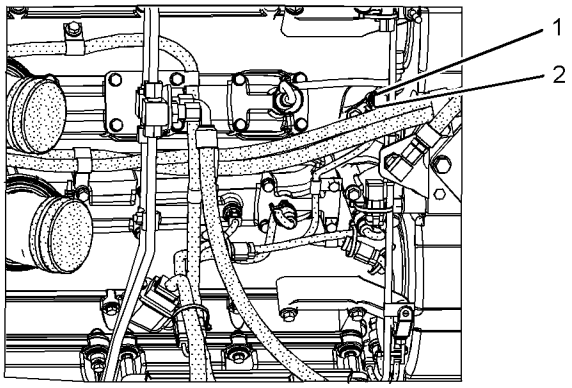


Illustration 486 g01150839

1. Install a new O-ring seal on coolant temperature sensor (1).

2. Install coolant temperature sensor (1) and tighten to a torque of 20 ± 5 N·m (15 ± 4 lb ft).

3. Connect harness assembly (2).

4. Fill the cooling system with coolant. Refer to Operation and Maintenance, “Refill Capacities” for the cooling system capacity.

i04598949

Coolant Temperature Sensor - Remove and Install

SMCS Code: 1906-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

1. Refer to Operation and Maintenance Manual, “Coolant - Change” for the proper draining and filling procedures.

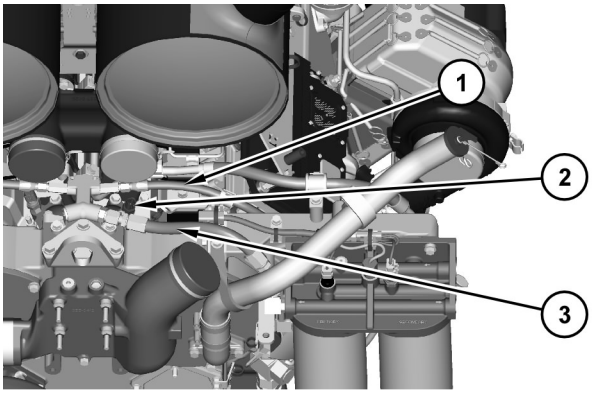


Illustration 487 g02751540

2. Disconnect hose assemblies (1) and (3).

3. Disconnect the harness assembly from coolant temperature sensor (2). Remove coolant temperature sensor (2).

Installation Procedure

1. Install coolant temperature sensor (2) in reverse order of removal.

2. Install a new O-ring seal on coolant temperature sensor (2).

a. Install coolant temperature sensor (2) and tighten to a torque of 20 ± 3 N·m (177 ± 27 lb in).

i02298137

Engine Oil Pressure Sensor - Remove and Install

SMCS Code: 1924-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

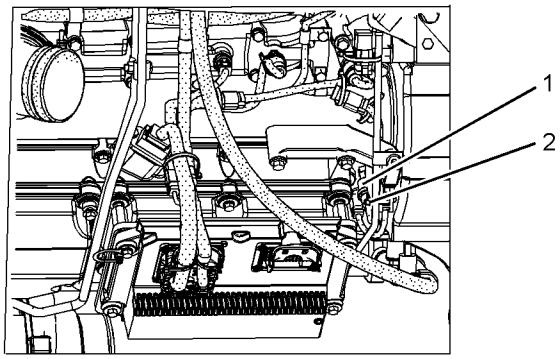


Illustration 488 g01150948

1. Disconnect harness assembly (2).

2. Remove engine oil pressure sensor (1) from the adapter on the cylinder block.

3. Remove the O-ring seal from engine oil pressure sensor (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

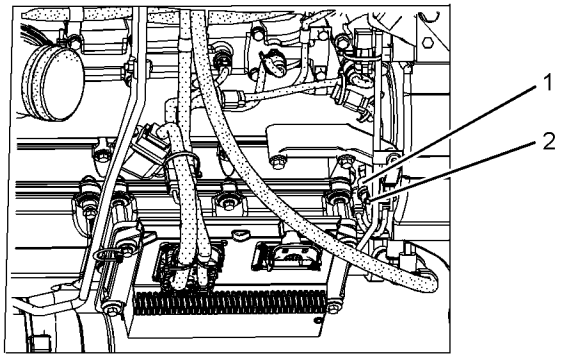


Illustration 489 g01150948

1. Install a new O-ring seal on engine oil pressure sensor (1).

2. Install engine oil pressure sensor (1) and tighten to a torque of 10 ± 2 N·m (89 ± 18 lb in).

3. Connect harness assembly (2).

i02298535

Fuel Pressure Sensor - Remove and Install

SMCS Code: 7414-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

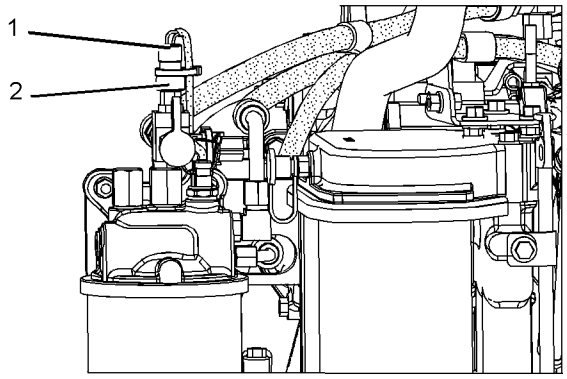


Illustration 490 g01151146

1. Turn the fuel supply valve to the OFF position.

2. Disconnect harness assembly (1).

3. Remove fuel pressure sensor (2) from the fuel filter base.

4. Remove the O-ring seal from fuel pressure sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

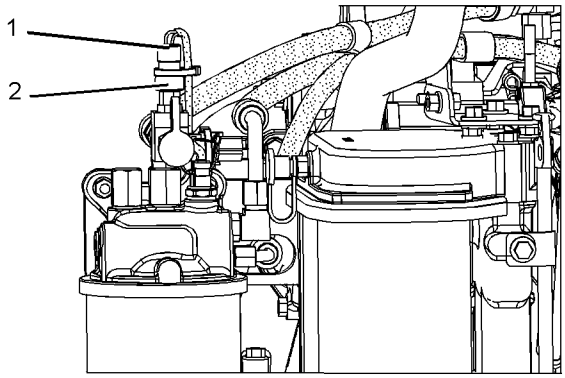


Illustration 491 g01151146

1. Install a new O-ring seal on fuel pressure sensor (2).

2. Install fuel pressure sensor (2) and tighten to a torque of 10 ± 2 N·m (89 ± 18 lb in).

3. Connect harness assembly (1).

4. Turn the fuel supply valve to the ON position.

i05721750

Fuel Pressure Sensor - Remove and Install

SMCS Code: 7414-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

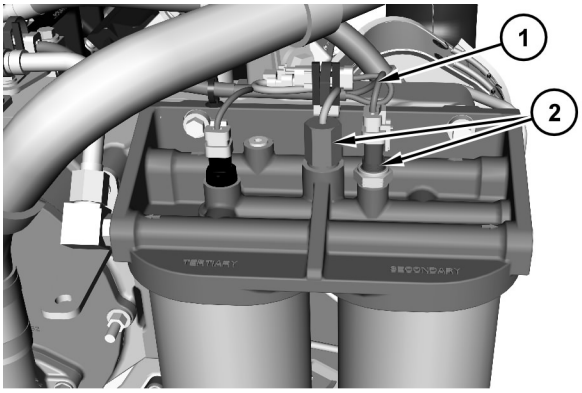


Illustration 492 g03637761

1. Turn the fuel supply valve to the OFF position.

2. Disconnect harness assembly (1).

3. Remove fuel pressure sensor (2) from the fuel filter base.

4. Remove the O-ring seal from fuel pressure sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Install fuel pressure sensor (2) in the reverse order of removal.

a. Tighten fuel pressure sensor (2) to a torque of 10 ± 2 N·m (89 ± 18 lb in).

i02298273

Fuel Temperature Sensor - Remove and Install

SMCS Code: 1922-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

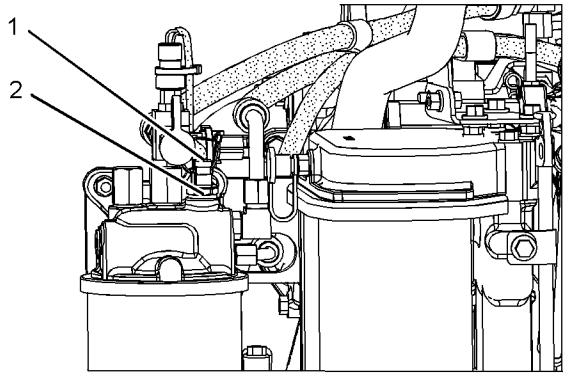


Illustration 493 g01151041

1. Turn the fuel supply valve to the OFF position.

2. Disconnect harness assembly (1).

3. Remove fuel temperature sensor (2) from the fuel filter base.

4. Remove the O-ring seal from fuel temperature sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

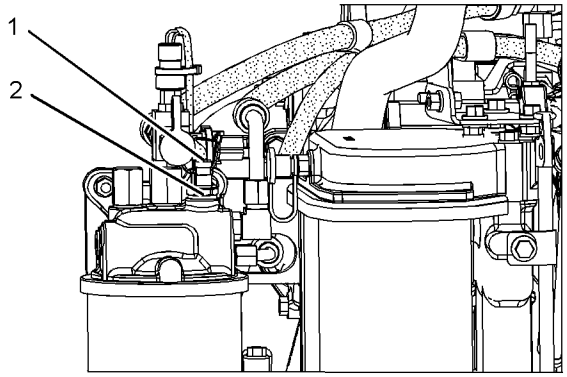


Illustration 494 g01151041

1. Install a new O-ring seal on fuel temperature sensor (2).

2. Install fuel temperature sensor (2) and tighten to a torque of 20 ± 5 N·m (15 ± 4 lb ft).

3. Connect harness assembly (1).

4. Turn the fuel supply valve to the ON position.

i05725109

Fuel Temperature Sensor - Remove and Install

SMCS Code: 1922-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

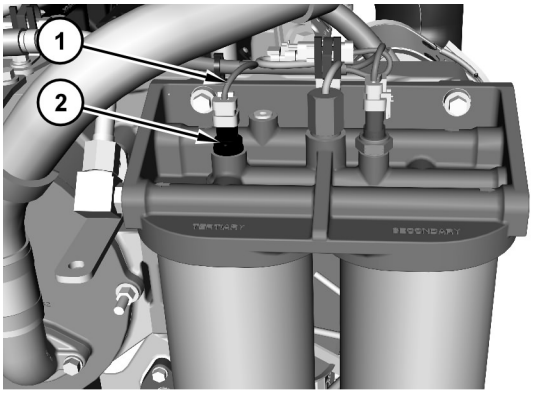


Illustration 495 g03639725

1. Turn the fuel supply valve to the OFF position.

2. Disconnect harness assembly (1).

3. Remove fuel temperature sensor (2) from the fuel filter base.

4. Remove the O-ring seal from fuel temperature sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Install fuel temperature sensor (2) in the reverse order of removal.

a. Tighten fuel temperature sensor (2) to a torque of 20 ± 5 N·m (15 ± 4 lb ft).

i02531239

Turbocharger Outlet Pressure Sensor - Remove and Install

SMCS Code: 1917-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

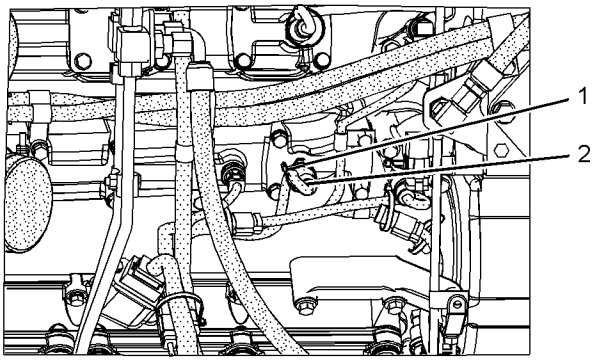


Illustration 496 g01151057

1. Disconnect harness assembly (2).

2. Remove turbocharger outlet pressure sensor (1) from the inlet manifold.

3. Remove the O-ring seal from turbocharger outlet pressure sensor (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

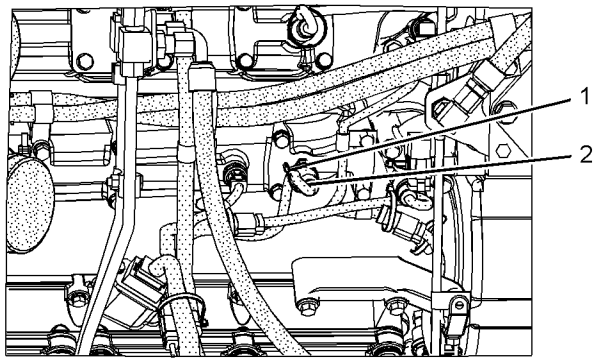


Illustration 497 g01151057

1. Install a new O-ring seal on turbocharger outlet pressure sensor (1).

2. Install turbocharger outlet pressure sensor (1) in the inlet manifold and tighten to a torque of 10 ± 2 N·m (89 ± 18 lb in).

3. Connect harness assembly (2).

i05687071

Turbocharger Outlet Pressure Sensor - Remove and Install

SMCS Code: 1917-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

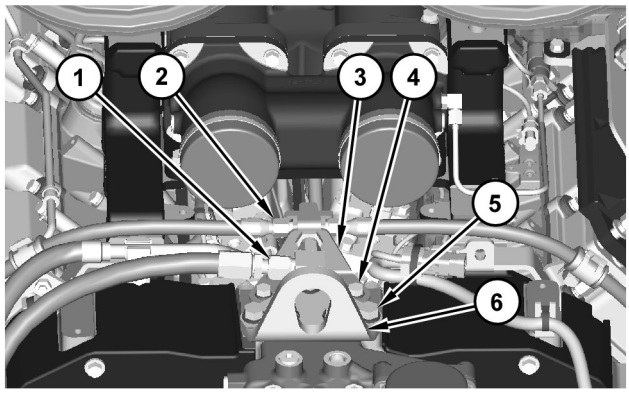


Illustration 498 g02252733

1. Disconnect hose assemblies (1) and (2).

2. Remove bolts (4) and position manifold (3) out of the way.

3. Remove bolts (5) and remove bracket (6).

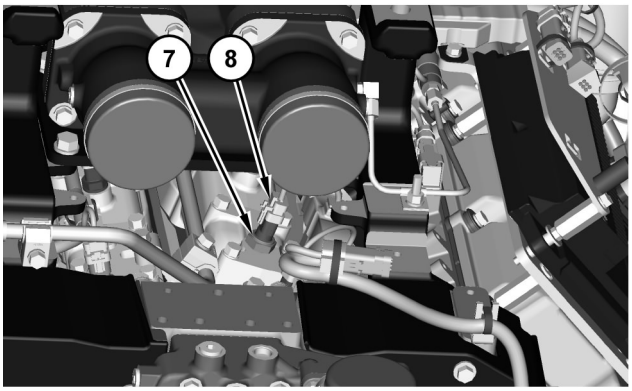


Illustration 499 g02253875

4. Disconnect harness assembly (8) and remove turbocharger outlet pressure sensor (7).

Installation Procedure

1. Install the turbocharger outlet pressure sensor (7) in the reverse order.

2. Tighten turbocharger outlet pressure sensor (7) to a torque of 10 ± 2 N·m (89 ± 18 lb in).

i02531227

Inlet Air Temperature Sensor - Remove and Install

SMCS Code: 1921-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

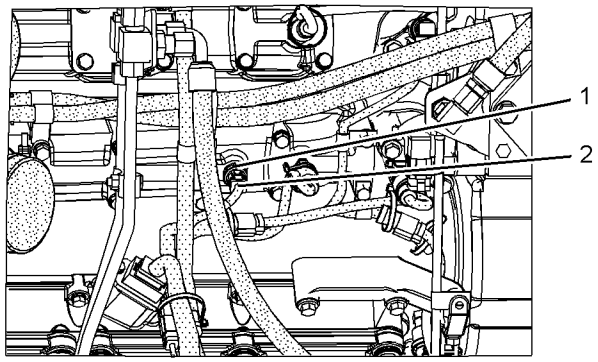


Illustration 500 g01151116

1. Disconnect harness assembly (2).

2. Remove inlet air temperature sensor (1) from the inlet manifold.

3. Remove the O-ring seal from inlet air temperature sensor (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

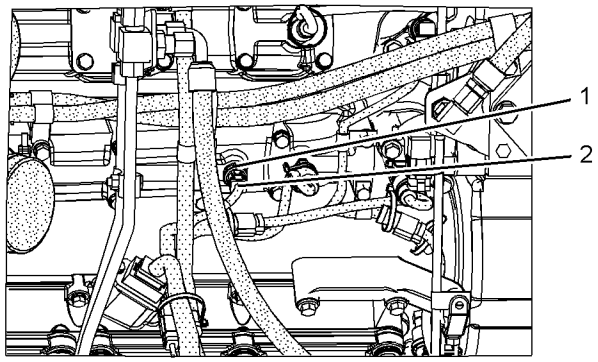


Illustration 501 g01151116

1. Install a new O-ring seal on inlet air temperature sensor (1).

2. Install inlet air temperature sensor (1) into the inlet manifold and tighten to a torque of 20 ± 5 N·m (15± 4 lb ft).

3. Connect harness assembly (2).

i05726010

Inlet Air Temperature Sensor - Remove and Install
(Right Side and Left Side)

SMCS Code: 1921-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

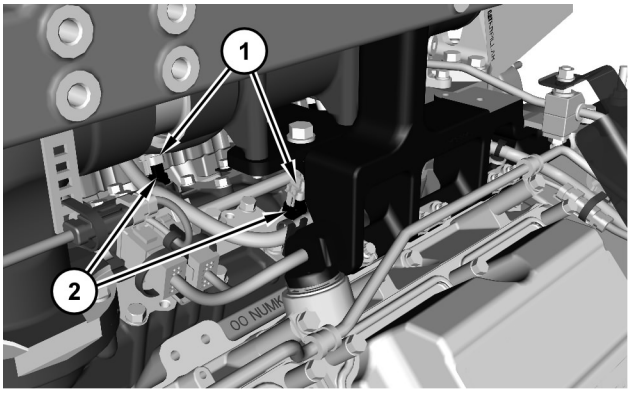


Illustration 502 g03640361

1. Disconnect harness assemblies (1) and remove inlet air temperature sensors (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Install inlet air temperature sensors (2) in the reverse order.

a. Tighten inlet air temperature sensors (2) to a torque of 20 ± 3 N·m (177 ± 27 lb in).

i02531004

Engine Trunnion - Remove and Install

SMCS Code: 1153-010

Removal Procedure

Table 94

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5255	Hydraulic Jack	1
B	-	Guide Stud 1/2 - 13 by 4 inch	2

Start By:

a. Remove the vibration damper. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

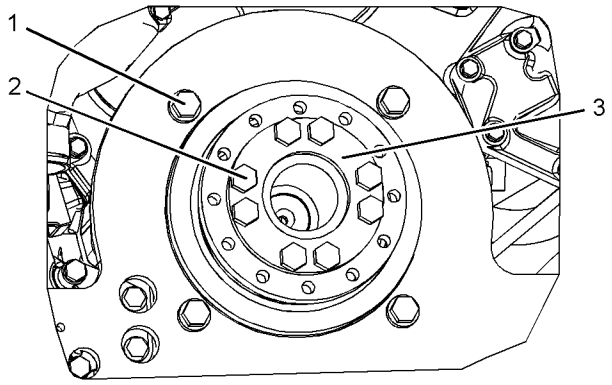


Illustration 503 g01148134

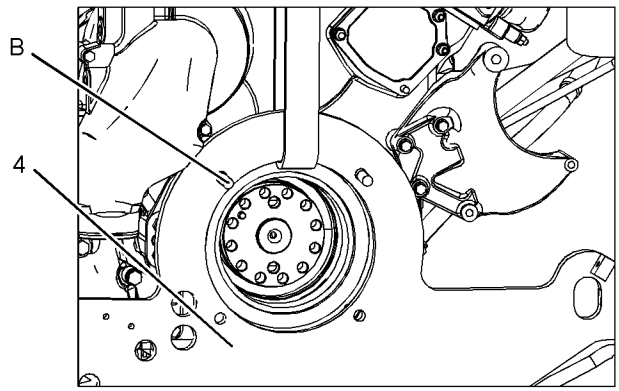


Illustration 504 g01148136

1. Remove bolts (2) and adapter (3).

2. Use Tooling (A) and suitable cribbing in order to support the engine. Support the engine on the front edge of the oil pan.

3. Remove two bolts (1). Install Tooling (B). Remove remaining bolts (1).

4. Attach a suitable lifting device to support assembly (4). The weight of support assembly (4) is approximately 50 kg (110 lb). Remove support assembly (4) from Tooling (B).

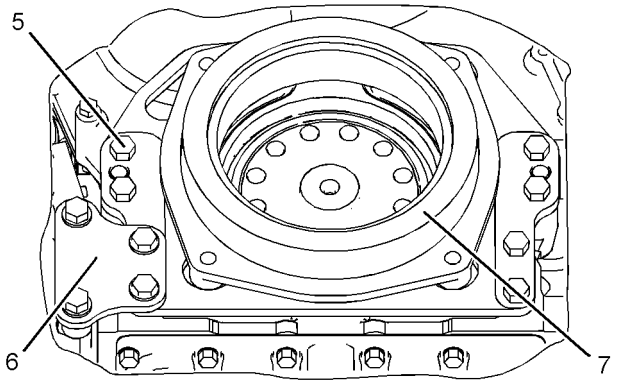


Illustration 505 g01148140

5. Remove bracket (6), bolts (5), and engine trunnion (7).

Installation Procedure

Table 95

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5255	Hydraulic Jack	1
B	-	Guide Stud 1/2 - 13 by 4 inch	2

1. Use Tooling (A) and suitable cribbing in order to support the engine. Support the engine on the front edge of the oil pan.

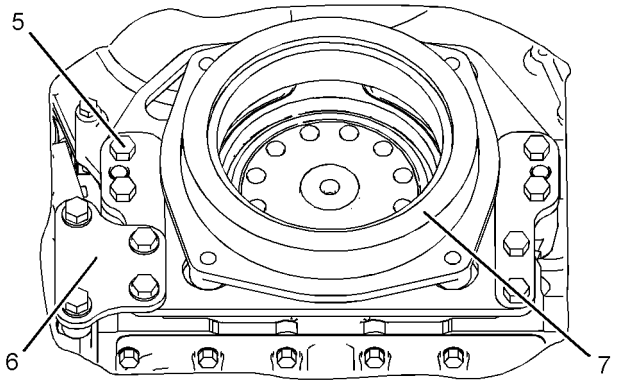


Illustration 506 g01148140

2. Position engine trunnion (7) on the engine. Install bolts (5) and bracket (6).

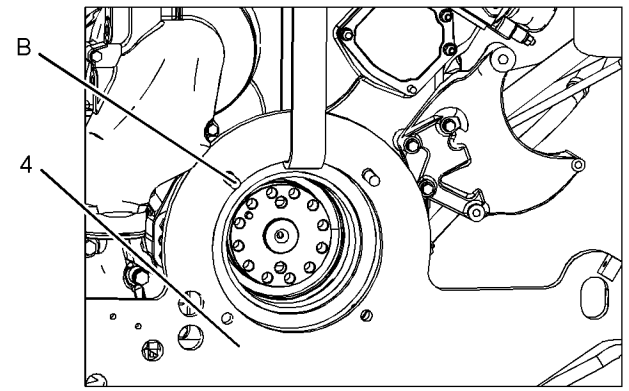


Illustration 507 g01148136

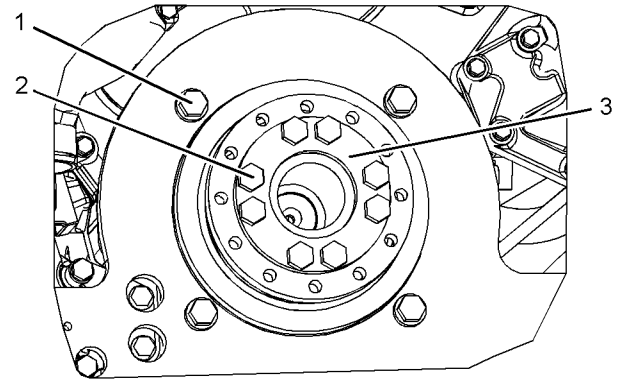


Illustration 508 g01148134

3. Install Tooling (B) on the engine.

4. Attach a suitable lifting device to support assembly (4). The weight of support assembly (4) is approximately 50 kg (110 lb). Position support assembly (4) on Tooling (B).

5. Install bolts (1). Remove Tooling (B). Install remaining bolts (1).

6. Remove Tooling (A) and the suitable cribbing.

7. Position adapter (3) and install bolts (2).

End By:

a. Install the vibration damper. Refer to Disassembly and Assembly, “Vibration Damper and Pulley - Remove and Install”.

i02298562

Electronic Control Module - Remove and Install

SMCS Code: 1901-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

1. Disconnect the negative battery terminal at the battery.

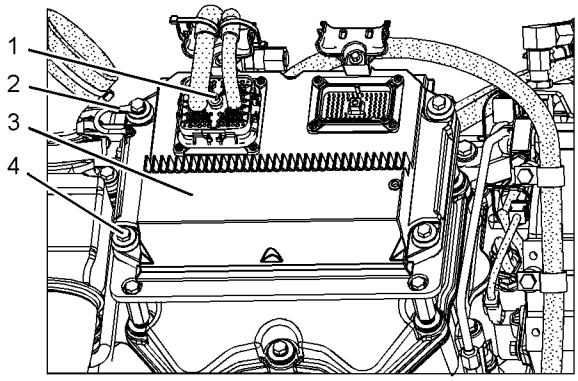


Illustration 509 g01151157

2. Loosen allen head screw (1). Disconnect the harness assembly from electronic control module (3).

3. Remove bolts (4). Remove electronic control module (3) and ground strap (2).

4. Remove the washers and the isolation mounts from electronic control module (3).

Installation Procedure

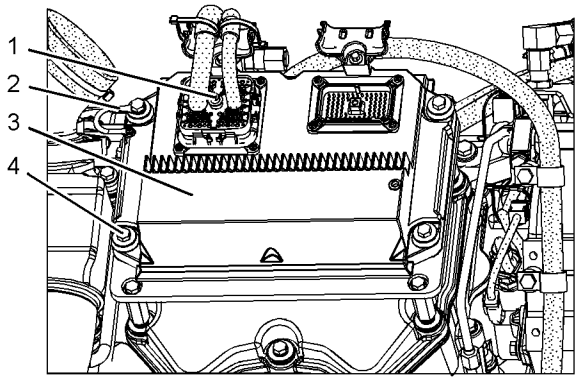


Illustration 510 g01151157

1. Position the isolation mounts on electronic control module (3). Position the spacers, the washers, ground strap (2) and electronic control module (3) on the support assemblies. Install bolts (4).

2. Connect the harness assembly to electronic control module (3). Tighten allen head screw (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).

3. Connect the negative battery terminal at the battery.

i05672149

Electronic Control Module - Remove and Install

SMCS Code: 1901-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

1. Disconnect the negative battery terminal at the battery.

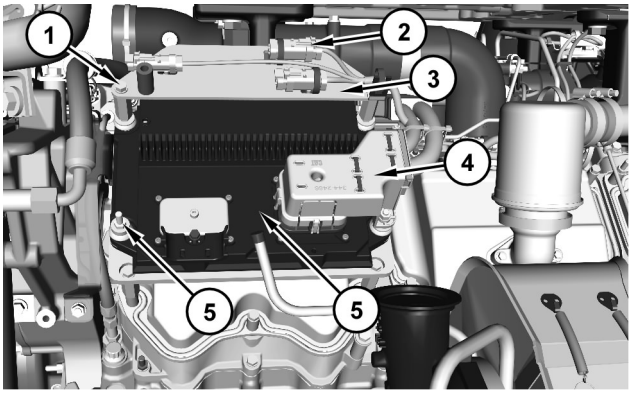


Illustration 511 g03596870

2. Disconnect harness assembly (2).

3. Remove bolts (1) and plate (3).

4. Disconnect harness assembly (4), remove nuts (6), and remove electronic control module (5).

Installation Procedure

1. Install electronic control module (5) in the reverse order of removal.

i02298677

Alternator - Remove and Install

SMCS Code: 1405-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

1. Turn the battery disconnect switch to the OFF position.

2. Remove the V-belt from the engine.

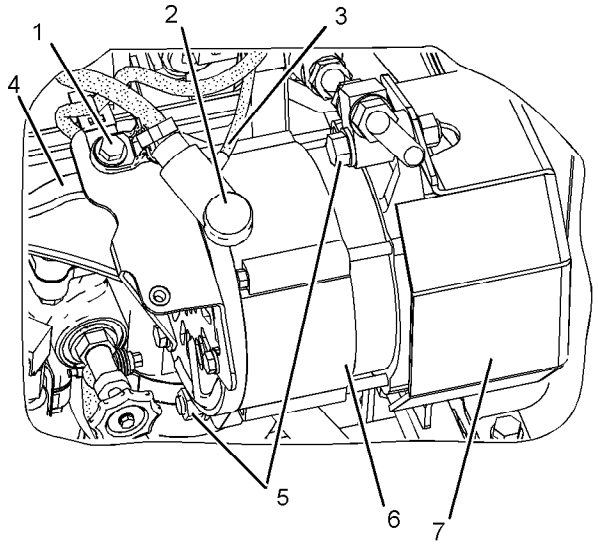


Illustration 512 g01098691

3. Disconnect cable assembly (2). Remove bolt (1). Disconnect ground strap (4). Disconnect harness assembly (3). Remove bolts (5). Remove guard (7). Remove alternator (6).

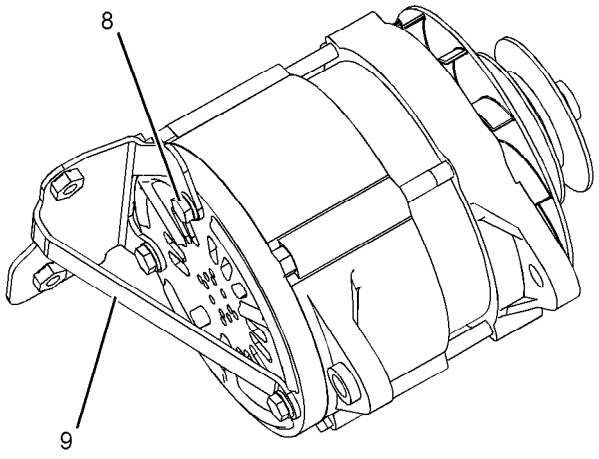


Illustration 513 g01098693

4. Remove bolts (8) and bracket (9).

Installation Procedure

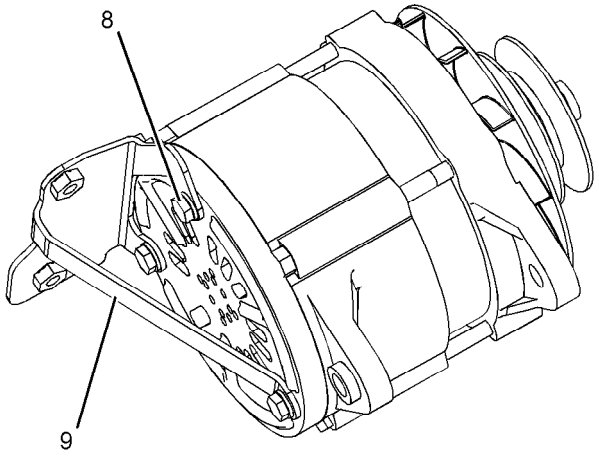


Illustration 514 g01098693

1. Position bracket (9) and install bolts (8).

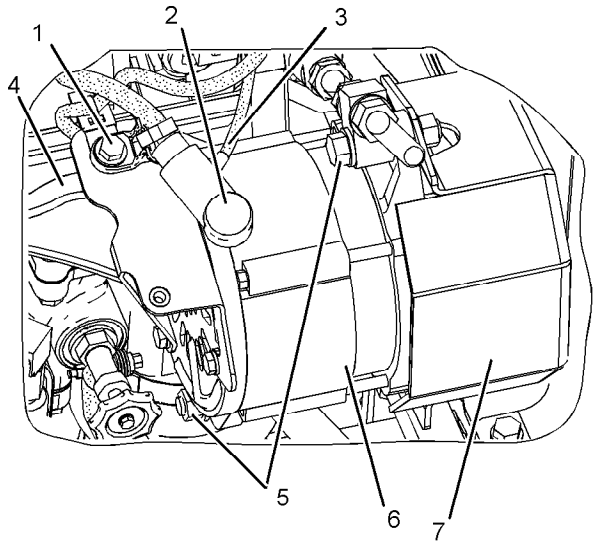


Illustration 515 g01098691

2. Position alternator (6). Position guard (7) and install bolts (5). Connect harness assembly (3). Connect ground strap (4). Install bolt (1). Connect cable assembly (2).

3. Install the V-belt on the engine.

4. Turn the battery disconnect switch to the ON position.

i02298688

Electric Starting Motor - Remove and Install

SMCS Code: 1453-010

S/N: JA41–Up

S/N: TC91–Up

S/N: PZB1–Up

S/N: TZB1–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZG1–Up

S/N: WZH1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: MZM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: NZT1–Up

S/N: LJW1–Up

S/N: EHX1–99999

S/N: LJX1–Up

S/N: MJX1–Up

Removal Procedure

1. Turn the battery disconnect switch to the OFF position.

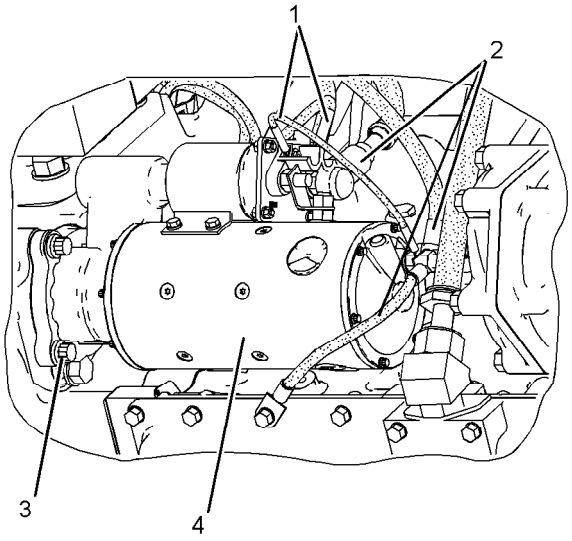


Illustration 516 g01099238

2. Disconnect harness assemblies (1) and cable assemblies (2). Attach a suitable lifting device to electric starting motor (4). The weight of electric starting motor (4) is approximately 36 kg (80 lb). Remove bolts (3). Remove electric starting motor (4) from the right side of the engine.

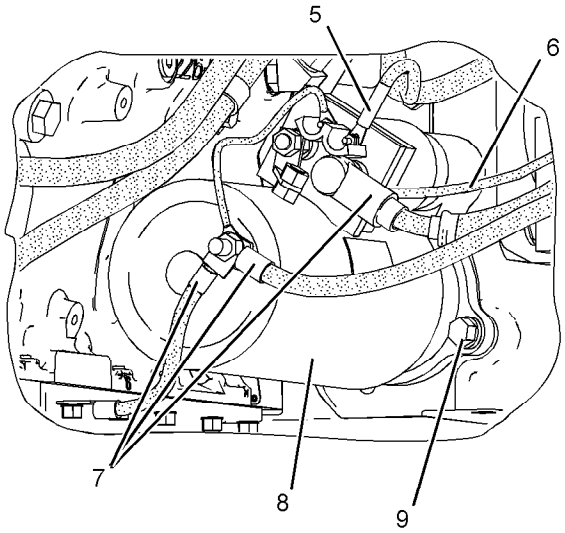


Illustration 517 g01099237

3. Disconnect harness assembly (5) and harness assembly (6). Disconnect cable assemblies (7). Attach a suitable lifting device to electric starting motor (8). The weight of electric starting motor (8) is approximately 36 kg (80 lb). Remove bolts (9). Remove electric starting motor (8) from the left side of the engine.

Installation Procedure

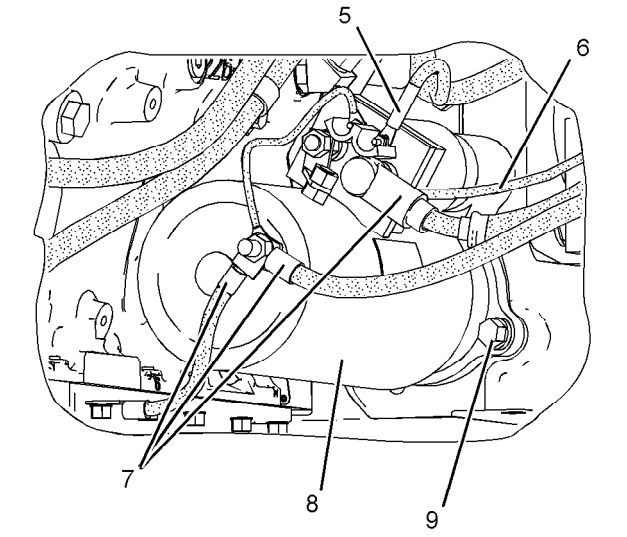


Illustration 518 g01099237

1. Attach a suitable lifting device to electric starting motor (8). The weight of electric starting motor (8) is approximately 36 kg (80 lb). Position electric starting motor (8) on the left side of the engine. Install bolts (9). Connect harness assembly (6) and harness assembly (5). Connect cable assemblies (7).

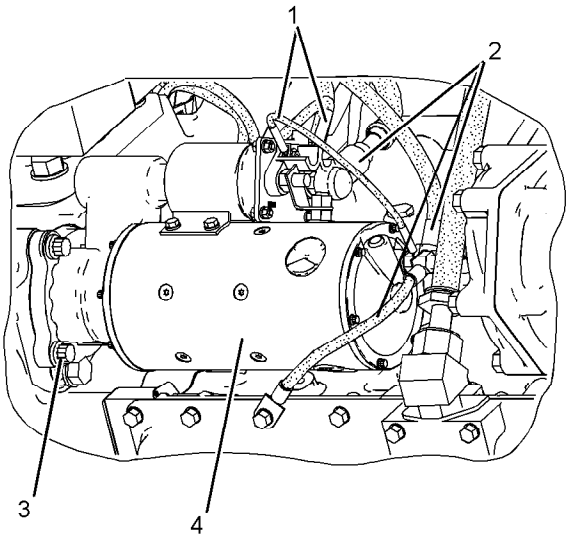


Illustration 519 g01099238

2. Attach a suitable lifting device to electric starting motor (4). The weight of electric starting motor (4) is approximately 36 kg (80 lb). Position electric starting motor (4) on the right side of the engine. Install bolts (3). Connect cable assemblies (2) and harness assemblies (1).

3. Turn the battery disconnect switch to the ON position.

i05677892

Electric Starting Motor - Remove and Install

SMCS Code: 1453-010

S/N: JA41–Up

S/N: TC91–Up

S/N: TZC1–Up

S/N: TZD1–Up

S/N: HPE1–Up

S/N: NZK1–Up

S/N: JHM1–Up

S/N: JZP1–Up

S/N: TZR1–Up

S/N: FZS1–Up

S/N: DLT1–Up

S/N: MJX1–Up

Removal Procedure

1. Turn the battery disconnect switch to the OFF position.

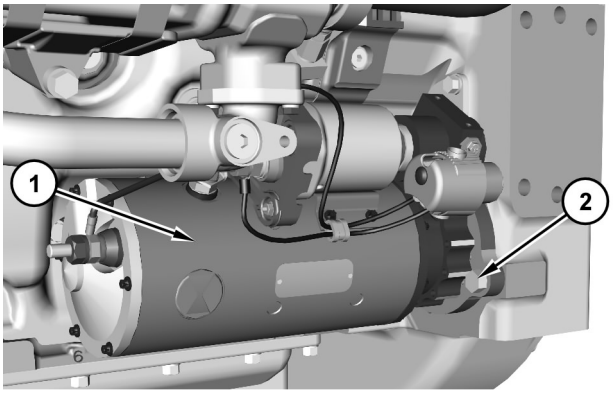


Illustration 520 g03602016

2. Disconnect the harness assemblies from electric starting motor (1).

3. Remove bolts (2) and electric starting motor (1). Electric starting motor (1) weighs approximately 38 kg (84 lb).

Installation Procedure

1. Install electric starting motor (1) in the reverse order of removal.

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CATERPILLAR®

RENR8809-01
May 2011



Specifications

990H Wheel Loader and 844H Wheel Dozer Power Train

BTW1-Up (Machine)
BWX1-Up (Machine)
MPR1-Up (Transmission)
2JT1-Up (Torque Converter)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Specifications Section

i01642582

Torque Converter and Pump Drive Housing

SMCS Code: 3105

Part No.: 271-0283

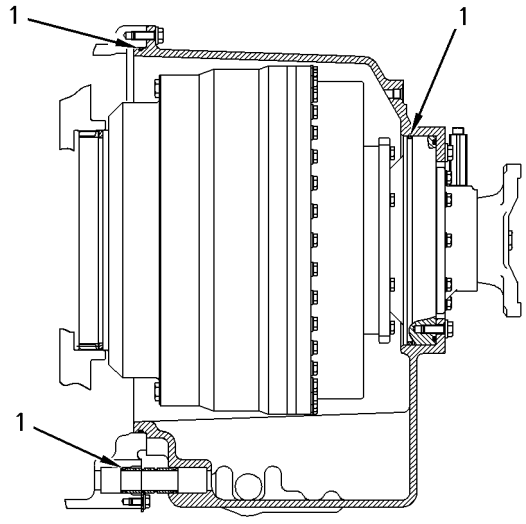


Illustration 1 g00849132

(1) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

i02396680

Torque Converter (Lockup)

SMCS Code: 3101-L7

Part No.: 6Y-3888

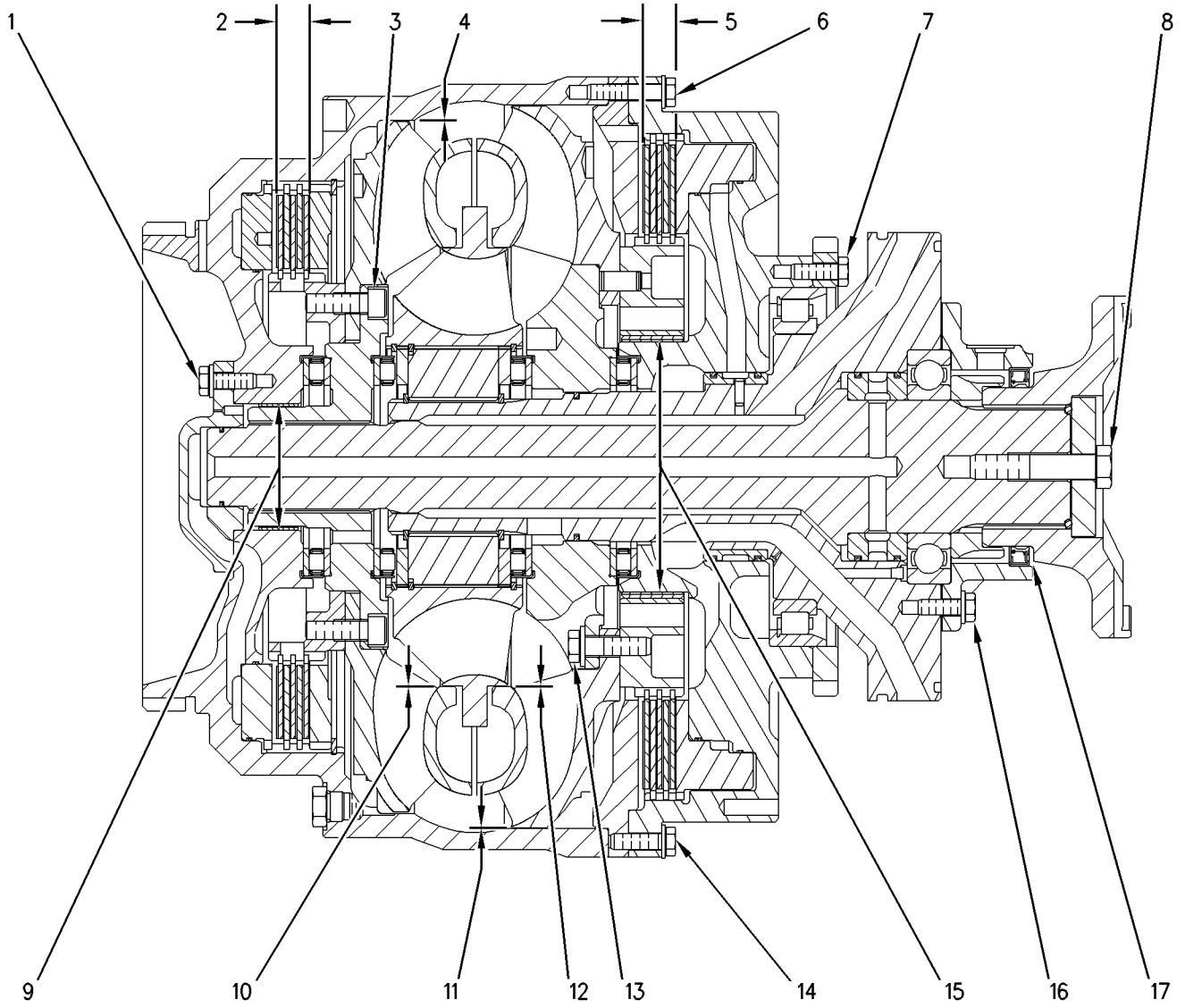


Illustration 2 g00855735

(1) Torque for the six bolts .. 60 ± 7 N·m (44 ± 5 lb ft)

(2) Lockup Clutch

Total thickness of two new clutch plates and three new friction discs for the lockup clutch ..... 21.35 ± 0.50 mm (.841 ± .020 inch)
Thickness of one new 1T-1315 Plate ..... 3.43 ± 0.13 mm (.135 ± .005 inch)
Thickness of one new 1T-0887 Clutch Disc Assembly ..... 4.83 ± 0.08 mm (.190 ± .003 inch)

(3) Torque for the 24 bolts ..... 105 ± 15 N·m (75 ± 10 lb ft)

(4) Clearance between the torque converter turbine and the torque converter housing assembly across the diameter ..... 1.80 ± 0.38 mm (.071 ± .015 inch)

(5) Impeller Clutch

Total thickness of two new clutch plates and three new friction discs for the impeller clutch ..... 21.35 ± 0.34 mm (.841 ± .013 inch)
Thickness of one new 1T-1897 Plate ..... 3.43 ± 0.05 mm (.135 ± .002 inch)
Thickness of one new 8E-8328 Friction Disc ..... 4.83 ± 0.08 mm (.190 ± .003 inch)

(6) Torque for the 36 bolts .. 60 ± 7 N·m (44 ± 5 lb ft)

(7) Torque for the six bolts .. 60 ± 7 N·m (44 ± 5 lb ft)

(8) Torque for the bolt .. 240 ± 25 N·m (175 ± 20 lb ft)

(9) Clutch Housing Assembly and Sleeve Bearing

Sleeve bearing inside diameter after installation in the clutch housing assembly ..... 76.327 ± 0.038 mm (3.0050 ± .0015 inch)
Diameter of the bearing surface of the hub ..... 76.187 ± 0.013 mm (2.9995 ± .0005 inch)

(10) Clearance between the torque converter turbine and the torque converter stator across the diameter ..... 0.79 ± 0.26 mm (.031 ± .010 inch)

(11) Clearance between the torque converter impeller and the torque converter housing across the diameter .. 1.85 ± 0.33 mm (.073 ± .013 inch)

(12) Clearance between the torque converter impeller and the torque converter stator across the diameter .. 0.79 ± 0.26 mm (.031 ± .010 inch)

(13) Torque for the 12 bolts ..... 105 ± 15 N·m (75 ± 10 lb ft)

(14) Torque for the two bolts ..... 60 ± 7 N·m (44 ± 5 lb ft)

(15) Impeller Housing and Adapter Assembly

Sleeve bearing inside diameter after installation in the adapter assembly ..... 160.24 ± 0.08 mm (6.309 ± .003 inch)
Diameter of the bearing surface of the impeller housing ..... 160.000 ± 0.013 mm (6.2992 ± .0005 inch)

(16) Torque for the eight bolts ..... 60 ± 7 N·m (44 ± 5 lb ft)

(17) Lubricate the lip seal with a minimal amount of the lubricant that is being sealed.

i00731988

Torque Converter Priority Valve

SMCS Code: 3180-VC

Part No.: 8E-8427

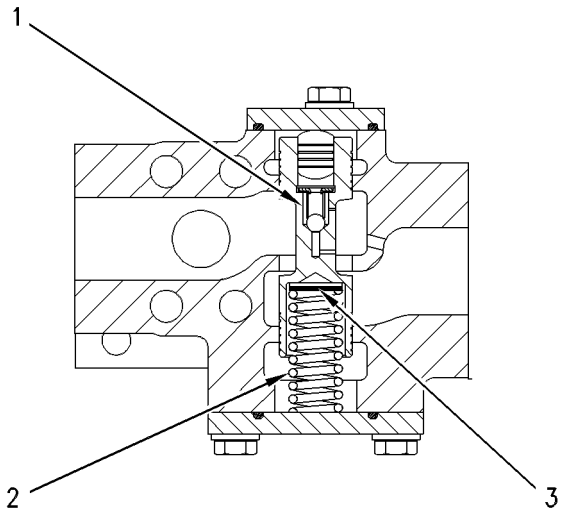


Illustration 3 g00326768

(1) 4M-2381 Spring

Length under test force ..... 12.2 mm (.48 inch)
Test force ..... 2.30 ± 0.18 N (.517 ± .041 lb)
Free length after test ..... 22.6 mm (.89 inch)
Outside diameter ..... 7.62 mm (.300 inch)

(2) 8E-8273 Spring

Length under test force ..... 50.3 mm (1.98 inch)
Test force ..... 501 ± 25 N (113 ± 6 lb)
Free length after test ..... 67.88 mm (2.672 inch)
Outside diameter ..... 23.9 mm (.94 inch)

(3) Spacers

8S-6214 Spacer thickness .. 0.4 mm (.016 inch)
8S-6215 Spacer thickness .. 0.9 mm (.035 inch)

As required, use spacers to achieve correct priority valve pressure.

Pressure setting for the priority valve .. 2200 ± 35 kPa (320 ± 5 psi)

i03665300

Modulating Valve (Torque Converter Impeller Clutch)

SMCS Code: 3139-VC

Part No.: 217-2708

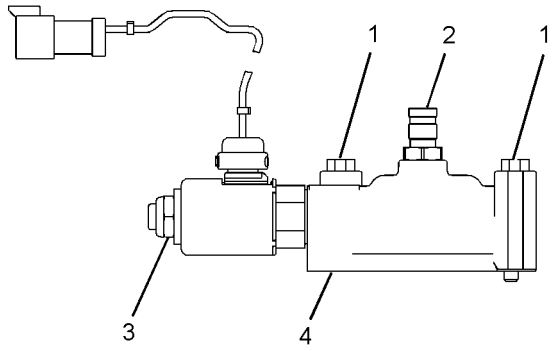


Illustration 4 g01441011

Operating voltage ..... 24 VDC

Nominal coil resistance at 25 ± 5 °C (77 ± 9 °F) ..... 7.75 ± 1.00 Ohms

(1) Torque for the two bolts ..... 30 ± 4 N·m (265 ± 35 lb in)

(2) Torque for the quick disconnect coupler ..... 14 ± 4 N·m (125 ± 35 lb in)

(3) Torque for the self-locking nut ..... 13.0 ± 1.5 N·m (115 ± 13 lb in)

(4) Install the 6D-7889 O-Ring Seal for the modulating valve.

i03665463

Modulating Valve (Torque Converter Lockup Clutch)

SMCS Code: 3139-VC

Part No.: 216-5342

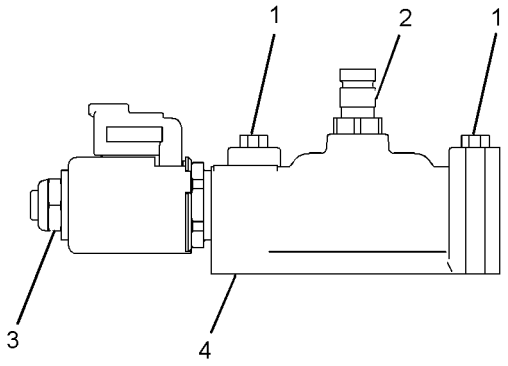


Illustration 5 g01441039

Operating voltage ..... 24 VDC

Coil resistance at 25 °C (77 °F) ..... 8.7 ± 0.4 Ohms

(1) Torque for the two bolts ..... 30 ± 4 N·m (265 ± 35 lb in)

(2) Torque for the quick disconnect coupler ..... 14 ± 4 N·m (125 ± 35 lb in)

(3) Torque for the self-locking nut ..... 13.0 ± 1.5 N·m (115 ± 13 lb in)

(4) Install the 6D-7889 O-Ring Seal for the modulating valve.

i02203412

Relief Valve (Torque Converter Outlet)

SMCS Code: 3133-OL

Part No.: 104-5013

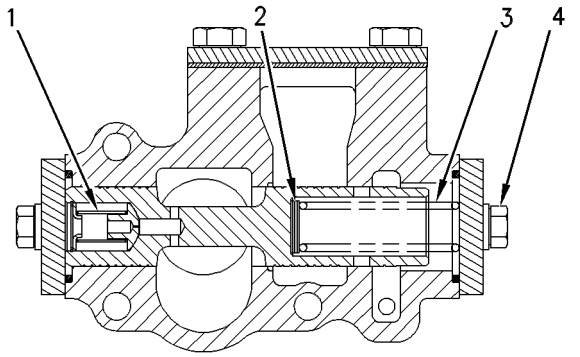


Illustration 6 g00545443

Pressure setting ..... 414 ± 34 kPa (60 ± 5 psi)

(1) 5M-9548 Spring for Poppet Valve

Length under test force ..... 21.3 mm (0.84 inch)
Test force ..... 4 ± 0.4 N (1.0 ± 0.08 lb)
Free length after test ..... 34.0 mm (1.34 inch)
Outside diameter ..... 12.2 mm (0.48 inch)

(2) As required, install the spacers.

5M-9622 Spacer

Spacer thickness ..... 1.6 mm (0.06 inch)
Spacer outside diameter ..... 20.62 ± 0.25 mm (0.812 ± 0.010 inch)
Adding one spacer or removing one spacer will change the outlet pressure by the following amount. ..... 32.6 kPa (4.73 psi)

5M-9623 Spacer

Spacer thickness ..... 0.90 mm (0.035 inch)
Spacer outside diameter ..... 20.62 ± 0.25 mm (0.812 ± 0.010 inch)
Adding one spacer or removing one spacer will change the outlet pressure by the following amount. ..... 18.6 kPa (2.70 psi)

5M-9624 Spacer

Spacer thickness ..... 0.25 mm (0.010 inch)
Spacer outside diameter ..... 20.62 ± 0.25 mm (0.812 ± 0.010 inch)
Adding one spacer or removing one spacer will change the outlet pressure by the following amount. ..... 5.1 kPa (0.74 psi)

(3) 8M-8627 Spring

Length under test force ..... 53.6 mm (2.11 inch)
Test force ..... 395 ± 32 N (88.8 ± 7.1 lb)
Free length after test ..... 79 mm (3.1 inch)
Outside diameter ..... 19.8 mm (0.78 inch)

(4) Torque for bolt ..... 47 ± 9 N·m (35 ± 7 lb ft)

i02431328

Speed Sensor (Torque Converter Output)

SMCS Code: 3141

Part No.: 266-8577

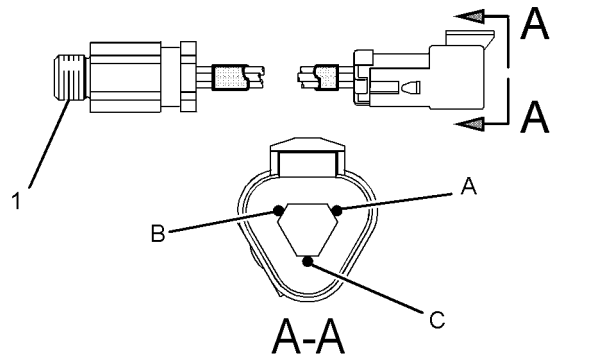


Illustration 7 g01215203

Table 1

Wiring Table		
Pin	Circuit	Color
A	Source Voltage	Orange
B	Ground	Black
C	Signal	White

(1) Torque for the final installation of the sensor ..... 25 ± 5 N·m (18 ± 4 lb ft)

Output frequency ..... 0 to 10 kHz

Duty cycle ..... 45% ± 10%

i02397298

Temperature Sensor (Torque Converter Oil)

SMCS Code: 301T

Part No.: 118-7226

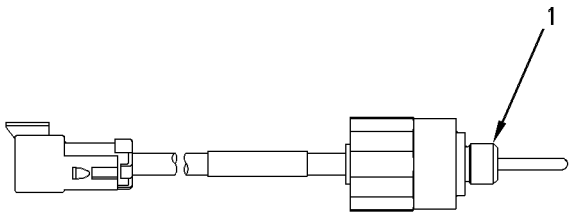


Illustration 8 g00104202

118-7226 Temperature Sensor Gp

(1) Final installation torque for the sensor ..... 20 ± 3 N·m (15 ± 2 lb ft)

Sensor type ..... Temperature

Operating voltage ..... 8 Volts

Output type ..... Pulse Width Modulated

Output frequency ..... 5 kHz

i02397326

Pressure Sensor (Torque Converter Impeller Clutch Oil)

SMCS Code: 1408-PXS; 3101-PXS

Part No.: 100-4311

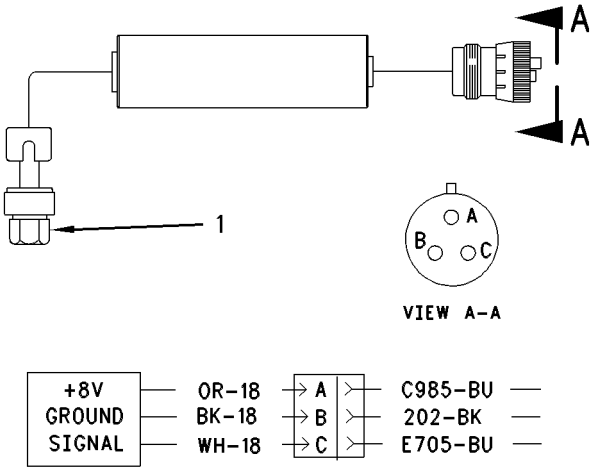


Illustration 9 g00496542

(1) Torque for installation of the sensor ... 10 ± 2 N·m (88 ± 18 lb in)

Operating voltage ..... 8 VDC

Output type ..... Pulse width modulated

Output frequency ..... 5 kHz

i00735020

Transmission Oil Pump

SMCS Code: 3066

Part No.: 6Y-6977

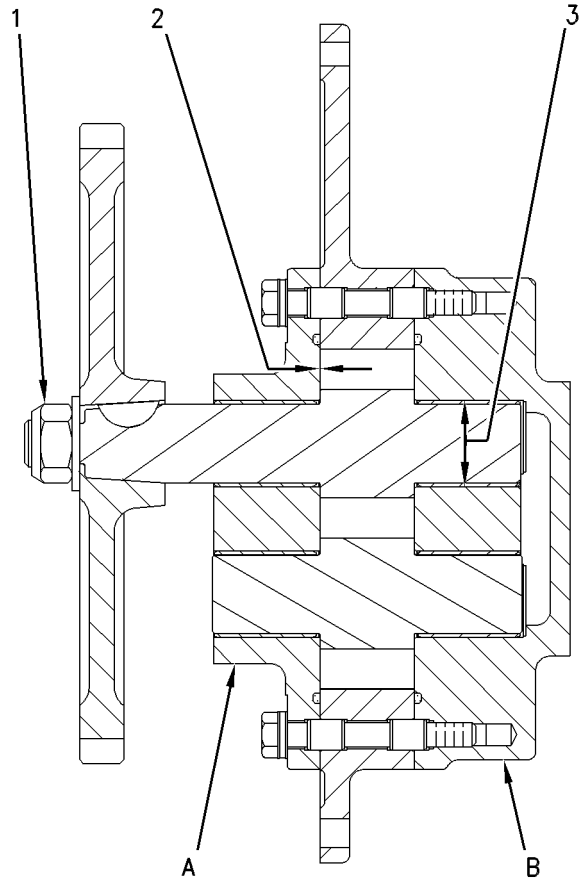


Illustration 10 g00328443

The pump is a one-section gear type pump.

Rotation is counterclockwise when the rotation is viewed from the drive end. For bench testing, use SAE 10W oil that is at 49°C (120°F).

Rotate the pump by hand. The pump must rotate freely.

Pump Output

Minimum output ..... 198 L/min (52 US gpm)
Pump speed ..... 1800 rpm
Pressure ..... 2760 kPa (400 psi)

(1) Torque for the locknut ..... 110 ± 13 N·m (80 ± 10 lb ft)

(2) Clearance between the gears and the covers ..... 0.081 to 0.133 mm (.0032 to .0052 inch)

(3) Bearings and Shafts

Bore of the bearings ..... 31.786 ± 0.008 mm (1.2514 ± .0003 inch)
Diameter of shafts ..... 31.742 ± 0.005 mm (1.2497 ± .0002 inch)

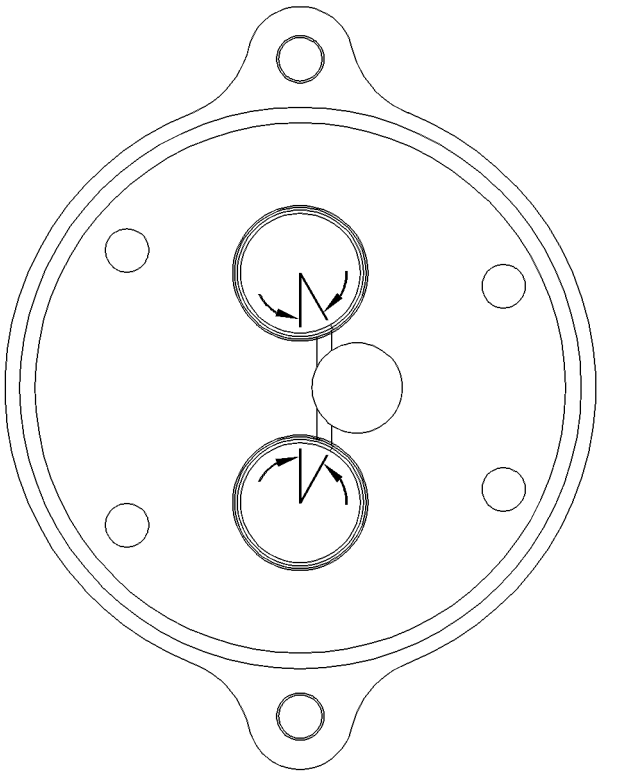
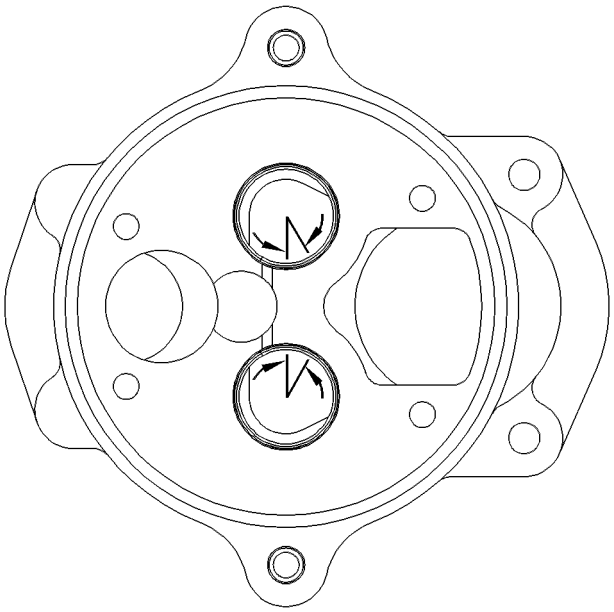


Illustration 11 g00328444

Cover Assembly (A).



g00328445

Illustration 12

Manifold assembly (B).

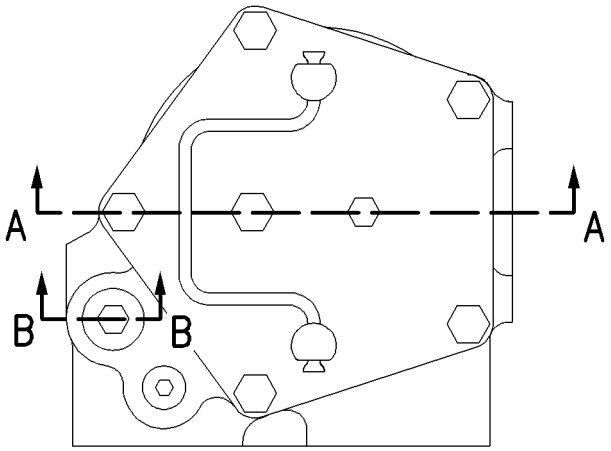
Note: Install the bearings into the bores so that the bearings are 1.5 ± 0.5 mm (.06 ± .02 inch) below the surface. Install the bearings so that the bearing joints are 30 ± 15° from the centerlines of the shafts, as shown.

i02397389

Oil Filter (Power Train)

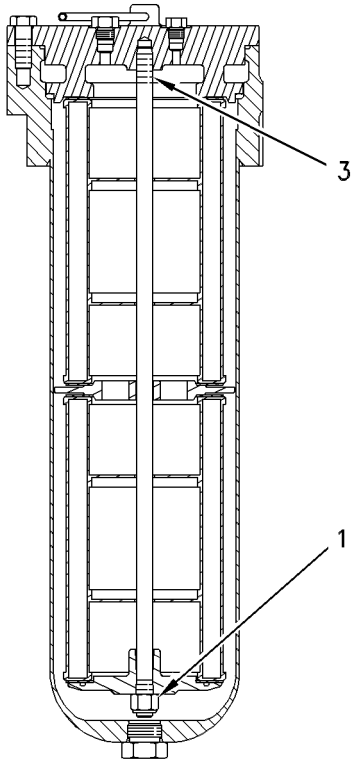
SMCS Code: 1435-BY; 3004; 3067

Part No.: 199-3389



g00103915

Illustration 13



g00103916

Illustration 14

Section A-A

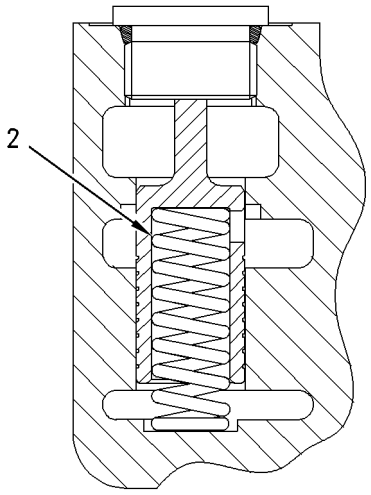


Illustration 15 g00806375

Section B-B

NOTICE
Do not use an air wrench to tighten the housing assembly.

Bypass valve pressure setting ..... 345 ± 21 kPa (50 ± 3 psi)

(1) Torque for the nut ..... 30 ± 5.4 N·m (22 ± 4 lb ft)

(2) 133-2199 Spring

Length under test force .... 46.11 mm (1.815 inch)
Test force ..... 107.4 ± 5.3 N (24 ± 1 lb)
Free length after test ..... 62.5 mm (2.461 inch)
Outside diameter ..... 15.24 mm (0.600 inch)

Bypass Switch (Power Train Oil Filter)

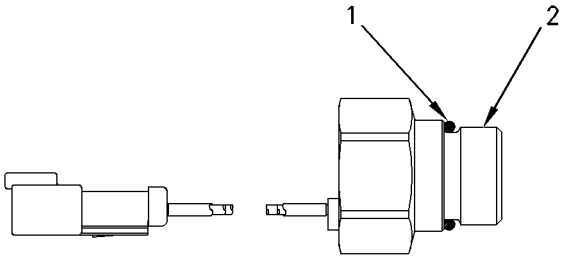


Illustration 16 g00622392

(1) Prior to assembly, lubricate the O-ring seal with a small amount of the lubricant that is being sealed.

(2) Final installation torque ..... 80 ± 10 N·m (59 ± 7 lb ft)

i02397929

Pinout Specifications for Electronic Control (Power Train)

SMCS Code: 4808; 7610-DTN

Part No.: 172-9389

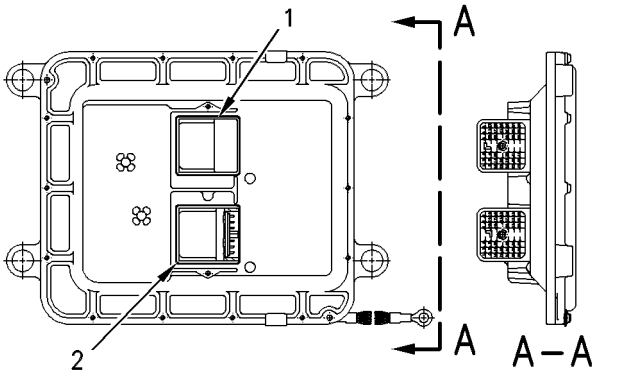


Illustration 17 g00550716

Electronic Control Module

(1) Connector J1. (2) Connector J2.

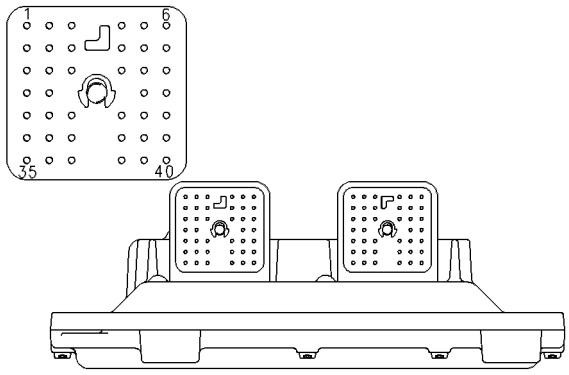


Illustration 18 g00291780

Table 2

40-Pin Connector J1	
Connector Pin(1)	**Function**
1	+ 24 Volt ECM (Electronic Control Module) Supply (Key ON)
2	Ground
3	CAT Data Link −
4	Axle Oil Cooler Fan Solenoid
5	Ground

(continued)

(Table 2, contd)

40-Pin Connector J1	
Connector Pin[1]	**Function**
6	+ 24 Volt ECM (Electronic Control Module) Supply (Key ON)
7	Solenoid Return
8	Start Relay
9	CAT Data Link +
10	Autolube Solenoid
11	Number 2 Clutch Solenoid (Forward)
13	Direction Switch (Neutral)
14	Direction Switch (Reverse)
15	Torque Converter Output Speed Return
16	Switch and Sensor Ground
17	Number 1 Clutch Solenoid (Reverse)
18	Ride Control Solenoid
19	Upshift Switch (N.C.)
20	Steering and Transmission Lock Switch 1 (N.O.)
21	Ride Control Switch (N.C.)
22	Ride Control Switch (N.O.)
23	Upshift Switch (N.O.)
24	Steering and Transmission Lock Switch 2 (N.C.)
25	Downshift Switch 1 (N.C.)
26	Downshift Switch 2 (N.O.)
27	Parking Brake Cab Switch (N.C.)
28	Autolube Manual Lube Switch
29	Reduced Rimpull Switch 3
30	Direction Switch (Forward)
31	Reduced Rimpull Switch 4
32	Torque Converter Lockup Switch
33	Reduced Rimpull Switch 2
34	Reduced/Maximum Rimpull Switch
35	Reduced Rimpull Switch 1
36	Parking Brake Cab Switch (N.O.)
37	Parking Brake Pressure Switch 1 (N.C.)
38	Quickshift Enable Switch (N.C.)
39	Parking Brake Pressure Switch 2 (N.O.)
40	Key Start Switch To Battery +

(1) The connector contacts that are not listed are not used.

Table 3

40-Pin Connector J2	
Connector Pin[1]	**Function**
1	Number 4 Clutch Solenoid Second Speed
3	Solenoid Return
4	Left Pedal Sensor
6	Impeller Clutch Pressure Sensor
7	Number 3 Clutch Solenoid Third Speed
8	Number 5 Clutch Solenoid First Speed
9	Sensor Supply +10V
10	Quickshift Enable Switch (N.O.)
11	Autolube Grease Pressure Sensor
12	Sensor Power Supply +8V
13	Lockup Clutch Solenoid
18	Autolube Grease Level Switch
19	Impeller Clutch Solenoid
22	Autolube Indicator LED
23	Engine Speed Sensor
24	Transmission Speed Sensor Return
28	Reduced Rimpull Indicator LED
29	Engine Speed Sensor Return
35	Transmission Speed Sensor
37	Backup Alarm
38	Torque Converter Output Speed Sensor
40	Primary Steering Pressure Warning LED

(1) The connector contacts that are not listed are not used.

i02659801

STIC Control

SMCS Code: 3033; 3034

Part No.: 4E-8413

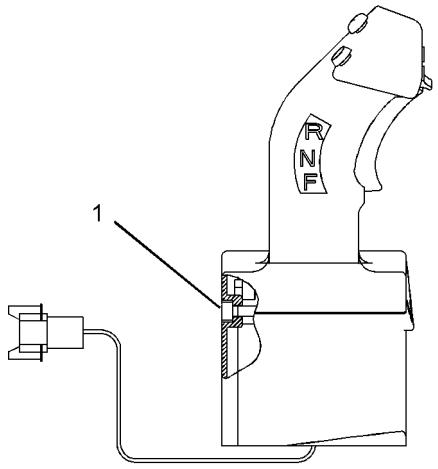


Illustration 19 g01127328

(1) Torque for the four bolts .. 6 ± 1 N·m (55 ± 9 lb in)

STIC Lockout Control

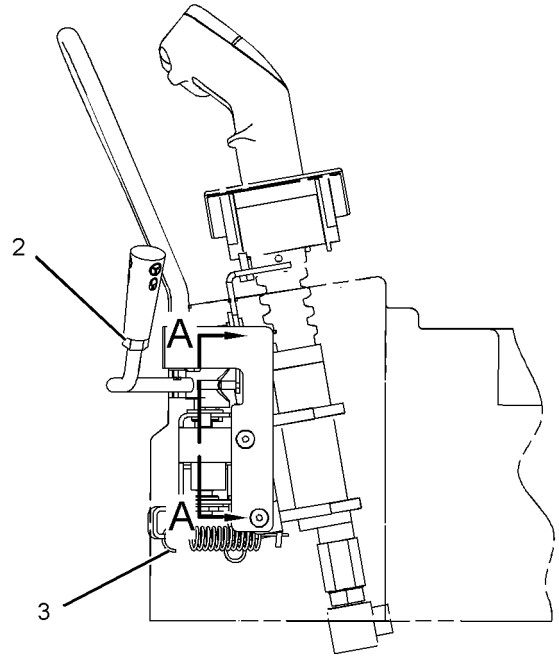


Illustration 20 g01346195
Left Side View

(2) Apply 155-0695 Thread Lock Compound to the threads.

(3) 8C-3442 Coil Spring

Length under test force ..... 57.9 mm (2.28 inch)
Test force ..... 71.2 ± 5.8 N (16.00 ± 1.30 lb)
Free length after test ..... 50.3 mm (1.98 inch)
Outside diameter ..... 17.48 ± 0.25 mm (0.688 ± 0.010 inch)

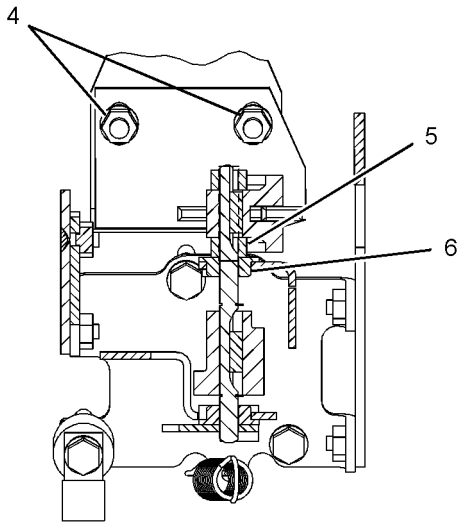


Illustration 21 g01127330
View A-A

(4) Torque for the two nuts .. 15 ± 3 N·m (11 ± 2 lb ft)

Note: Be sure that there is no space between bearing (6) and nut (5).

Limit Switch (STIC Lockout Control)

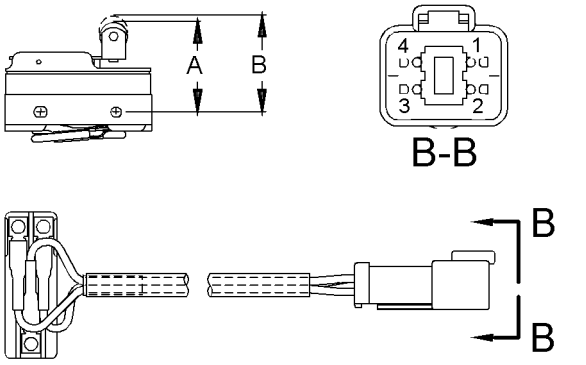


Illustration 22 g01346209

Maximum actuating force ..... 1.7 N (0.4 lb)

Minimum force for overtravel .... 2.39 N·m (21.2 lb in)

(A) Operating position ..... 30.18 ± 0.38 mm (1.188 ± 0.015 inch)

Contact (2) and contact (1) are closed when the switch is in the operating position.

(B) Free position ..... 32.16 ± 0.38 mm (1.266 ± 0.015 inch)

Contact (2) and contact (4) are closed when the switch is in the free position.

Temperature range ..... −40 °C to 85 °C (−40 °F to 185 °F)

i01644257

Transmission Hydraulic Control

SMCS Code: 3073

Part No.: 8E-6392

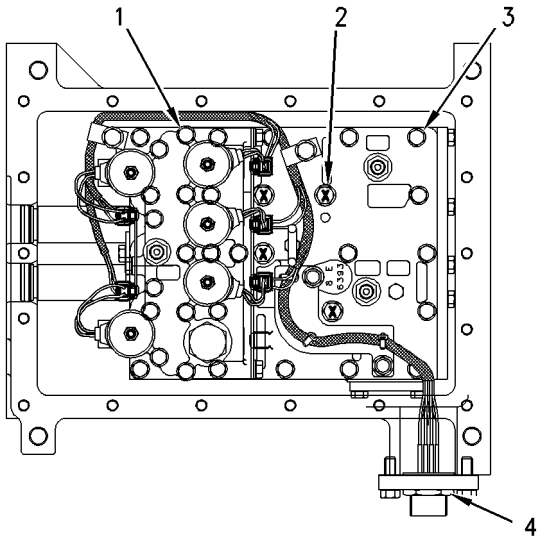


Illustration 23 g00856739

(1) Torque for the 10 bolts ..... 30 ± 4 N·m (265 ± 35 lb in)

(2) Torque for the four bolts fastening the valve group to the planetary housing. The four bolts are marked with an X. .... 48 ± 4 N·m (425 ± 35 lb in)

(3) Torque for the 21 bolts ..... 30 ± 4 N·m (265 ± 35 lb in)

(4) Torque for the nut ..... 9 ± 1 N·m (80 ± 9 lb in)

i02398593

Transmission Control Valve

SMCS Code: 3073

Part No.: 8E-6393

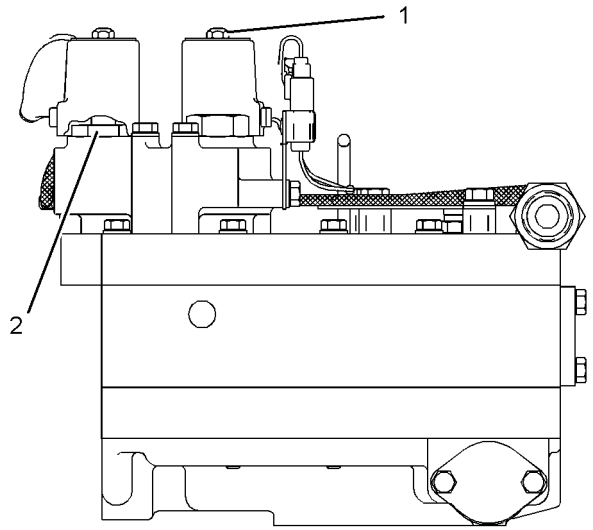


Illustration 24 g01197903

(1) Torque for the five locknuts ..... 9.0 ± 0.5 N·m (80 ± 4 lb in)

(2) Torque for the five cartridge assemblies ..... 50 ± 5 N·m (37 ± 4 lb ft)

i01643949

Selector and Pressure Control Valve (Transmission)

SMCS Code: 3073-QV

Part No.: 106-0550

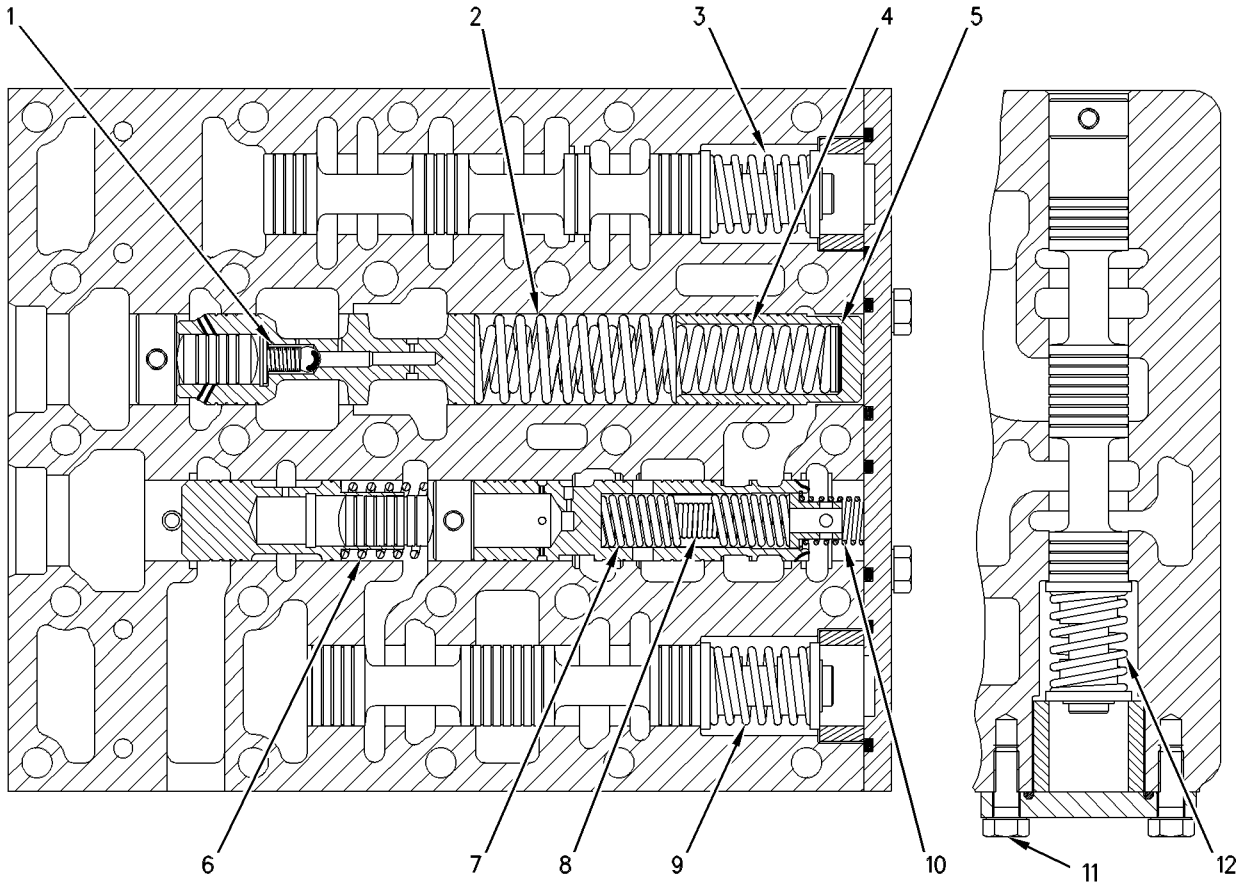


Illustration 25

g00103261

(1) 4M-2381 Spring

Length under test force ..... 12.2 mm (.48 inch)
Test force ..... 2.30 ± 0.18 N (.517 ± .041 lb)
Free length after test ..... 22.6 mm (.89 inch)
Outside diameter ..... 7.62 mm (.300 inch)

(2) 7G-4842 Spring (outside)

Identification marks ..... two red stripes
Length under test force ..... 36.3 mm (1.43 inch)
Test force ..... 175 ± 6 N (39 ± 1.3 lb)
Free length after test ..... 68.45 mm (2.695 inch)
Outside diameter ..... 27.79 mm (1.094 inch)

(3), (9), (12) 6I-9519 Spring

Length under test force ..... 31.3 mm (1.23 inch)
Test force ..... 64.5 ± 3.2 N (14.50 ± .72 lb)
Free length after test ..... 47.18 mm (1.857 inch)
Outside diameter ..... 24.5 mm (.965 inch)

(4) 9P-3041 Spring (inside)

Identification marks ..... two red stripes
Length under test force ..... 85.5 mm (3.37 inch)
Test force ..... 313 ± 11 N (70 ± 2.5 lb)
Free length after test .... 117.40 mm (4.622 inch)
Outside diameter ..... 21.21 mm (.835 inch)

(5) Spacers

5M-9622 Spacer

Thickness of one spacer .... 1.60 mm (.063 inch)
Outside diameter of spacer .... 20.62 ± 0.25 mm (.812 ± .010 inch)

Pressure changes by adding or removing one spacer approximately ..... 98 kPa (14 psi)

5M-9623 Spacer

Thickness of one spacer .... 0.90 mm (.035 inch)
Outside diameter of spacer .... 20.62 ± 0.25 mm (.812 ± .010 inch)
Pressure changes by adding or removing one spacer approximately ..... 57 kPa (8 psi)

5M-9624 Spacer

Thickness of one spacer .... 0.25 mm (.010 inch)
Outside diameter of spacer .... 20.62 ± 0.25 mm (.812 ± .010 inch)
Pressure changes by adding or removing one spacer approximately ..... 16 kPa (2 psi)

(6) 6P-4978 Spring

Length under test force .. 27.15 mm (1.069 inch)
Test force ..... 67 ± 3.4 N (15.1 ± .76 lb)
Free length after test ..... 38.10 mm (1.500 inch)
Outside diameter ..... 24.61 mm (.969 inch)

(7) 6P-9784 Spring (outside)

Identification marks ..... one yellow stripe
Length under test force .. 56.39 mm (2.220 inch)
Test force ..... 130 ± 6.5 N (29.2 ± 1.50 lb)
Free length after test ..... 88.60 mm (3.488 inch)
Outside diameter ..... 16.26 mm (.640 inch)

(8) 6P-9783 Spring (inside)

Identification marks ..... one yellow stripe
Length under test force .. 56.39 mm (2.220 inch)
Test force ..... 62 ± 3 N (13.9 ± .7 lb)
Free length after test ..... 88.60 mm (3.488 inch)
Outside diameter ..... 11.02 mm (.434 inch)

(10) 6P-9785 Spring

Identification marks ..... one yellow stripe
Length under test force .... 19.48 mm (.767 inch)
Test force ..... 23.5 ± 1.2 N (5.28 ± .27 lb)
Free length after test ..... 32.00 mm (1.260 inch)
Outside diameter ..... 13.51 mm (.532 inch)

(11) Torque for two bolts .... 30 ± 7 N·m (22 ± 5 lb ft)

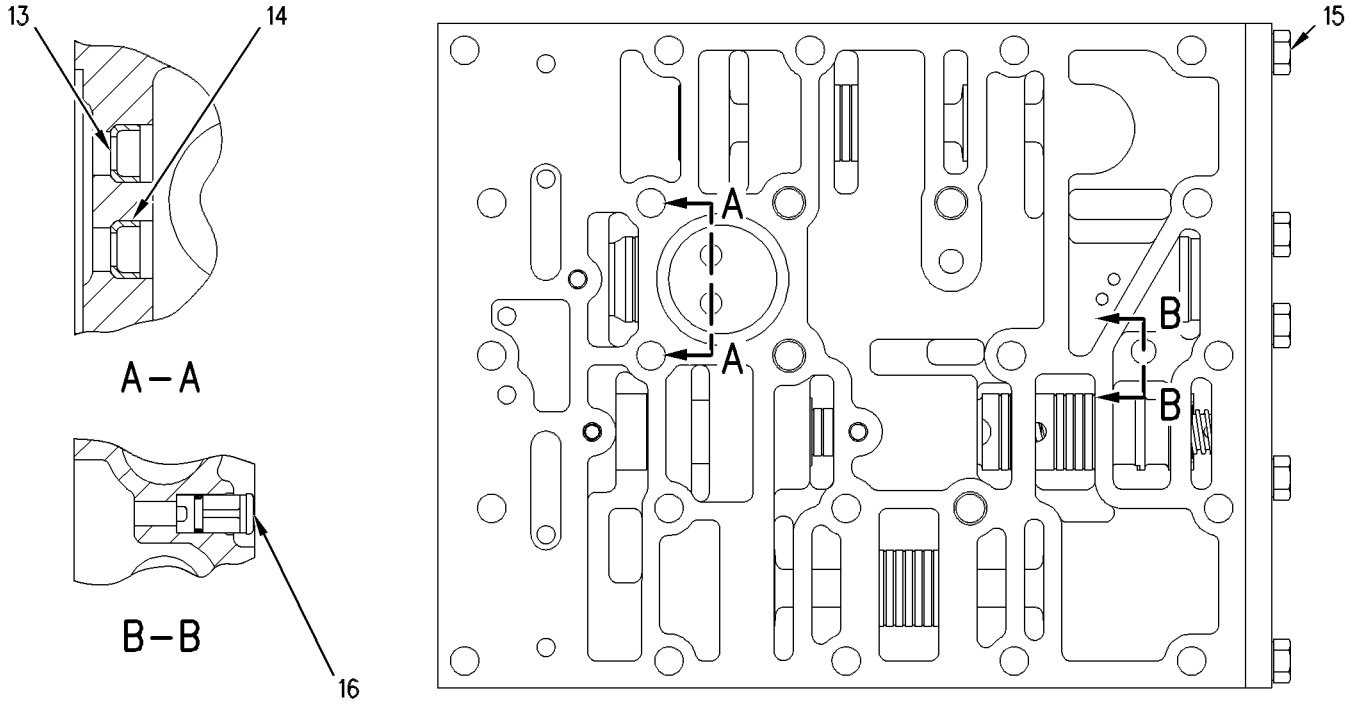


Illustration 26 g00334138

(13), (14) Install the orifices into position, as shown.

(15) Torque for five bolts .... 30 ± 7 N·m (22 ± 5 lb ft)

(16) Install the orifice with the screen outward.

i02715561

Solenoid Valve (Transmission Clutch)

SMCS Code: 3174

Part No.: 147-5399

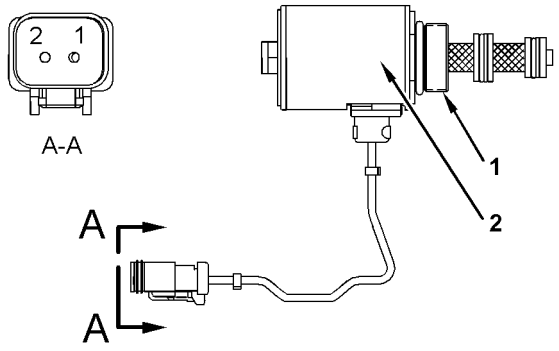


Illustration 27 g01048013

(1) 107-8611 Cartridge As

Final installation torque for the cartridge assembly ..... 50 ± 5 N·m (37 ± 4 lb ft)
Final installation torque for the locknut that retains the coil ..... 9 ± 0.5 N·m (80 ± 4 lb in)
Flow of SAE 10 oil at 200 kPa (30 psi) pressure drop and 121 °C (250 °F) ..... 3.5 L/min (0.9 US gpm)
Maximum pressure rating ..... 4138 kPa (600 psi)

(2) 218-9901 Coil

Nominal coil voltage ..... 12 VDC
Maximum coil voltage ..... 14.5 VDC

Current

Nominal current draw at 25 °C (77 °F) winding temperature ..... 1.47 Amperes
Maximum current draw at −40 °C (−40 °F) winding temperature ..... 2.4 Amperes

Resistance

Nominal coil resistance at 25 ± 5 °C (77 ± 41 °F) ..... 8.15 ± 0.6 Ohms
Maximum coil resistance at 121 °C (250 °F) ..... 13.3 Ohms
Minimum coil resistance at −40 °C (−40 °F) ..... 6 Ohms

i03929869

Speed Sensor (Transmission Output)

SMCS Code: 3175

Part No.: 193-2550

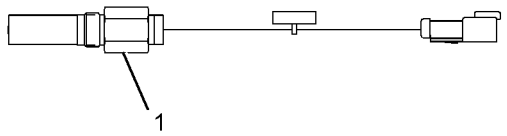


Illustration 28 g01404945

(1) Final installation torque for the speed sensor group ..... 25 ± 5 N·m (221 ± 44 lb in)

Operating temperature ..... −40 to 120 °C (−40 to 248 °F)

i02399797

Transmission Planetary

SMCS Code: 3160

Part No.: 239-7154

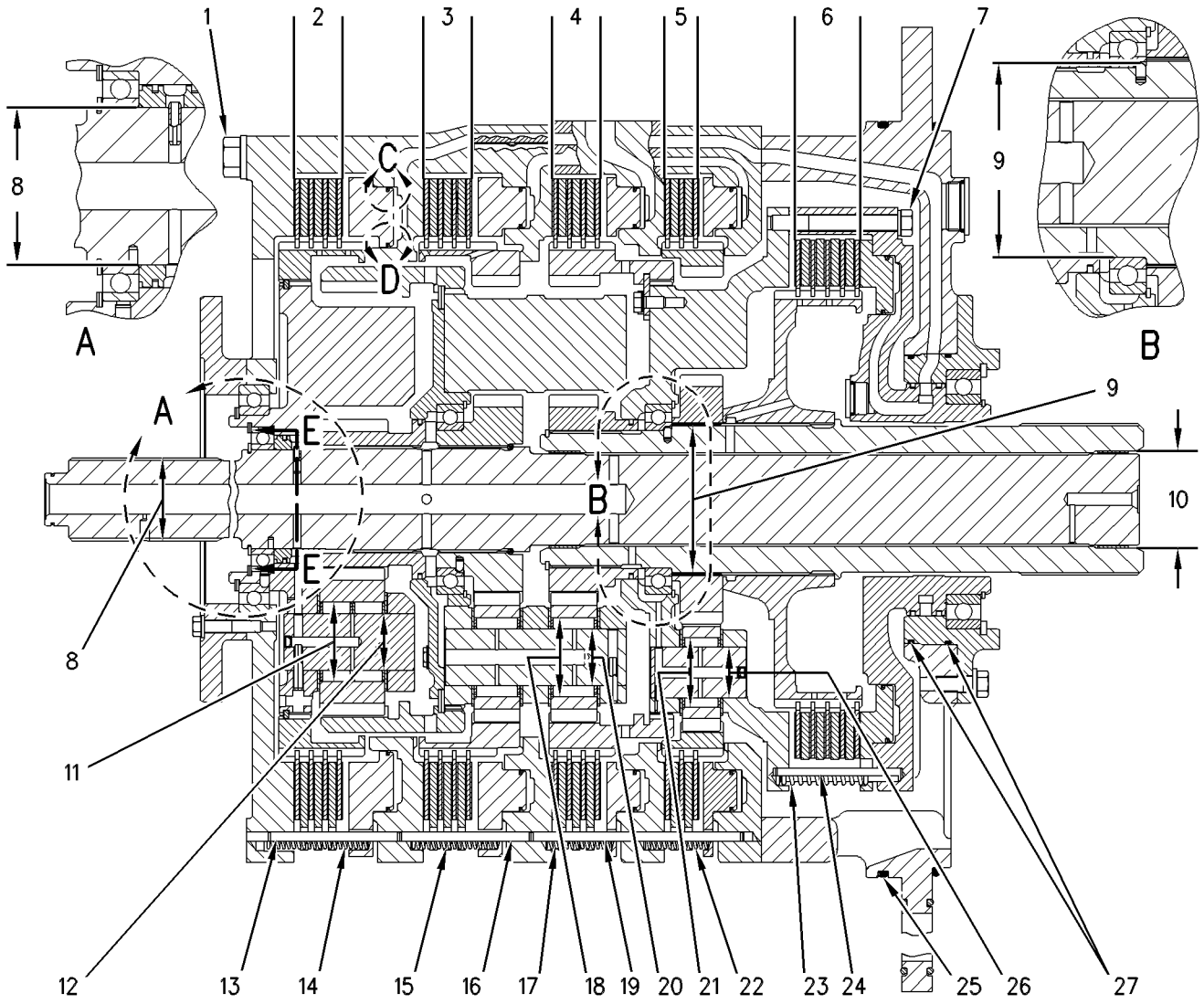


Illustration 29 g00336659

(1) Torque for the 17 bolts ..... 410 ± 50 N·m (300 ± 35 lb ft)

(2) Number 1 Clutch

Thickness of four new disc assemblies and three new clutch plates for the number 3 clutch ..... 41.41 ± 0.56 mm (1.630 ± 0.022 inch)
Thickness of one new 8E-0985 Clutch Disc ..... 5.59 ± 0.08 mm (0.220 ± 0.003 inch)
Thickness of one new 3P-7584 Plate ..... 6.35 ± 0.08 mm (0.250 ± 0.003 inch)

(3) Number 2 Clutch

Thickness of four new disc assemblies and three new clutch plates for the number 3 clutch ..... 41.41 ± 0.56 mm (1.630 ± 0.022 inch)
Thickness of one new 8E-0985 Clutch Disc ..... 5.59 ± 0.08 mm (0.220 ± 0.003 inch)
Thickness of one new 3P-7584 Plate ..... 6.35 ± 0.08 mm (0.250 ± 0.003 inch)

(4) Number 3 Clutch

Thickness of four new disc assemblies and three new clutch plates for the number 3 clutch ..... 41.41 ± 0.56 mm (1.630 ± 0.022 inch)

Thickness of one new 8E-0985 Clutch Disc ..... 5.59 ± 0.08 mm (0.220 ± 0.003 inch)
Thickness of one new 3P-7584 Plate ..... 6.35 ± 0.08 mm (0.250 ± 0.003 inch)

(5) Number 4 Clutch

Thickness of three new disc assemblies and two new clutch plates for the number 4 clutch ..... 29.47 ± 0.40 mm (1.160 ± 0.016 inch)
Thickness of one new 8E-0985 Clutch Disc ..... 5.59 ± 0.08 mm (0.220 ± 0.003 inch)
Thickness of one new 3P-7584 Plate ..... 6.35 ± 0.08 mm (0.250 ± 0.003 inch)

(6) Number 5 Clutch

Thickness of five new disc assemblies and four new clutch plates for the number 5 clutch ..... 54.72 ± 0.72 mm (2.154 ± 0.028 inch)
Thickness of one new 173-3270 Friction Disc ..... 5.59 ± 0.08 mm (0.220 ± 0.003 inch)
Thickness of one new 3P-7447 Plate ..... 6.73 ± 0.08 mm (0.265 ± 0.003 inch)

(7) Torque for the 12 bolts ..... 115 ± 7 N·m (85 ± 5 lb ft)

(8) Installation dimension of the dowel in the shaft ..... 84.33 ± 0.13 mm (3.320 ± 0.005 inch)

(9) Installation dimension of the dowel in the shaft ..... 117.15 ± 0.13 mm (4.612 ± 0.005 inch)

(10) Clearance between the bearing and the shaft at both ends ..... 0.193 ± 0.038 mm (0.0076 ± 0.0015 inch)

(11) Inside diameter of a new planetary gear for the number 1 clutch ..... 66.274 ± 0.010 mm (2.6092 ± 0.0004 inch)

(12) Diameter of new planetary gear shaft ..... 47.193 ± 0.008 mm (1.8580 ± 0.0003 inch)

(13), (16) 2S-8924 Pin

Quantity 12
Length ..... 109.52 mm (4.312 inch)
Outside diameter ..... 15.812 ± 0.013 mm (0.6225 ± 0.0005 inch)

(14), (15) 4M-5016 Spring

Quantity 24
Length under test force .. 68.07 mm (2.680 inch)
Test force ..... 124 ± 8.9 N (27.88 ± 2.00 lb)
Free length after test ..... 83.3 mm (3.28 inch)
Outside diameter ..... 14.30 mm (0.563 inch)

(17), (22) 9H-5537 Spring

Quantity 24
Length under test force ..... 46.7 mm (1.84 inch)
Test force ..... 127.9 ± 10.2 N (28.75 ± 2.30 lb)
Free length after test ..... 62.7 mm (2.47 inch)
Outside diameter ..... 14.30 mm (0.563 inch)

(18) Inside diameter of new planetary gears for the number 2 clutch and the number 3 clutch ..... 66.274 ± 0.010 mm (2.6092 ± 0.0004 inch)

(19) 3P-7576 Dowel

Quantity 6
Length ..... 176.00 mm (6.930 inch)
Outside diameter ..... 15.812 ± 0.012 mm (0.6225 ± 0.0005 inch)

(20) Diameter of new planetary gear shaft ..... 47.193 ± 0.008 mm (1.8580 ± 0.0003 inch)

(21) Inside diameter of new planetary gear ..... 58.298 ± 0.010 mm (2.2952 ± 0.0004 inch)

(23) 3P-7566 Spring

Quantity 12
Length under test force ..... 74.4 mm (2.93 inch)
Test force ..... 305 ± 16 N (68.6 ± 3.6 lb)
Free length after test ..... 86.1 mm (3.39 inch)
Outside diameter ..... 16.36 mm (0.644 inch)

(24) 1B-2524 Pin

Quantity 12
Length ..... 102 mm (4.0 inch)
Outside diameter ..... 9.53 mm (0.375 inch)

(25) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

(26) Diameter of new planetary gear shaft ..... 42.400 ± 0.006 mm (1.6693 ± 0.0002 inch)

(27) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

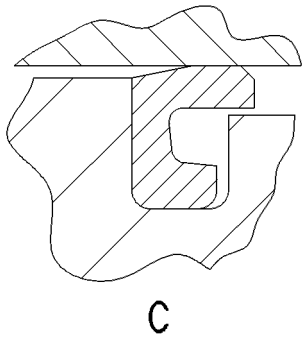
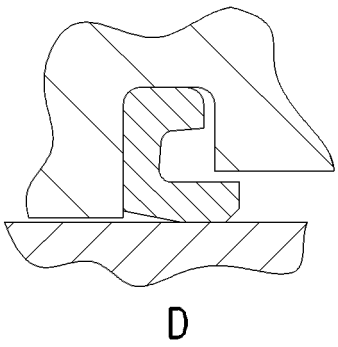
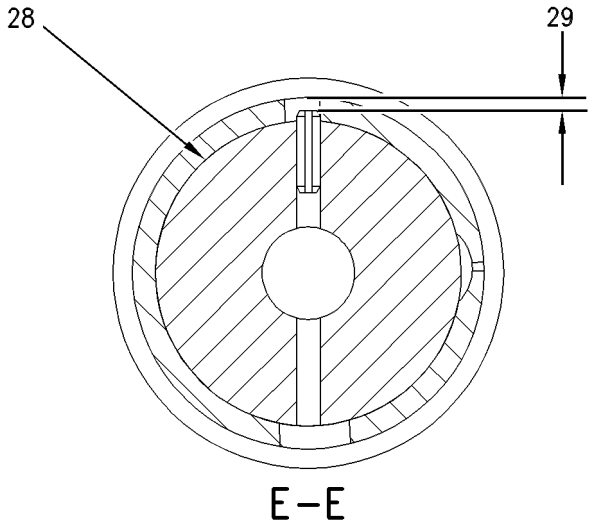


Illustration 30 g00336660
Detail C



g00336662

Illustration 31
Detail D



g00336664

Illustration 32
Section E-E

(28) Apply 4C-4032 Bearing Mount Compound to the ring carrier prior to assembly.

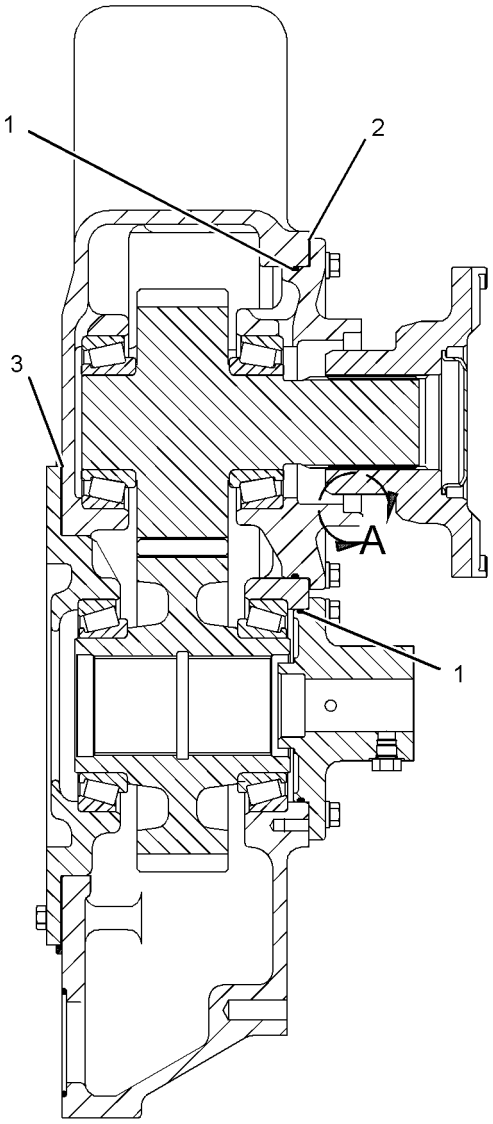
(29) Make sure that the spring pin is 3.5 ± 0.5 mm (0.14 ± 0.02 inch) below the inside diameter of the ring carrier after installation.

i04375174

Input Transfer Gears

SMCS Code: 3159-IV

Part No.: 239-7155



g01198707

Illustration 33

(1) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

(2) 8E-7132 Shim Pack

Total thickness of the shim pack ..... 2.1 mm (0.083 inch)
Thickness of six shims ..... 1.80 mm (0.071 inch)
Thickness of six shims ..... 0.30 mm (0.012 inch)

Use shims in order to provide desired minimum end play of 0.152 mm (0.006 inch) and maximum end play of 0.203 mm (0.008 inch) on the upper gear, as required.

(3) 128-1546 Shim Pack

Total thickness of the shim pack ..... 2.025 mm (0.08 inch)
Thickness of five shims ..... 0.635 mm (0.0250 inch)
Thickness of five shims .... 0.89 mm (0.035 inch)
Thickness of one shim ..... 0.50 mm (0.020 inch)

Use shims in order to provide desired minimum end play of 0.152 mm (0.006 inch) and maximum end play of 0.203 mm (0.008 inch) on the lower gear, as required.

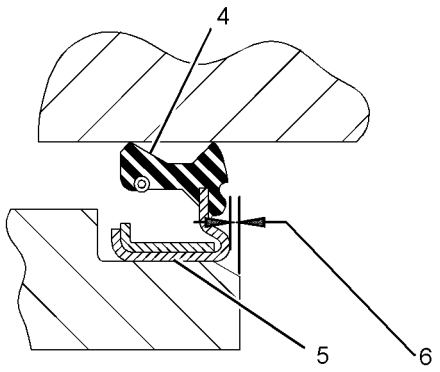


Illustration 34 g01198719

Detail A

(4) Lubricate the seal lip with a minimal amount of the lubricant that is being sealed.

(5) Apply 5P-3413 Pipe Sealant to the lip seal prior to installation.

(6) Install the lip seal to a depth of 1.0 ± 0.1 mm (0.04 ± 0.004 inch) below the face of the cage.

i02400107

Output Transfer Gears

SMCS Code: 3159-OJ

Part No.: 239-7156

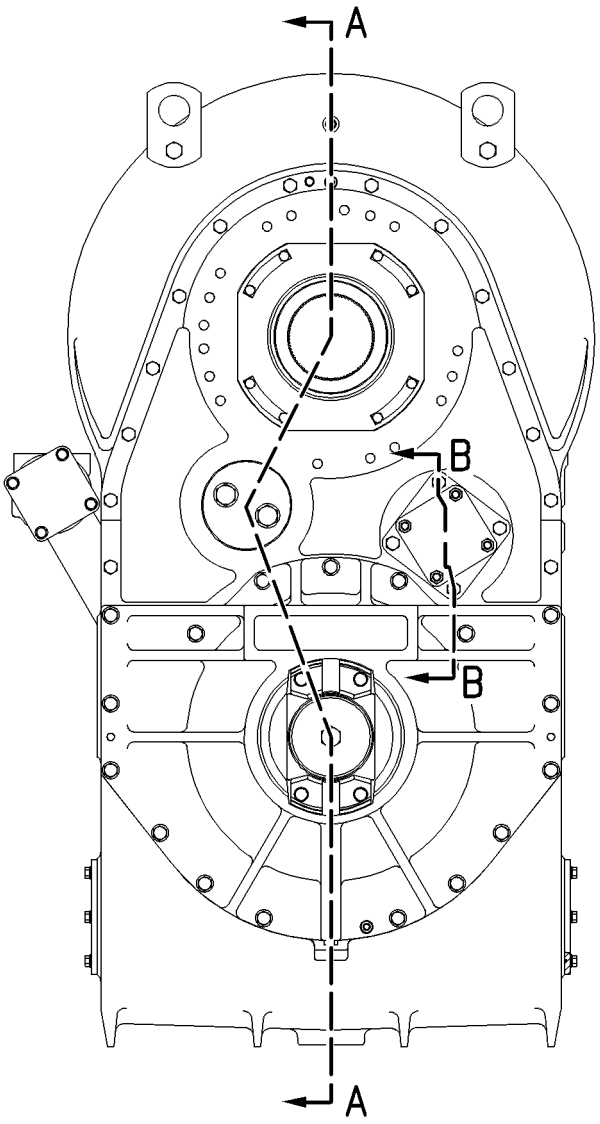


Illustration 35 g00337498

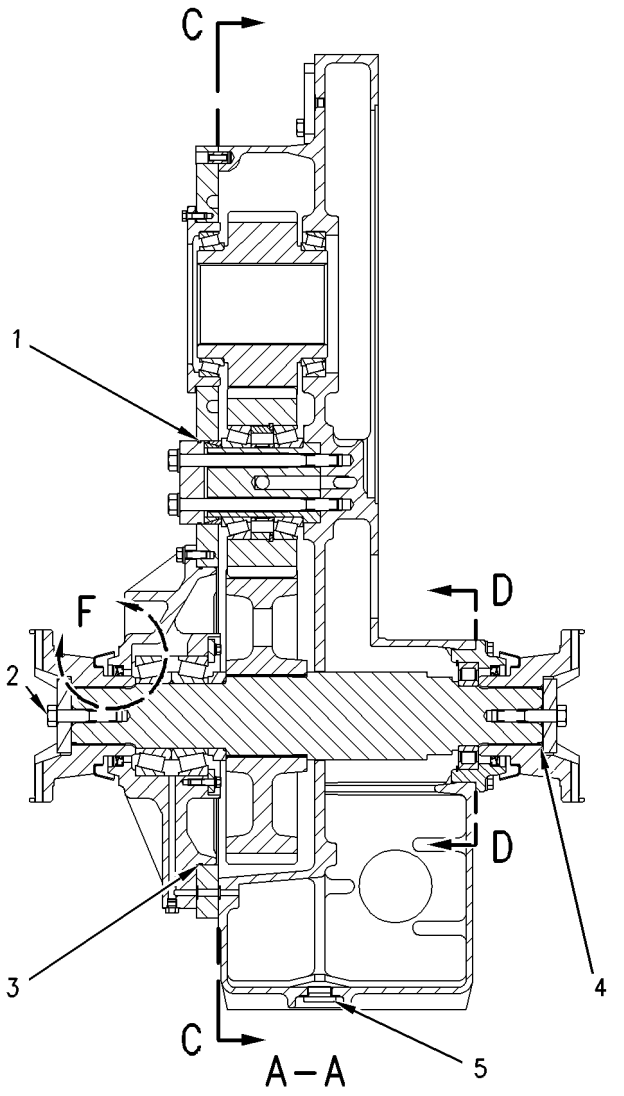


Illustration 36 g00851361
Section A-A

(1) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

(2) Torque for the two bolts ..... 475 ± 50 N·m (350 ± 37 lb ft)

(3) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

(4) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

(5) Torque for the drain assembly ..... 100 ± 10 N·m (75 ± 7 lb ft)

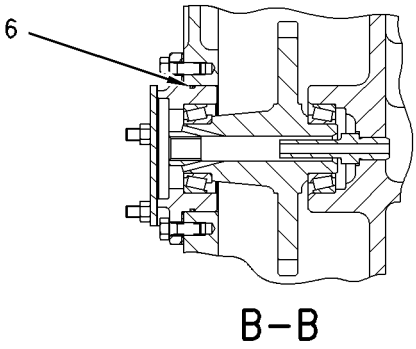


Illustration 37 g00851369
Section B-B

(6) Lubricate the bore with a minimal amount of the lubricant that is being sealed.

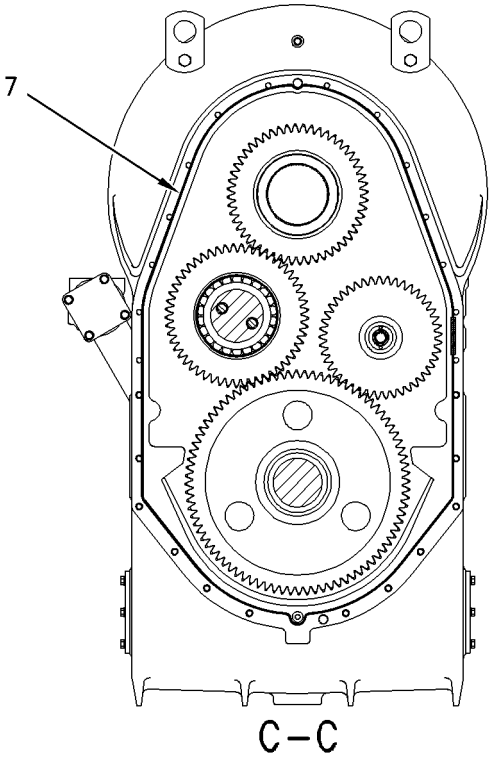


Illustration 38 g00851370
Section C-C

(7) Apply a continuous 3.0 mm (.12 inch) bead of 6V-5765 Sealant to the case before the cover is installed.

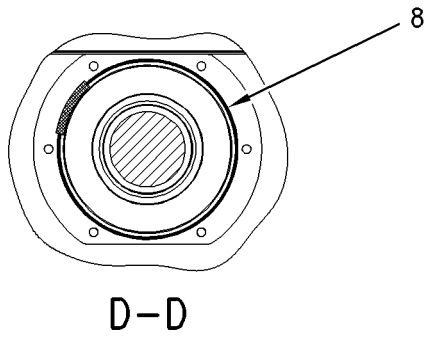


Illustration 39 g00851373
Section D-D

(8) Apply a continuous 3.0 mm (0.12 inch) bead of 6V-5765 Sealant to the case before the cage is installed.

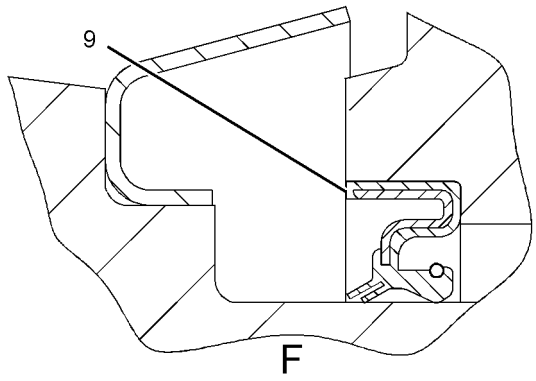


Illustration 40 g01198836
Detail F

(9) Install the lip seal so that the seal is flush with the face of the bearing cage.

i02400199

Input Drive Shaft

SMCS Code: 3253-IV

Part No.: 232-6627

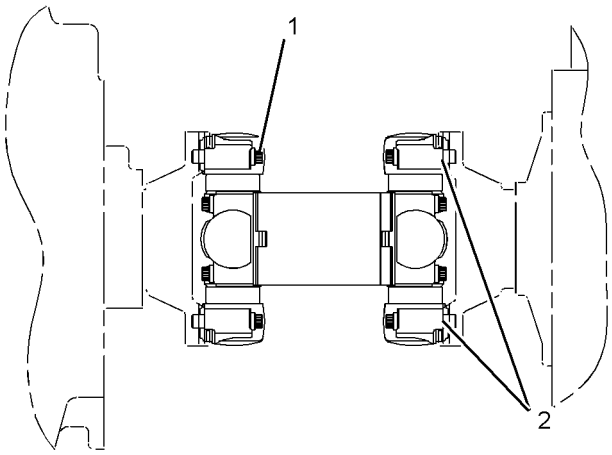


Illustration 41 g01198878

(1) Torque for eight bolts ..... 150 ± 15 N·m (110 ± 11 lb ft)

(2) Prior to assembly, wipe the face of the bearing cap and the face of the yoke. Make sure that both of the mounting faces are clean.

i02524930

Drive Shaft

SMCS Code: 3253

Part No.: 8R-5452

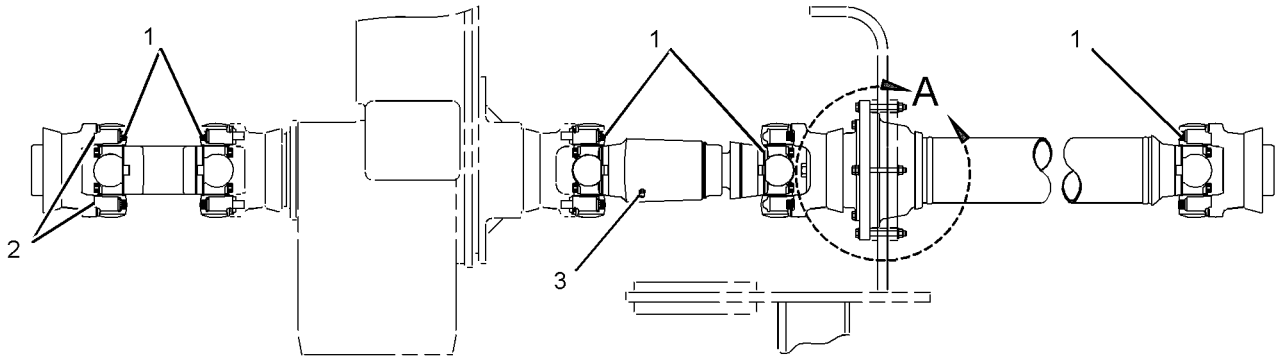


Illustration 42 g01199056

(1) Torque for twenty bolts ..... 530 ± 70 N·m (400 ± 50 lb ft)

(2) Prior to assembly, wipe the face of the bearing cap and the face of the yoke. Make sure that both of the mounting faces are clean.

(3) Lubricate the spline when the machine is fully articulated. Use molybdenum grease to lubricate the spline.

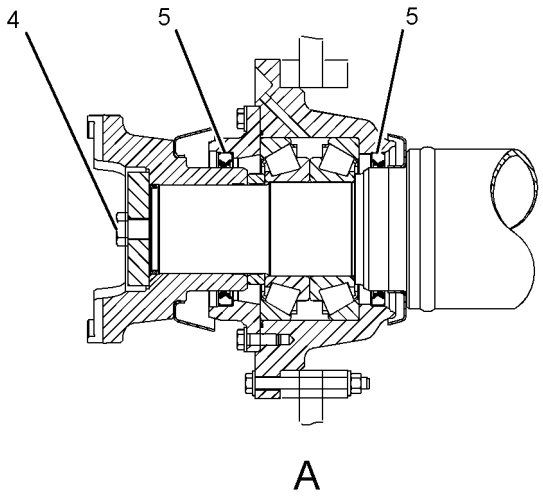


Illustration 43 g01199066

Detail A

(4) Torque for the bolt .. 570 ± 80 N·m (420 ± 60 lb ft)

(5) Lubricate the seal lip with a minimal amount of lithium grease prior to assembly.

i02682609

Differential and Bevel Gear

SMCS Code: 3256; 3258

Part No.: 121-4658

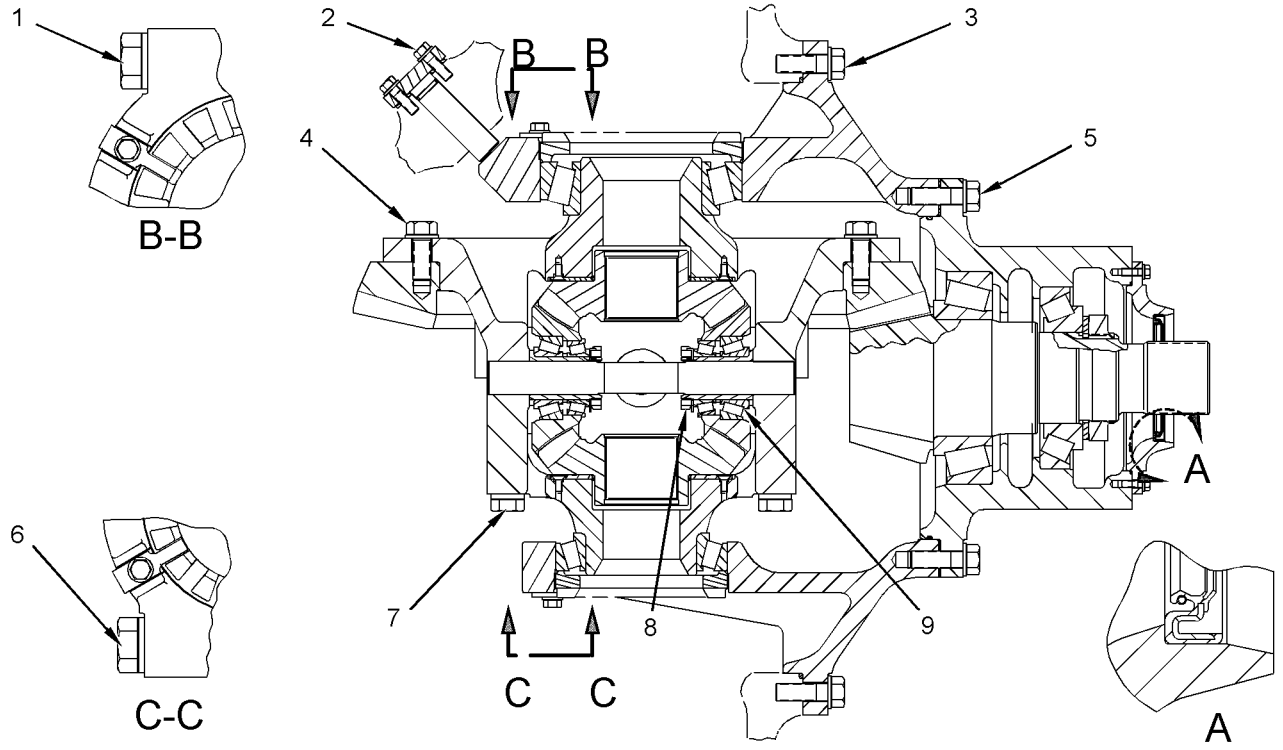


Illustration 44 g01347617

(1) Torque for the bolts that fasten the bearing caps to the carrier assembly ..... 1825 ± 175 N·m (1350 ± 130 lb ft)

(2) Torque for the four bolts that fasten the cover to the axle housing ... 135 ± 20 N·m (100 ± 15 lb ft)

(3) Torque for the 36 bolts that fasten the carrier assembly to the axle housing ..... 750 ± 90 N·m (550 ± 65 lb ft)

(4) Torque for the 36 bolts that fasten the bevel gear to the carrier assembly ..... 750 ± 90 N·m (550 ± 65 lb ft)

(5) Torque for the 20 bolts that fasten the pinion housing to the carrier assembly .... 750 ± 90 N·m (550 ± 65 lb ft)

(6) Torque for the bolts that fasten the bearing caps to the carrier assembly ..... 1825 ± 175 N·m (1350 ± 130 lb ft)

(7) Torque the eight bolts that fasten the upper differential case to the lower differential case in an alternating sequence to 460 ± 70 N·m (340 ± 50 lb ft) and then turn each bolt by an additional 180 ± 10 degrees in an alternating sequence.

(8) Rotate 4D-7534 Roller Bearing Assembly (9) in order to ensure proper seating of rollers. Tighten the four 2F-9064 Nuts (8) to the following torque 70 ± 15 N·m (52 ± 11 lb ft).

i02400809

Fixed Axle (Front)

SMCS Code: 3278

Part No.: 8R-5471

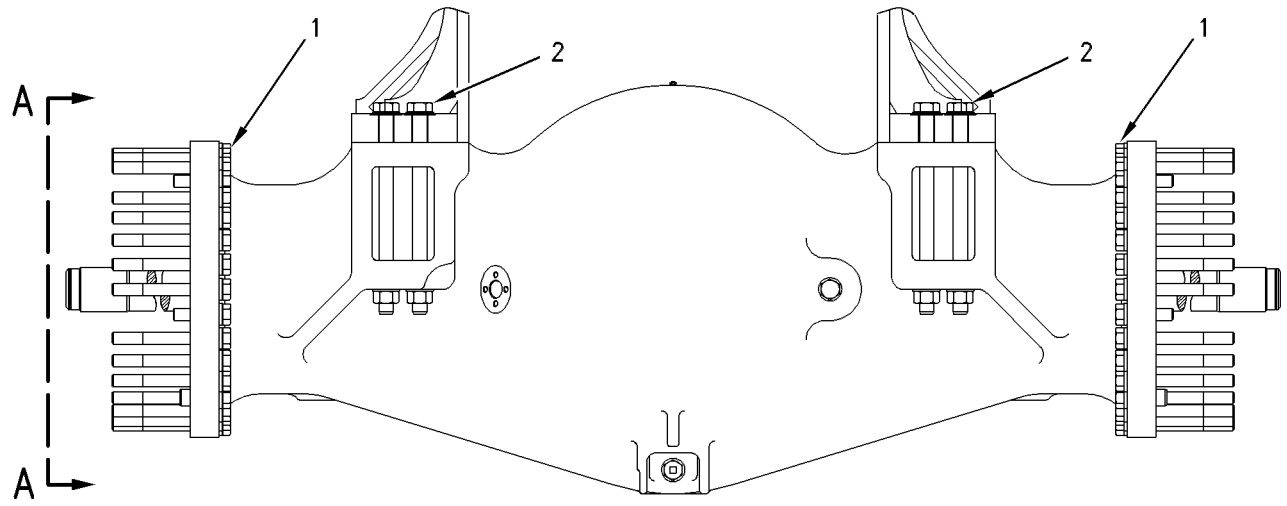


Illustration 45
Front View

g00363575

(1) Torque for the 34 bolts ..... 1150 ± 150 N·m (850 ± 110 lb ft)

(2) Torque for the eight bolts ..... 2000 ± 250 N·m (1480 ± 185 lb ft)

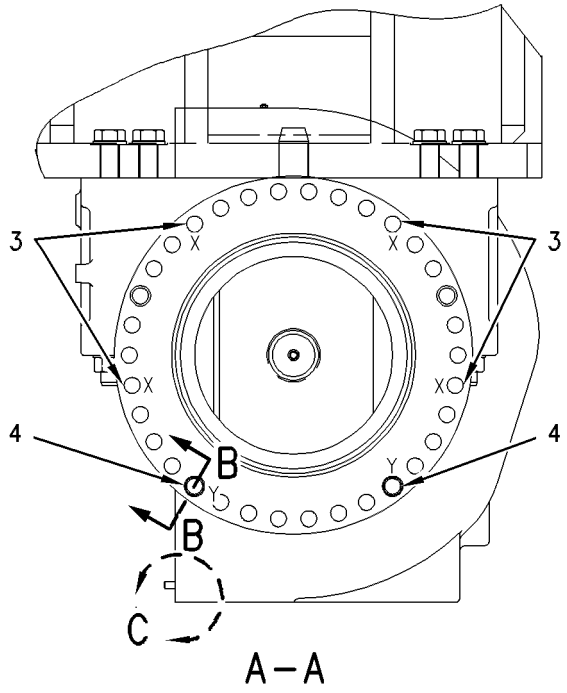


Illustration 46
View A-A

g00363632

(3) Install the eight 9X-8896 Bolts at the four locations on both of the axle flanges. The four locations are identified with an X.

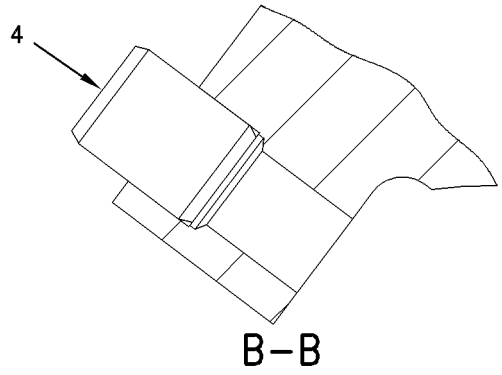


Illustration 47 g00363777

Section B-B

(4) Install the four 104-7006 Dowels at the two locations on both of the axle flanges. The two locations are identified with a Y.

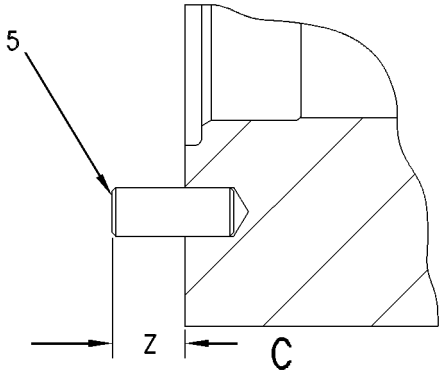


Illustration 48 g00363778

Detail C

(5) Install the pin so that the height of the pin equals dimension Z.

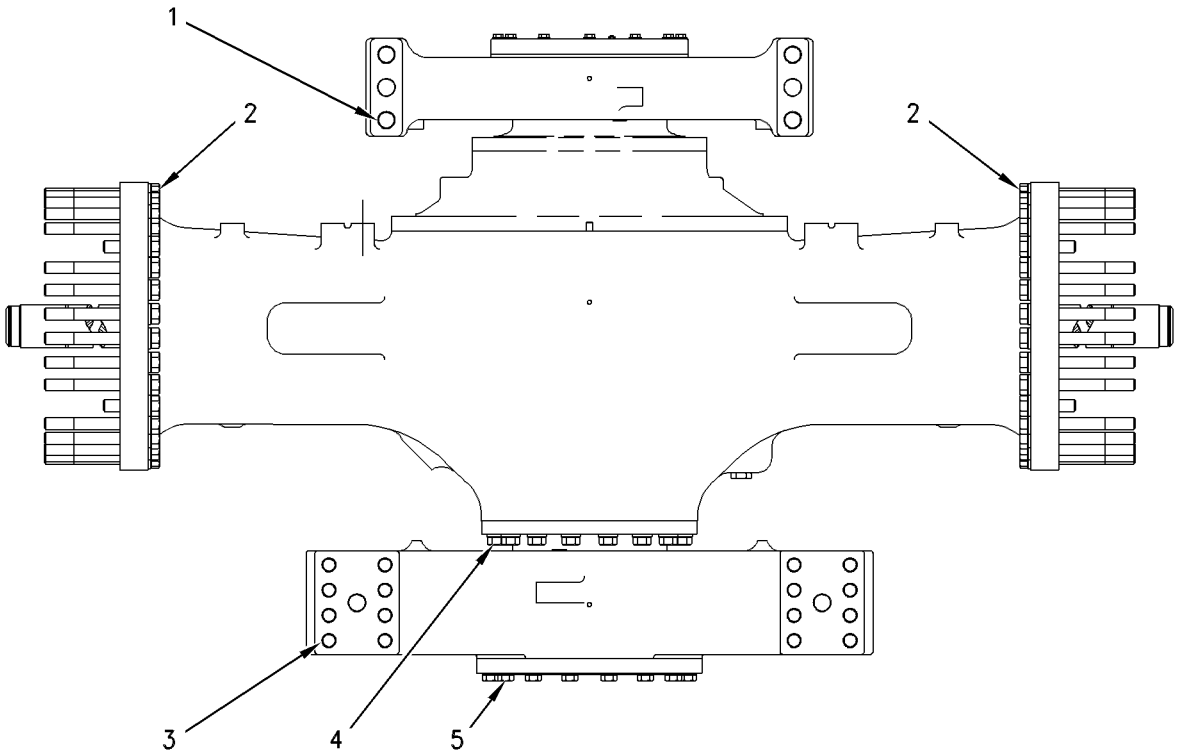
Dimension Z ..... 19 ± 2 mm (0.75 ± 0.08 inch)

i02400860

Oscillating Axle (Rear)

SMCS Code: 3278

Part No.: 8R-5467



g00365074

Illustration 49

Top View

(1) Torque for the four bolts ..... 1800 ± 200 N·m (1320 ± 150 lb ft)

(2) Torque for the 34 bolts ..... 1150 ± 150 N·m (850 ± 110 lb ft)

(3) Torque for the 16 bolts ..... 900 ± 100 N·m (660 ± 75 lb ft)

(4) Torque for the 16 bolts ..... 750 ± 90 N·m (550 ± 65 lb ft)

(5) Torque for the 16 bolts ..... 475 ± 60 N·m (350 ± 45 lb ft)

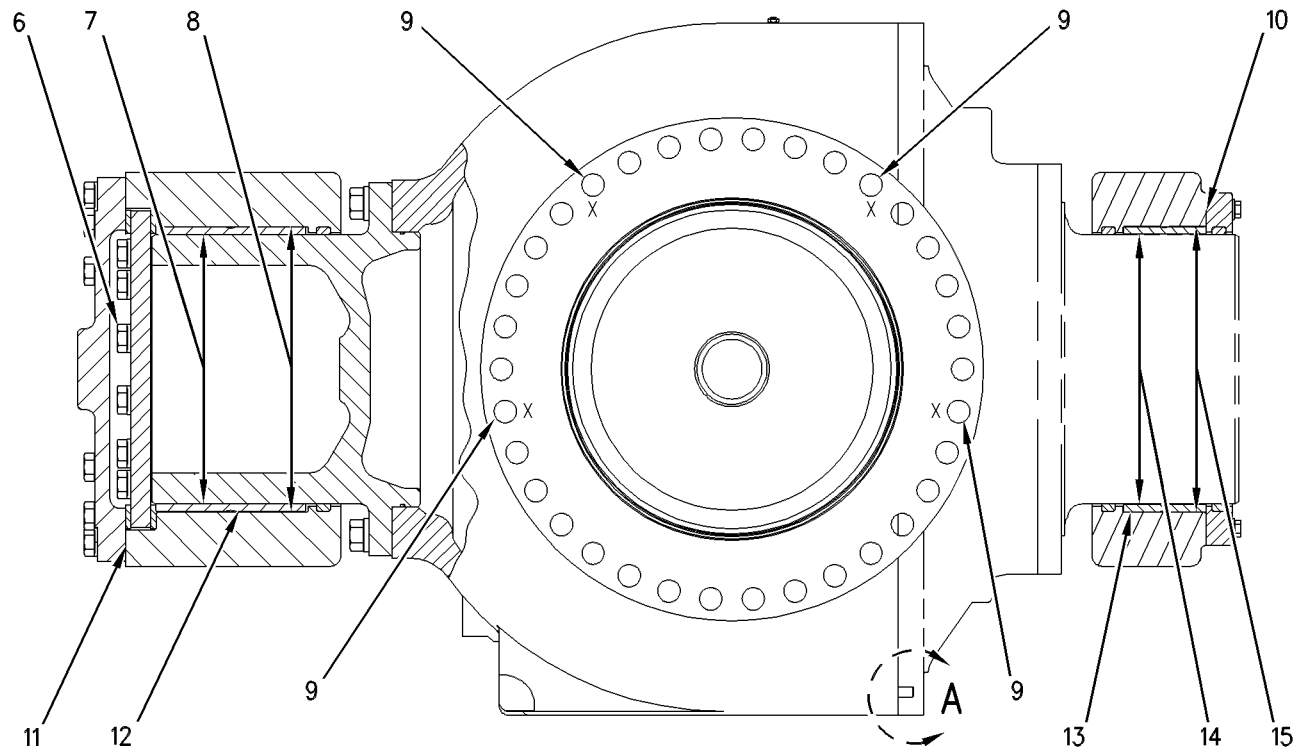


Illustration 50
g00365078
Right Side View

(6) Torque for the 12 bolts ..... 475 ± 60 N·m (350 ± 45 lb ft)

(7) Outside diameter of the trunnion
..... 330.15 ± 0.05 mm (12.998 ± 0.002 inch)

(8) Inside diameter of the trunnion support
..... 349.20 ± 0.10 mm (13.748 ± 0.004 inch)

(9) Install the eight 9X-8896 Bolts at the four locations on both of the axle flanges. The four locations are identified with an X.

(10) Apply 6V-5765 Sealant to the machined face of the trunnion support before installing the bearing retainer.

(11) Apply 6V-5765 Sealant to the machined face of the trunnion support before installing the cover.

(12) Sleeve Bearing

Outside diameter of the sleeve bearing
..... 349.53 ± 0.15 mm (13.761 ± 0.006 inch)
Inside diameter of the sleeve bearing
..... 331.19 ± 0.29 mm (13.039 ± 0.011 inch)

(13) Sleeve Bearing

Outside diameter of the sleeve bearing
..... 349.53 ± 0.15 mm (13.761 ± 0.006 inch)
Inside diameter of the sleeve bearing
..... 331.19 ± 0.29 mm (13.039 ± 0.011 inch)

(14) Outside diameter of the pinion housing
..... 330.15 ± 0.05 mm (12.998 ± 0.002 inch)

(15) Inside diameter of the trunnion support
..... 349.20 ± 0.10 mm (13.748 ± 0.004 inch)

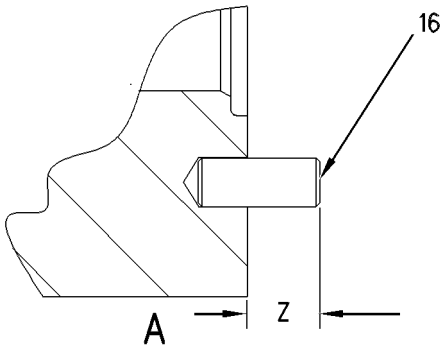


Illustration 51
g00365080
Detail A

(16) Install the pin so that the height of the pin equals dimension Z.

Dimension Z ..... 19 ± 2 mm (0.75 ± 0.08 inch)

i02401249

Final Drive and Wheel

SMCS Code: 4051

Part No.: 9U-3022

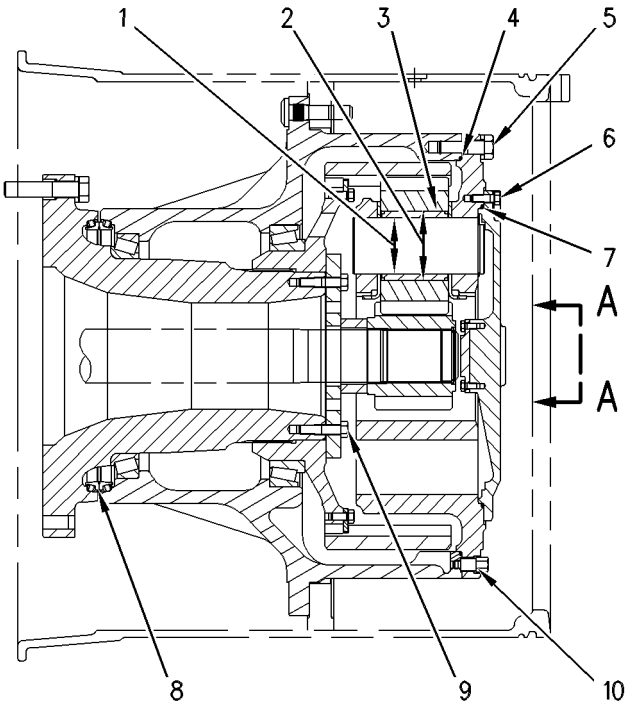


Illustration 52 g00366512

(1) Diameter of the planetary shaft ..... 95.321 ± 0.010 mm (3.7528 ± 0.0004 inch)

(2) Inside diameter of the planetary gear ..... 118.10 ± 0.02 mm (4.650 ± 0.001 inch)

(3) Sleeve bearing

Outside diameter of the sleeve bearing ..... 117.919 ± 0.013 mm (4.6425 ± 0.0005 inch)
Inside diameter of the sleeve bearing ..... 95.395 ± 0.013 mm (3.7557 ± 0.0005 inch)

Note: Coat the sleeve bearings thoroughly with clean final drive oil prior to installation.

(4) Lubricate the O-Ring with a minimal amount of the lubricant that is being sealed.

(5) Planetary carrier bolts

Torque for the 46 bolts ..... 400 ± 60 N·m (295 ± 45 lb ft)
Torque-turn after reaching the specified torque ..... 120 ± 10°

(6) Torque for the nine bolts ..... 135 ± 20 N·m (100 ± 15 lb ft)

(7) Lubricate the O-Ring with a minimal amount of the lubricant that is being sealed.

(8) Rubber toric seals and all surfaces that contact the toric seals must be clean and dry when the parts are assembled. Apply a thin coat of oil on the contact surfaces of the metal seals prior to installing the metal seals. The metal seals must be assembled square with the bore. The rubber toric seals must not bulge and the rubber toric seals must not be twisted.

(9) Torque for the 20 bolts ..... 270 ± 40 N·m (200 ± 30 lb ft)

(10) Lubricate the O-Ring with a minimal amount of the lubricant that is being sealed.

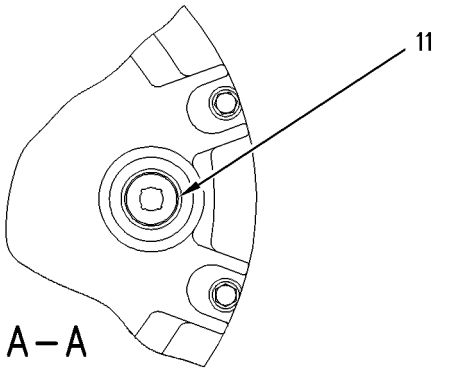


Illustration 53 g00366514
View A-A

(11) Lubricate the O-Ring with a minimal amount of the lubricant that is being sealed. Torque for the magnetic plug ..... 105 ± 10 N·m (75 ± 7 lb ft)

i02401283

Rim Mounting

SMCS Code: 4209-MT

Part No.: 133-8375

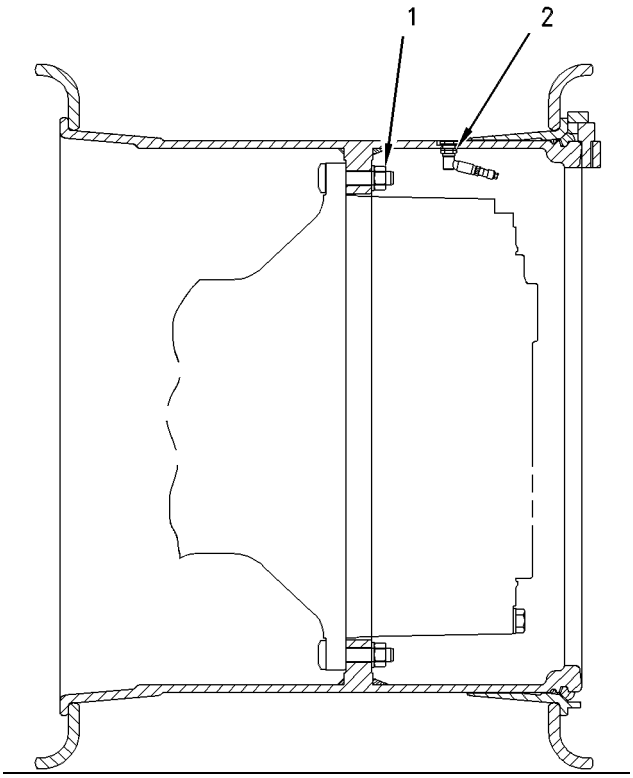


Illustration 54 g00366832

(1) Torque for the 48 nuts ..... 900 ± 100 N·m (660 ± 75 lb ft)

(2) Torque for the valve assembly .... 21.2 ± 2.8 N·m (15.5 ± 2 lb ft)

i02401302

Temperature Sensor (Axle Oil)

SMCS Code: 429T

Part No.: 134-2252

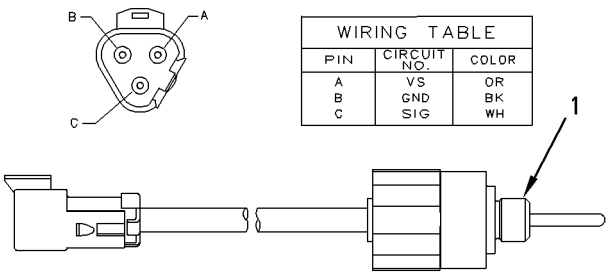


Illustration 55 g01018672

(1) Torque for installing the sensor ..... 20 ± 3 N·m (15 ± 2 lb ft)

Operating voltage ..... 8 V

Output type ..... Pulse width modulated

Output frequency ..... 500 Hz

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RENR8810-02 (en-us)
August 2018

Systems Operation

990H Wheel Loader and , 844H Wheel Dozer
Power Train

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

i02405219

General Information

SMCS Code: 3000; 4000; 4800

S/N: BWX1–Up

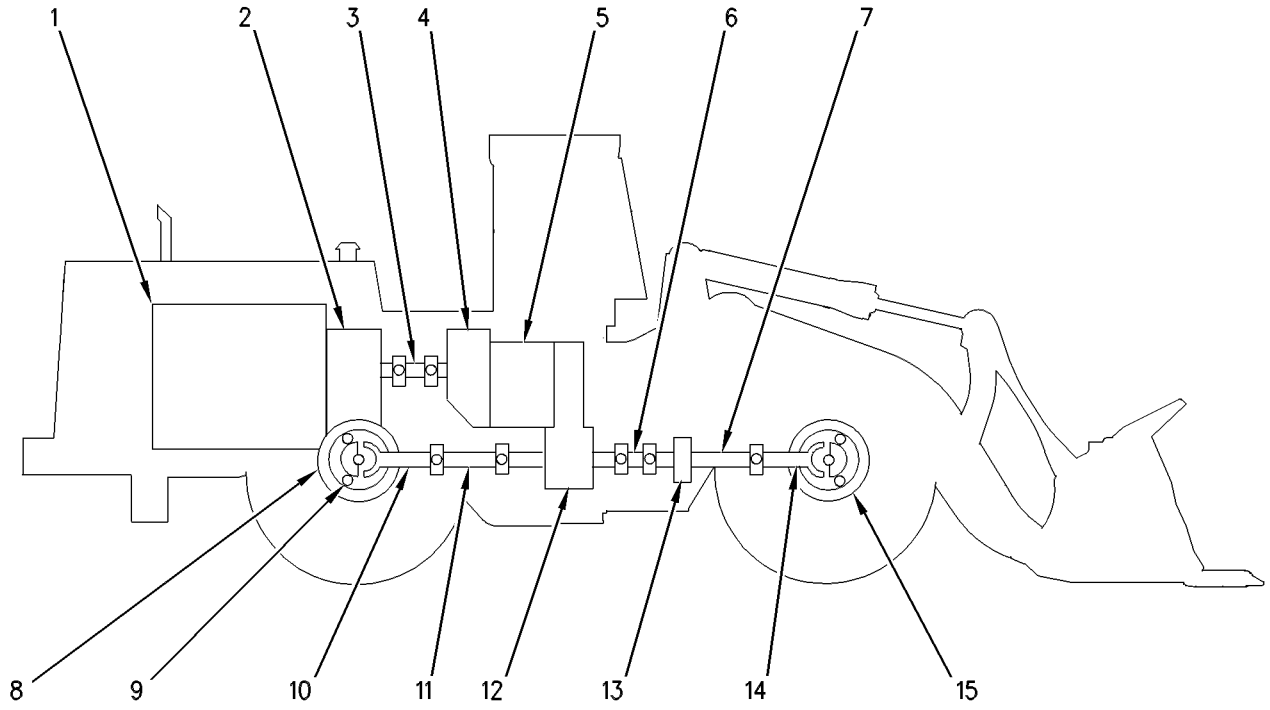


Illustration 1 g00371074

Location of Power Train Components for the 990H Wheel Loader

(1) Diesel engine
(2) Torque converter
(3) Upper drive shaft
(4) Input transfer gears
(5) Transmission
(6) Drive shaft
(7) Drive shaft
(8) Rear final drives
(9) Planetary gears for final drives
(10) Rear drive pinion
(11) Drive shaft
(12) Output transfer gears
(13) Bearing cage
(14) Front drive pinion
(15) Front final drives

Note: The general information that follows is applicable to the 990H Wheel Loader.

Power from diesel engine (1) is sent from the flywheel to torque converter (2). The torque converter is a torque converter impeller clutch with a lockup clutch. The lockup clutch provides direct drive capability. Inside the torque converter, an impeller is fastened to the hub of a hydraulically activated clutch. The impeller clutch allows a controlled reduction in the torque transmitting capacity of the converter. This places a limit on the amount of torque converter output.

The power train electronic control module (ECM) and the reduced rimpull select switch control the impeller clutch. The left service brake pedal is also used to vary the amount of torque converter capacity in order to control the wheel slip. The left service brake pedal also varies the amount of torque converter capacity in order to increase the hydraulic system response.

The lockup clutch is controlled by a switch on the right side console. When the lockup clutch is enabled by the switch, the power train ECM determines when the lockup clutch is engaged.

Power from the output shaft of the torque converter is sent through drive shaft (3) to input transfer gears (4). The output gear of the input transfer gears turns the input shaft of the transmission (5).

Five clutches in the transmission, which are activated hydraulically, provide three forward speeds and three reverse speeds. Speed and direction are selected by using the STIC Control.

The transmission output shaft sends power through the idler gears in output transfer gears (12) to the output gear of the output transfer gears. The output gear sends power through drive shaft (11) to rear drive pinion (10). The output gear also sends power to front drive pinion (14) through drive shaft (6) and drive shaft (7) and through bearing cage (13).

Each pinion, bevel gear, and differential gear has a specific axle. Each gear turns a specific axle. The axles are connected to final drives (8) and (15). The final drives turn the wheels.

i02405435

General Information

SMCS Code: 3000; 4000; 4800

S/N: BTW1–Up

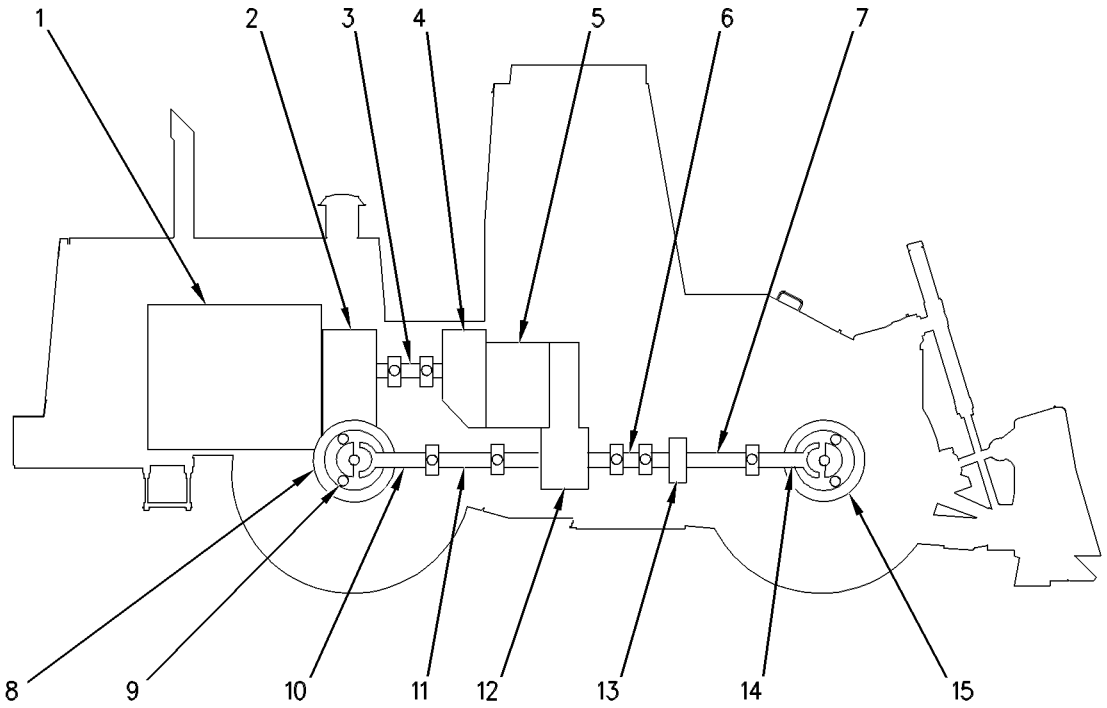


Illustration 2 g00371855

Location of the Power Train Components for the 844H Wheel Dozer

(1) Diesel engine
(2) Torque converter
(3) Upper drive shaft
(4) Input transfer gears
(5) Transmission
(6) Drive shaft
(7) Drive shaft
(8) Rear final drives
(9) Planetary gears for final drives
(10) Rear drive pinion
(11) Drive shaft
(12) Output transfer gears
(13) Bearing cage
(14) Front drive pinion
(15) Front final drives

Note: The general information that follows is applicable to the 844H Wheel Dozer.

Power from diesel engine (1) is sent from the flywheel to torque converter (2). The torque converter is a torque converter impeller clutch with a lockup clutch. The lockup clutch provides direct drive capability. Inside the torque converter, an impeller is fastened to the hub of a hydraulically activated clutch. The impeller clutch is locked in the fully engaged position. This allows the maximum amount of torque transfer. The impeller clutch disengages during directional shifts in order to allow directional shifts at full throttle.

The power train electronic control module (ECM) controls the impeller clutch. The left service brake pedal is also used to vary the amount of torque converter capacity in order to control the wheel slip. The left service brake pedal also varies the amount of torque converter capacity in order to increase the hydraulic system response.

The lockup clutch is controlled by a switch on the right side console when the machine is in first speed. When the lockup clutch is enabled by the switch, the power train ECM determines when the lockup clutch is engaged. The power train ECM determines when the lockup clutch is engaged automatically in second speed and third speed.

Power from the output shaft of the torque converter is sent through drive shaft (3) to input transfer gears (4). The output gear of the input transfer gears turns the input shaft of the transmission (5).

Five clutches in the transmission, which are activated hydraulically, provide three forward speeds and three reverse speeds. Speed and direction are selected by using the STIC Control.

The transmission output shaft sends power through the idler gears in output transfer gears (12) to the output gear of the output transfer gears. The output gear sends power through drive shaft (11) to rear drive pinion (10). The output gear also sends power to front drive pinion (14) through drive shaft (6) and drive shaft (7) and through bearing cage (13).

Each pinion, bevel gear, and differential gear has a specific axle. Each gear turns a specific axle. The axles are connected to final drives (8) and (15). The final drives turn the wheels.

i02402635

Power Train Electronic Control System

SMCS Code: 4800; 7610-DTN

The following components are the main parts of the power train electronic control system: STIC Steering and Transmission Control, electronic control module, five solenoid valves, quickshift switch, torque converter lockup clutch, torque converter impeller clutch, no clutch neutral function, ride control function and backup alarm function.

Power Train Electronic Control Module (ECM)

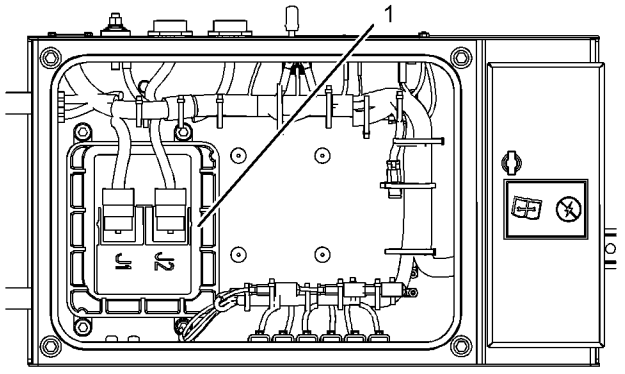


Illustration 3 g01200002

Right Side of the Machine

(1) Power train electronic control module (ECM)

The power train ECM is located on the right side of the machine under the right side platform. The primary function of the power train ECM is shifting the transmission. In order for the transmission to be shifted to the desired speed and to the desired direction, the power train ECM receives the operator input from the STIC steering and transmission control.

The power train ECM also controls starting the engine and the backup alarm. The power train ECM will not allow the engine to be started unless the direction control switch is in the NEUTRAL position. The backup alarm is activated whenever the direction control switch is in the REVERSE position.

The power train ECM controls the torque converter impeller clutch and the torque converter lockup clutch.

The power train ECM has a built-in diagnostic system in order to detect faults in the power train electrical system. The power train ECM has a diagnostic display. The diagnostic display consists of three LED lights and a three digit display area.

For more information on the operation of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

STIC Steering and Transmission Control

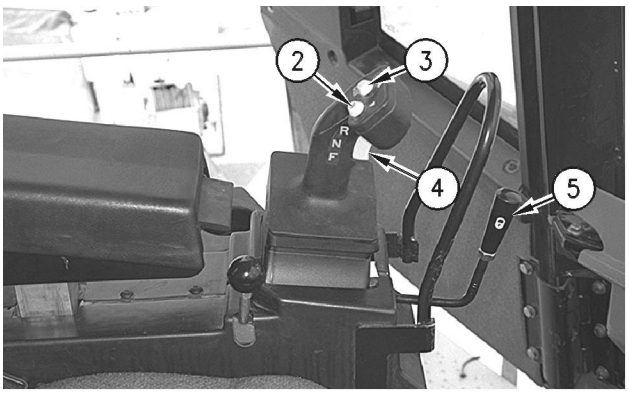


Illustration 4 g00107001

STIC Steering and Transmission Control

(2) Transmission downshift switch
(3) Transmission upshift switch
(4) STIC transmission direction control switch
(5) STIC steering and transmission lock control

The STIC steering and transmission control is a sealed unit. The STIC steering and transmission control is positioned on the left console. STIC transmission direction control switch (4) is a three-position switch that selects either neutral, forward, or reverse. Transmission upshift switch (3) makes momentary contact in order to select the next higher speed. Transmission downshift switch (2) makes momentary contact in order to select the next lower speed.

STIC Steering and Transmission Lock Control

When the STIC steering and transmission lock control (5) is moved to the LOCKED position, steering is disabled and a switch is depressed. The closed switch causes the power train ECM to shift the transmission into neutral.

When the STIC steering and transmission lock control is moved to the UNLOCK position, the operator has control of the steering and control of the transmission. The power train ECM will not shift the transmission into a speed until the direction control switch is first moved into the NEUTRAL position.

Parking Brake Interlock

When the parking brake control is disengaged, the transmission will shift normally. When the parking brake control is engaged, the transmission will not shift out of neutral to first speed forward or first speed reverse. If the transmission is in first speed forward or in first speed reverse and the parking brake is moved to the engaged position, the transmission will shift into neutral. If the transmission is in second speed forward or in third speed forward, the transmission will remain engaged.

When the power train ECM shifts the transmission to neutral, the power train ECM will not shift the transmission into a speed until the following conditions are met:

- The transmission direction control switch is moved to the NEUTRAL position.
- The transmission direction control switch is moved to the FORWARD position or the transmission direction control switch is moved to the REVERSE position.

If there is a hydraulic failure and the parking brake cannot be released, a drive-through mode is provided. If the parking brake control knob is placed in the DISENGAGED position and the transmission is in first speed forward or in first speed reverse, the machine may be moved. The machine should be moved only for a short distance.

Quickshift Function

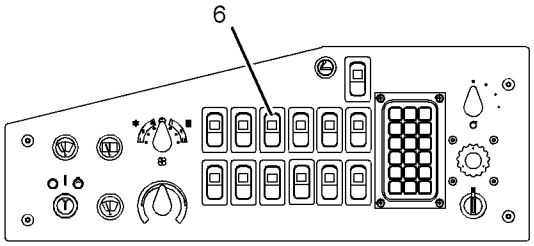


Illustration 5 g01200015

Right Side Console

(6) Quickshift switch

If a shift from forward to reverse is made from first speed, the transmission will automatically shift into second speed reverse. This occurs when the quickshift switch is in the ON position.

Quickshift switch (6) is located on the right console. If a shift from forward to reverse is made from first speed, the transmission will automatically shift into second speed reverse. This occurs when the quickshift switch is in the ON position. The transmission must have been in first speed forward before the shift to reverse is made in order for the quickshift function to operate. If the transmission speed is shifted to first speed with the transmission in neutral direction, and then shifted in direction from neutral to reverse, the transmission speed will not automatically upshift to second speed.

When a shift is made to forward again, the transmission will remain in second speed forward. The downshift switch must be used in order to shift the transmission back to first speed at the beginning of the next work cycle.

Solenoid Valves

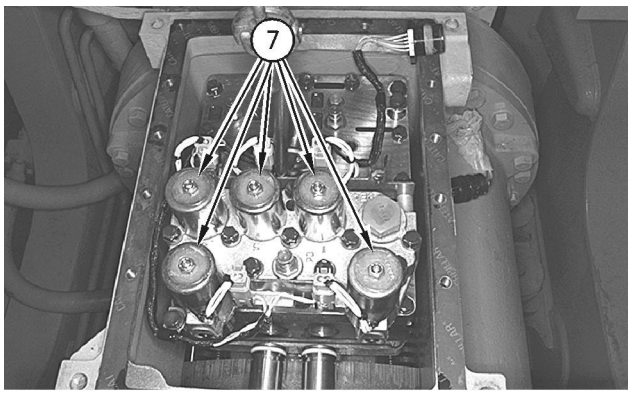


Illustration 6 g00107004

Transmission Hydraulic Control Valve

(7) Solenoid valves

Solenoid valves (7) are installed in the transmission hydraulic control valve. The solenoid valves are two-position, three-way valves. The solenoid valves are normally open to the drain. When the solenoid is energized, the solenoid valve spool moves in order to direct pressure oil to one end of a control valve spool. The control valve spool then directs pressure oil to a clutch.

Neutral Start Function

The neutral start function allows the engine to start when the transmission is in neutral. The neutral start function requires the STIC control or the shift handle to be in the NEUTRAL position before the engine will crank. The operator controls this feature by placing the direction switch in the NEUTRAL position. Then, the operator turns the key start switch to the START position. When the neutral start function is operating, the transmission control activates the start relay. This allows the starting motor to turn.

Torque Converter Lockup Clutch

Machines that are equipped with an electronic torque converter will have the lockup clutch function. The lockup clutch function controls the direct drive electrically. When the transmission control activates the lockup solenoid the lockup clutch in the torque converter mechanically connects the torque converter input shaft to the torque converter output shaft. This function efficiently connects the power train to the engine.

The transmission control engages the lockup clutch when all of the following conditions are present:

- The lockup enable switch is in the ON position.
- The speed of the torque converter is greater than 1565 RPM.
- The machine has been in the present speed and direction for at least two seconds.
- The left brake pedal is fully released.
- The lockup clutch solenoid was deactivated for four seconds.

The transmission control disengages the lockup clutch when any one of the following conditions is present:

- The lockup enable switch for the clutch is moved to the OFF position.
- A shift is made.
- The speed of the torque converter decreases to less than 1415 RPM.
- The left brake pedal is depressed.

Note: To prevent engine overspeed, the lockup clutch can not be engaged when the speed of the torque converter is greater than 2250 RPM.

Note: During the engagement of the lockup clutch, the impeller clutch pressure is maintained at a value of 550 kPa (80 psi).

Torque Converter Impeller Clutch

Normal Operation

The position of the left brake pedal is used to determine the impeller clutch pressure. Depressing the left brake pedal reduces the impeller clutch pressure. This reduction will make more engine power available for the implement systems and the steering systems. This available power will reduce the maximum rimpull that will allow the operator to control wheel slippage. Fully depressing the left brake pedal engages the service brakes.

Engines that are controlled electronically have a function that is called rimpull. The rimpull allows the operator to select the amount of reduction in the impeller clutch pressure. The pressure is set to one of four preset levels without depressing the left pedal. The amount of impeller clutch pressure is selected by using the rimpull select switch instead of the left pedal.

This feature is enabled when the reduced rimpull ON/OFF switch is in the ON position and the transmission is in first gear forward. When the rimpull select switch is in the OFF position, the amount of rimpull that is available is 100 percent. If the left pedal is depressed and the rimpull select switch is in the ON position, then the amount of impeller clutch pressure is reduced to the preset level that is selected. The pressure will be reduced. The amount of the pressure reduction will be determined when the left pedal is depressed.

The rimpull select switch is an input of the power train electronic control. The rimpull select switch tells the amount of rimpull that the operator wants to be sent to the power train electronic control. The control responds by activating the appropriate reduced rimpull mode.

The rimpull select switch is a rotary switch that has four positions. Position 1 (small dot) of the rimpull select switch is the least amount of impeller clutch pressure. Position 4 (large dot) of the rimpull select switch is the largest amount of impeller clutch pressure. The control sorts the reduction of rimpull. The control assigns the least amount of rimpull to position 1. The control assigns the largest amount of rimpull to position 4. If the programmed values are corrupted, the control resets the values to the factory settings.

The presets at the factory for the impeller clutch pressure include the following percentages of reduction: 60, 70, 80 and 90. The pressures can be changed by using Mode 5 of the Caterpillar Monitoring System (CMS).

Directional Shifts

When the operator requests a directional shift, the transmission control performs the following steps:

1. If a pressure that is less than the pressure to hold is requested, then the control ignores the left brake pedal position.

2. When the shift begins, the impeller clutch pressure is reduced and the impeller clutch pressure is maintained at a value of 550 kPa (80 psi).

3. When the transmission clutches engage, the impeller clutch pressure is increased to an intermediate value and maintained for 0.3 seconds. The transmission control uses the torque converter and transmission speed sensors to determine when the transmission clutches are engaged.

4. For the next 0.3 seconds, the impeller clutch pressure is increased to the maximum value. The top value is maintained until conditions require a change of impeller clutch pressure. The conditions that require a change of impeller clutch pressure include the following items:left brake pedal position, engine speed and lockup clutch engaged

Engine Response

In order to increase engine response and machine response during engine acceleration from low idle, the impeller clutch operates according to the following items:

- The position of the left brake pedal is ignored, unless a pressure that is less than the engine response is requested. Braking is not affected.
- From low idle to 1200 RPM, the impeller clutch pressure is maintained at a value of 550 kPa (80 psi).
- From 1200 to 1400 RPM, the impeller clutch pressure is gradually increased to the maximum value. The top value is maintained until conditions require a change of impeller clutch pressure. The conditions that require a change of impeller clutch pressure include the following items:left brake pedal position, engine speed and lockup clutch engaged.

Reverse Turbine

The high temperatures of the impeller clutch are produced when the machine is allowed to move backward on an incline and a forward gear is engaged. The reverse turbine reduces the temperatures that are created when the machine is operated in this manner. If the speed of the torque converter is less than 500 RPM in reverse, then the control increases the impeller clutch pressure and the left brake pedal is ignored.

No Clutch Neutral Function

The no clutch neutral feature is provided in order to improve the quality of directional shifts. The no clutch neutral feature momentarily prevents the engagement of the neutral clutch as the operator changes from forward to reverse or reverse to forward direction. The power train ECM delays the engagement of the neutral clutch for two seconds. The delay occurs when the operator shifts into NEUTRAL or shifts through NEUTRAL. During this delay, none of the transmission clutch solenoid valves are energized.

Ride Control Function

The ride control function uses the following components:

- Transmission Speed Sensor
- Ride Control Switch
- Transmission Control
- Ride Control Relay

The ride control is an optional feature that is determined by the option code input. This feature is enabled when the operator places the ride control switch in the ON position or in the AUTO position. In the ON position, the ride control is always activated and the ECM energizes the ride control relay continuously. In the AUTO position, the activation of the ride control is dependent on the machine ground speed. When the transmission speed increases above approximately 700 rpm (6 mph), ride control is activated. When the transmission speed decreases below approximately 600 rpm (5.25 mph), ride control is deactivated. As ride control is activated and deactivated the ride control solenoid is energized and de-energized by the ride control relay.

Backup Alarm Function

The backup alarm is used in order to alert personnel that the machine is backing up. When this function is enabled the ECM causes the backup alarm to SOUND. When the operator selects REVERSE the ECM activates the backup alarm.

The function is enabled when the operator selects REVERSE at the shift lever. The shift lever tells the ECM that the shift lever is in REVERSE.

i02403170

Electronic Control Module (Power Train)

SMCS Code: 7610-DTN

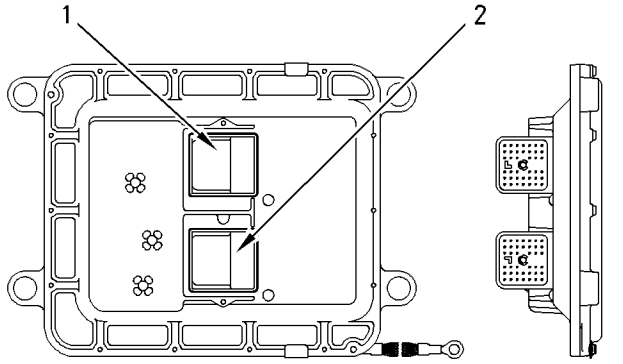


Illustration 7 g00291779

Power Train Electronic Control Module (ECM)

(1) Connector J1. (2) Connector J2.

The power train ECM shifts the transmission. The transmission direction control switch sends the operator input to the power train ECM. The operator input indicates the desired speed for the transmission and the desired direction for the transmission. The power train ECM makes decisions that are based on the input information. The ECM also makes decisions that are based on the information within the ECM memory. After the power train ECM receives the input information and the information from memory, the power train ECM sends a corresponding response via the outputs.

Input

The machine has several input devices. Input devices inform the power train ECM of the operating conditions of the machine. The switch input and the sensor input are used by the machine. The switch input of the power train ECM are provided with the following signals from the switches: an open, a ground and a +battery. Sensors provide a constantly changing signal to the power train ECM. Refer to Table 1 and Table 2 .

Outputs

The power train ECM responds to decisions by sending electrical signals through the outputs. The outputs can create an action or the outputs can provide information to the power train ECM. Table 1 and Table 2 list the outputs for the power train ECM.

Input/Output

The CAT Data Link is used to communicate with the other electronic control modules on the machine. The CAT Data Link is bidirectional. This allows the power train ECM to receive information and this allows the power train ECM to send information. The CAT Data Link allows the sharing of information with other electronic controls.

- The power train ECM receives the harness code input from the Caterpillar Monitoring System.
- The power train ECM sends the following information to the Caterpillar Monitoring System: engine speed, machine ground speed, parking brake switch status, transmission speed selection, transmission direction selection and service code of the transmission.
- The monitoring system displays this information for the operator or for service personnel.

A module identifier (MID) is assigned to all of the electronic controls that use the CAT Data Link. The MID for the power train ECM is 081.

Reference: For more information on the CAT Data Link, refer to the Service Manual module Systems Operation, “Data Link” for the machine that is being serviced.

Reference: For more information on the Caterpillar Monitoring System, refer to the Service Manual module Systems Operation, “Monitoring System (Power Train Functions)” for the machine that is being serviced.

Reference: For more information on troubleshooting the power train ECM, refer to the Service Manual module Troubleshooting, Testing and Adjusting for the machine that is being serviced.

Table 1

Contact Description of the Power Train ECM (Connector J1)		
No.(1)	**Function**	**Type**
1	(+) Battery	Power
2	(-) Battery	Ground
3	Cat Data Link (-)	Input/Output
4	Axle Oil Cooler Fan Solenoid	Solenoid Output
5	(-) Battery	Ground
6	(+) Battery	Power
7	Solenoid Return	Solenoid Return
8	Start Relay	Solenoid Output
9	CAT Data Link (+)	Input/Output

(continued)

(Table 1, contd)

Contact Description of the Power Train ECM (Connector J1)		
No.(1)	**Function**	**Type**
10	Autolube Solenoid	Solenoid Output
11	Number 2 Clutch Solenoid (Forward)	Solenoid Output
13	Neutral Direction Switch to Ground	Switch Input (open/ground)
14	Reverse Direction Switch to Ground	Switch Input (open/ground)
15	Torque Converter Output Speed Return	Ground
16	Switch And Sensor Return	Ground
17	Number 1 Clutch Solenoid (Reverse)	Solenoid Output
18	Ride Control Solenoid	Solenoid Output
19	Upshift Switch (N/C)	Switch Input (open/ground)
20	Steering and Transmission Lock Switch 1 (N/O)	Switch Input (open/ground)
21	Ride Control Switch 1 (N/C)	Switch Input (open/ground)
22	Ride Control Switch 2 (N/O)	Switch Input (open/ground)
23	Upshift Switch To Ground (N/O)	Switch Input (open/ground)
24	Steering and Transmission Lock Switch 2 (N/C)	Switch Input (open/ground)
25	Downshift Switch 1 (N/C)	Switch Input (open/ground)
26	Downshift Switch 2 (N/O)	Switch Input (open/ground)
27	Parking Brake Cab Switch (N/C)	Switch Input (open/ground)
28	Autolube Manual Lube Switch	Switch Input (open/ground)
29	Reduced Rimpull Switch 3	Switch Input (open/ground)
30	Direction Switch (Forward)	Switch Input (open/ground)
31	Reduced Rimpull Switch 4	Switch Input (open/ground)
32	Torque Converter Lockup Switch	Switch Input (open/ground)

(continued)

(Table 1, contd)

Contact Description of the Power Train ECM (Connector J1)		
No.(1)	**Function**	**Type**
33	Reduced Rimpull Switch 2	Switch Input (open/ground)
34	Reduced/Maximum Rimpull ON/OFF Switch	Switch Input (open/+battery)
35	Reduced Rimpull Switch 1	Switch Input (open/ground)
36	Parking Brake Cab Switch (N/O)	Switch Input (open/ground)
37	Parking Brake Pressure Switch 1 (N/C)	Switch Input (open/ground)
38	Quickshift Enable Switch (N/C)	Switch Input (open/ground)
39	Parking Brake Pressure Switch 2 (N/O)	Switch Input (open/ground)
40	Key Start Switch	Switch Input (open/+battery)

(1) The connector contacts that are not listed are not used.

Table 2

Contact Description of the Power Train ECM (Connector J2)		
No.(1)	**Function**	**Type**
1	Number 4 Clutch Solenoid (Second Speed)	Solenoid Output
3	Solenoid Return	Solenoid Return
4	Left Pedal Sensor	Pulse Width Modulated
6	Impeller Clutch Pressure Sensor	Pulse Width Modulated
7	Number 3 Clutch Solenoid (Third Speed)	Solenoid Output
8	Number 5 Clutch Solenoid (First Speed)	Solenoid Output
9	Sensor Power Supply (+10 V)	Sensor Supply +10V
10	Quickshift Enable Switch (N/O)	Pulse Width Modulated
11	Autolube Grease Pressure Sensor	Pulse Width Modulated
12	Sensor Power Supply (+8 V)	Sensor Supply +8V
13	Lockup Clutch Solenoid	Solenoid Output
18	Autolube Grease Level Switch	Switch Input (open/ground)

(continued)

(Table 2, contd)

Contact Description of the Power Train ECM (Connector J2)		
No.(1)	**Function**	**Type**
19	Impeller Clutch Solenoid	Solenoid Output
22	Autolube Indicator LED	LED Diagnostic Driver
23	Engine Speed Sensor	Frequency Input
24	Transmission Speed Sensor Return	Frequency Input
28	Reduced Rimpull Indicator LED	LED Diagnostic Driver
29	Engine Speed Sensor Return	Frequency Input
35	Transmission Speed Sensor	Frequency Input
37	Backup Alarm	Solenoid Output
38	Torque Converter Output Speed	Frequency Input
40	Primary Steering Pressure Warning LED	LED Diagnostic Driver

(1) The connector contacts that are not listed are not used.

i02403295

Switches

SMCS Code: 1435; 3171; 7332

Switches provide three types of switch inputs to the power train electronic control module (ECM), an open signal, a ground signal or a +battery signal. Switches are open or closed.

- When the switch is open, no signal is provided to the corresponding input of the power train ECM.
- When a switch is closed, a ground signal or a +battery signal is provided to the corresponding input of the power train ECM.

All of the following switches are ground to the power train ECM. The switches are ground through wire 202-BK(Black) to J1-16 of the power train ECM.

Parking Brake Knob



Illustration 8 g00760756

The parking brake knob is an input of the power train ECM. This switch informs the power train ECM when the operator wants to engage the parking brake.

The parking brake is engaged when the parking brake knob is in the OUT position. When the operator engages the parking brake, the normally open (N/O) pole opens and the normally closed (N/C) pole closes to ground. This tells the power train ECM that the parking brake is engaged. The parking brake is released when the parking brake knob is in the IN position. When the parking brake is disengaged, the N/O pole is closed and the N/C pole is open. This condition tells the power train ECM that the parking brake is disengaged. The N/C pole connects to connector contact J1-27 of the power train ECM. The N/O pole connects to connector contact J1-36 of the power train ECM. The common terminal of the switch connects to ground.

Note: The normally closed (N/C) circuit and normally open (N/O) circuit of the parking brake knob are used for diagnostic purposes. A circuit failure is present if the two circuits are open at the same time or if the two circuits are grounded at the same time. This fault is then shown on the display of the power train ECM.

Table 3

Status of the Parking Brake Knob		
Switch Position	**N/O(1) J1-36**	**N/C(2) J1-27**
Out	Closed	Open
In	Open	Closed

(1) N/O means Normally Open.
(2) N/C means Normally Closed.

Reference: For more information on the parking brake function, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Pressure Switch (Parking Brake Oil)

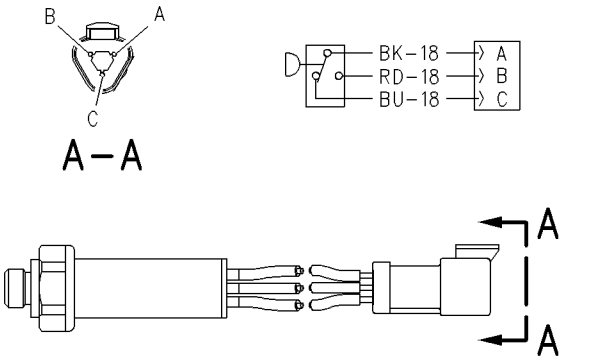


Illustration 9 g00287701

The parking brake pressure switch is an input of the power train electronic control module (ECM). This switch informs the power train ECM when the parking brake is engaged.

The parking brake pressure switch is a double-pole, single-throw pressure switch. When the operator engages the parking brake, the normally open (N/O) pole opens and the normally closed (N/C) pole closes to ground. This tells the power train ECM that the parking brake is engaged. When the parking brake is disengaged, the N/O pole is closed and the N/C pole is open. This tells the power train ECM that the parking brake pressure switch circuit is operating correctly. No action is required. The N/C pole connects to connector contact J1-37 of the power train ECM. The N/O pole connects to connector contact J1-39 of the power train ECM. The common terminal of the switch connects to ground.

Note: The normally closed (N/C) circuit and normally open (N/O) circuit of the parking brake pressure switch are used for diagnostic purposes. A circuit failure is present if the two circuits are open at the same time or if the two circuits are grounded at the same time. This fault is then shown on the display of the power train ECM.

Table 4

Status of the Parking Brake Switch		
Switch Position	**N/O(1) J1-39**	**N/C(2) J1-37**
High Pressure	Closed	Open
No Pressure	Open	Closed

(1) N/O means Normally Open.
(2) N/C means Normally Closed.

Reference: For more information on the diagnostic operations, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the parking brake function, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Reduced Rimpull Switches

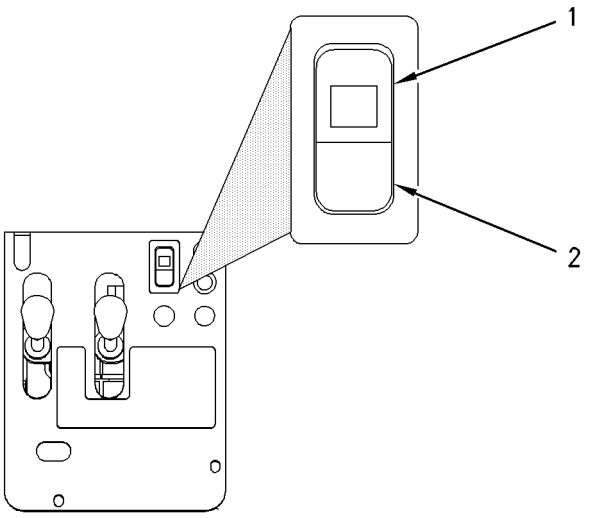


Illustration 10 g00845028

Reduced Rimpull On/Off Switch

(1) Position for maximum rimpull
(2) Position for reduced rimpull

The reduced rimpull on/off switch is a two-position switch. The reduced rimpull on/off switch tells the power train electronic control module (ECM) if the reduced rimpull mode is active. The switch has one input connection to the power train ECM on connector contact J1-34. The valid combination for each switch position is shown in Table 5 that follows.

Table 5

Status of the Reduced Rimpull On/Off Switch	
Switch Position	**N/O(1) J1-34**
Reduced	Closed
Max	Open

(1) N/O means Normally Open.

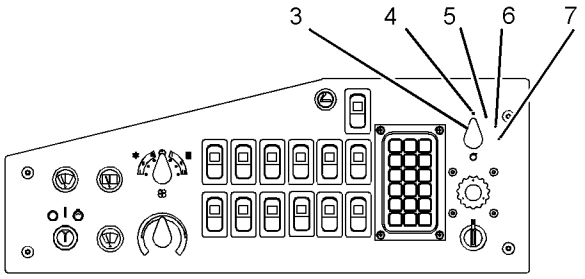


Illustration 11 g01200258

(3) Reduced Rimpull Select Switch
(4) High
(5) Medium high
(6) Medium low
(7) Low

The reduced rimpull select switch is a four-position switch. The reduced rimpull select switch tells the power train electronic control module (ECM) the correct setting for the reduction of rimpull. The switch has four input connections to the power train ECM on connector J1: 90% rimpull (large dot) at contact 35, 80% rimpull at contact 33, 70% rimpull at contact 29 and 60% rimpull (small dot) at contact 31. The valid combinations for each switch position are shown in Table 6 that follows. If an invalid combination is detected by the power train ECM, a circuit failure is present.

Table 6

Status of the Reduced Rimpull Select Switch				
Switch Position	**#1 (J1-35)**	**#2 (J1-33)**	**#3 (J1-29)**	**#4 (J1-31)**
60% Rimpull	Open	Open	Open	Closed
70% Rimpull	Open	Open	Closed	Open
80% Rimpull	Open	Closed	Open	Open
90% Rimpull	Closed	Open	Open	Open

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Shift Switches for STIC Steering Control

Only one style of steering is available for the 990H Wheel Loader and the 844H Wheel Tractor. The STIC steering control is the style of steering that is used. The steering unit also contains the transmission controls.

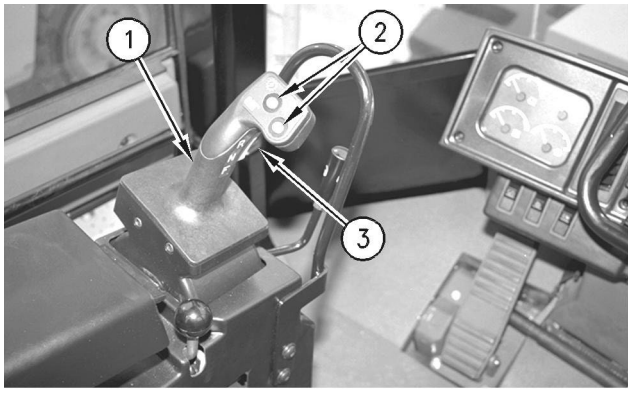


Illustration 12 g00573097

Location of STIC Steering Control

(1) STIC Steering Control
(2) Upshift and downshift switches
(3) Transmission direction control switch

STIC steering control (1) is a joystick control. The operator can select the direction of the machine with transmission direction control switch (3). The operator can select the transmission speed by pressing the upshift and downshift switches (2).

Switch (Transmission Direction Control)

Transmission direction control switch (3) is located on the back left side of STIC steering control (1). The transmission upshift and downshift switches (2) are located on the front left side of STIC steering control (1). Transmission direction control switch (3) is a three-position switch that selects either forward, neutral, or reverse.

The operator selects a direction by moving transmission direction control switch (3) to one of three positions. Transmission direction control switch (3) tells the power train electronic control module (ECM) the direction of travel that is selected. The following connections to the power train ECM are on connector J1: contact 30 (forward), contact 13 (neutral) and contact 14 (reverse). The selected switch position is grounded. The switch positions that are not selected are open. The valid combinations for each switch position are shown in Table 7 that follows.

Table 7

Status for Direction Control Switch			
Switch Position	**Reverse (J1-14)**	**Neutral (J1-13)**	**Forward (J1-30)**
Reverse	Closed	Open	Open
Neutral	Open	Closed	Open
Forward	Open	Open	Closed

Reference: For more information on the function of the transmission direction control switch, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Switch (Transmission Upshift)

The transmission upshift switch makes momentary contact in order to select the next higher speed. The operator selects a speed by depressing the upshift and downshift switches (2).

The transmission upshift switch has two input connections at the power train electronic control module (ECM). The two input connections at the power train ECM on connector J1 follow: upshift N/C at contact 19 and upshift N/O at contact 23. When the operator presses the upshift switch, the upshift N/C circuit is open and the upshift N/O circuit is closed to ground. When the switch is not activated, the upshift N/C circuit is closed to ground and the upshift N/O circuit is open. The valid combinations for each switch position are shown in Table 8 that follows.

Table 8

Status for Upshift Switch		
Switch Position	**N/O(1) J1-23**	**N/C(2) J1-19**
Depressed	Closed	Open
Released	Open	Closed

(1) N/O means Normally Open.
(2) N/C means Normally Closed.

Reference: For more information on the function of the transmission upshift switch, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Switch (Transmission Downshift)

The transmission downshift switch makes momentary contact in order to select the next lower speed. The operator selects a speed by depressing the upshift and downshift switches (2).

The transmission downshift switch has two input connections to the power train electronic control module (ECM) on connector J1: downshift N/C at contact 25 and downshift N/O at contact 26. When the operator presses the downshift switch, the downshift N/C circuit is open and the downshift N/O circuit is closed to ground. When the switch is not activated, the downshift N/C circuit is closed to ground and the downshift N/O circuit is open. The valid combinations for each switch position are shown in Table 9 that follows.

Table 9

Status for Downshift Switch		
Switch Position	**N/O(1) J1-26**	**N/C(2) J1-25**
Depressed	Closed	Open
Released	Open	Closed

(1) N/O means Normally Open.
(2) N/C means Normally Closed.

Reference: For more information on the function of the transmission downshift switch, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Quickshift Switch

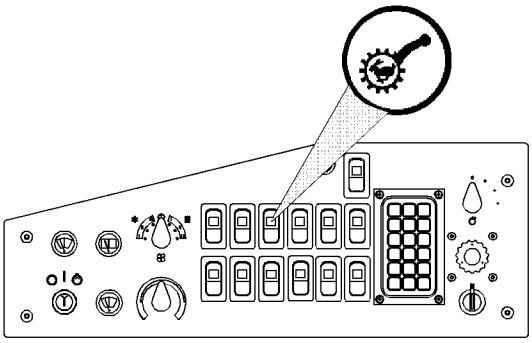


Illustration 13 g01200293

The quickshift switch is a two-position switch. The quickshift switch tells the power train electronic control module (ECM) if the quickshift function is activated. The switch has two input connections to the power train ECM: connector contact J2-10 and connector contact J1-38. The valid combination for each switch position is shown in Table 10 that follows.

Table 10

Status of the Quickshift Switch		
Switch Position	**N/O(1) J2-10**	**N/C(2) J1-38**
On	Closed	Open
Off	Open	Closed

(1) N/O means Normally Open.
(2) N/C means Normally Closed.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Start Switch (Key)

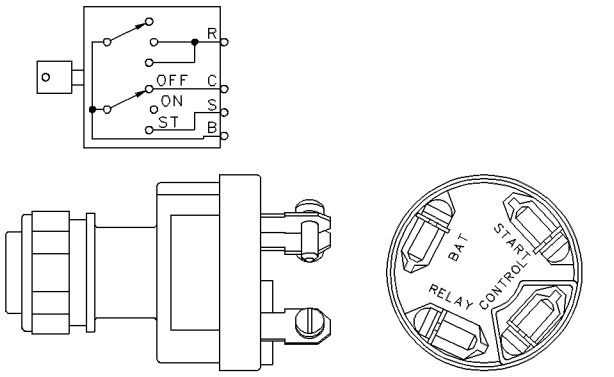


Illustration 14 g00291705

Key Start Switch

The key start switch is an input of the power train electronic control module (ECM). The key start switch informs the power train ECM of an attempt to start the engine. The power train ECM then initiates the neutral start function.

During normal machine operation, the start terminal of the key start switch is open. When the key start switch is turned to the START position, the start terminal closes to the +battery and the +battery voltage is present at connector contact J1-40 of the power train ECM. When all starting conditions are satisfied, the power train ECM sends a +battery signal to the connector contact J1-8 for the start relay and engine cranking begins.

Note: After the key start switch is initially turned to the START position, the switch will not return to the START position from the ON position. The switch must be turned to the OFF position first. Then, the switch can be turned to the START position.

Reference: For more information on the neutral start function, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Transmission Lock Switch (Transmission Neutral Lock)

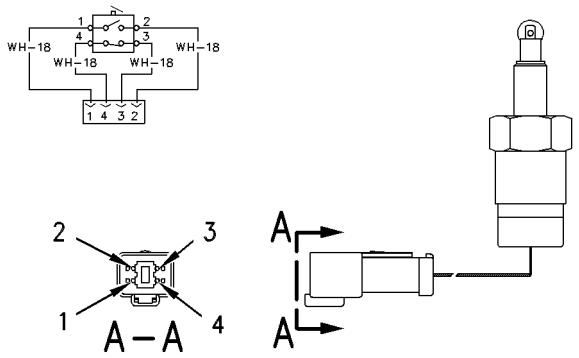


Illustration 15 g00573835

Transmission Lock Switch (Transmission Neutral Lock)

Note: The transmission lock switch (transmission neutral lock) is part of the STIC steering control.

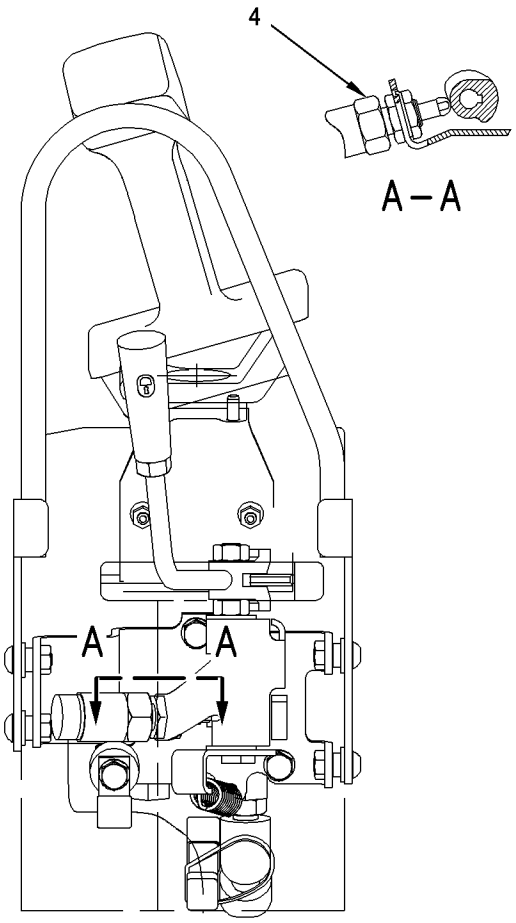


Illustration 16 g00574729

View of the STIC Steering Control from the Monitor Panel

(4) Transmission lock switch (transmission neutral lock).

The transmission lock switch (transmission neutral lock) is used to lock the transmission in the neutral position. The transmission lock switch (transmission neutral lock) is activated by a large lever. The lever is located at the left side of the operator's seat. The transmission will be locked if the lever is in the locked position. The transmission will be unlocked if the lever is in the unlocked position.

The transmission lock switch (transmission neutral lock) is placed in the locked position while the transmission is in neutral. While the transmission is in the neutral position direction shifts out of neutral are inhibited. If the transmission lock switch (transmission neutral lock) is set to the locked position the transmission is shifted to neutral while the transmission is in any forward or reverse speed range. The transmission will remain in neutral until the operator moves the direction switch out of neutral into forward or reverse after the transmission lock switch (transmission neutral lock) is placed in the unlocked position.

Conversely, if the transmission lock switch (transmission neutral lock) is set to the unlocked position, the operator will have full control over the transmission. The valid combinations for each switch position are shown in Table 11 that follows.

Table 11

Transmission Lock Switch Transmission Neutral Lock		
Switch Position	**N/O(1) J1-20**	**N/C(2) J1-24**
Locked	Closed	Open
Unlocked	Open	Closed

(1) N/O means Normally Open.
(2) N/C means Normally Closed.

Reference: For more information on the transmission lock switch (transmission neutral lock), refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the function of the power train ECM, refer to Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Lockup Clutch Switch (Torque Converter Lockup)

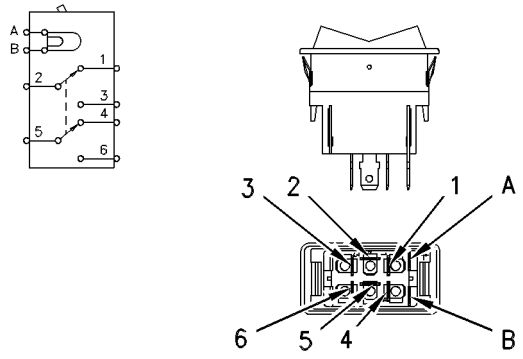


Illustration 17 g00574911

Lockup clutch switch

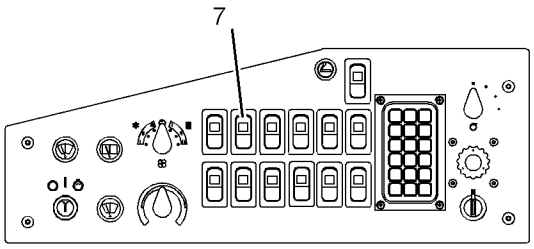


Illustration 18 g01200317

(7) Location of the lockup clutch switch

The lockup clutch switch (7) is an input of the power train electronic control module (ECM). The lockup clutch switch signals the power train ECM to enable the lockup clutch function.

The lockup clutch switch is a two-position rocker switch. When the switch is actuated, the switch closes connector contact J1-32 to ground. When the switch is deactivated, the switch is open to ground. The switch has eight terminals. Terminals 5 and 6 are used to turn on the indicator for the lockup clutch. Terminal A and terminal B turn on the indicator for the switch. Terminal 3 connects to connector contact J1-32 of the power train ECM. Terminal 2 connects to the ground.

The valid combinations for each switch position are shown in Table 5 that follows.

Table 12

Lockup Clutch Switch	
Switch Position	**N/O(1) J1-32**
On	Closed
Off	Open

(1) N/O means Normally Open.

Note: The normally open circuit of the lockup clutch switch is used as input to the power train electronic control module (ECM). The ECM does not diagnose faults on this switch.

Ride Control Switch

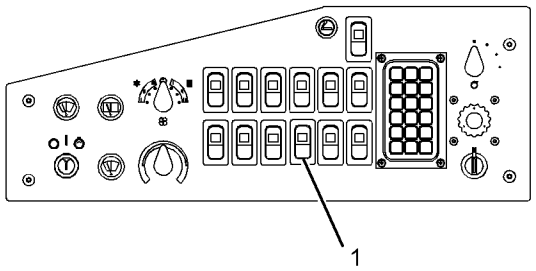


Illustration 19 g01200324

(1) Ride control switch

The ride control switch (1) is an input to the power train ECM. The ride control switch informs the power train electronic control module (ECM) of the mode of ride control that is selected. There are three modes of ride control: AUTO, ON and OFF.

The ride control switch has two input connections to the power train ECM at connector J1: input 1 at contact 21 and input 2 at contact 22. When the operator selects the AUTO position, input 1 is closed to ground and input 2 is open. When the ON position is selected, input 1 is open and input 2 is closed to ground. When the OFF position is selected, input 1 and input 2 are closed to ground. The valid combinations for each switch position are shown in Table 13 that follows.

Table 13

Status of the Ride Control Switch			
Mode	**Switch Position**	**J1-21**	**J1-22**
ON	Up	Open	Closed
OFF	Center	Closed	Closed
AUTO	Down	Closed	Open

Reference: For more information on the ride control function, refer to Systems Operation, “Ride Control Function” for the machine that is being serviced.

Autolube Grease Level Switch

Some machines are equipped with an optional autolube system. The autolube grease level switch is an input to the power train ECM. The autolube grease level switch informs the ECM of the status of the grease level in the system.

The autolube grease level switch has one input connection to the power train ECM at connector J2-18. When the grease level is normal, the switch is closed to ground. When the grease level becomes low, the switch is open. The valid combinations for each switch position are shown in Table 12 that follows.

Table 14

Autolube Grease Level Switch	
Switch Position	**J2-18**
Low grease level	Open
Normal grease level	Closed

Manual Lube Switch (Autolube)

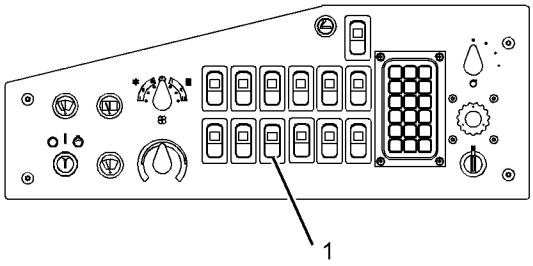


Illustration 20 g01200351

(1) Manual lube switch

Some machines are equipped with an optional autolube system. The manual lube switch for the autolube system is an input to the power train ECM. The manual lube switch is a momentary switch that allows the operator to provide a single injection of grease at any time.

The manual lube switch has one input connection to the power train ECM at connector J1-28. When the switch is actuated, the switch opens connector contact J1-28. When the switch is deactivated, the switch is closed to ground.

The valid combinations for each switch position are shown in Table 15 that follows.

Table 15

Manual Lube Switch	
Switch Position	**J1-28**

(continued)

(Table 15, contd)

Released	Closed
Depressed	Open

i02403923

Sensors

SMCS Code: 1907; 1912; 301T; 3141; 3175

Sensors provide information to the power train electronic control module (ECM) about changing conditions. The sensor signal changes proportionally to the changing conditions. The following type of sensor signals are recognized by the power train ECM:

- Frequency signals: The frequency (Hz) of the sensor signal varies as the condition changes.
- Pulse width modulated signals (PWM): The duty cycle of the sensor signal varies as the condition changes. The frequency of this signal is constant.

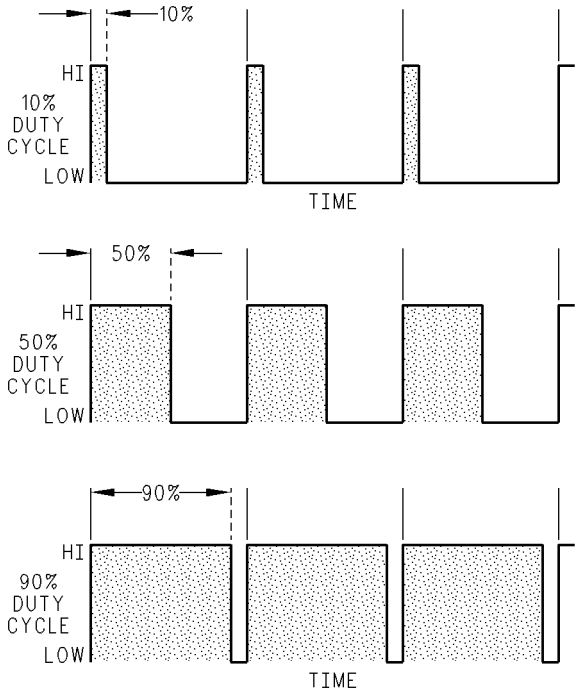


Illustration 21 g00288430

Pulse Width Modulated Signal

Speed Sensors (Transmission Output and Torque Converter Output)

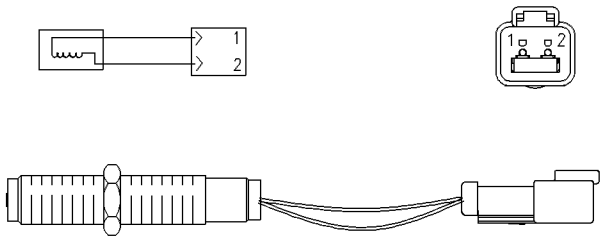


Illustration 22 g00288428

Transmission Output Speed Sensor

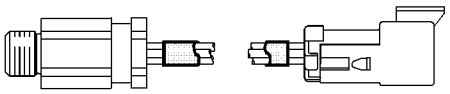


Illustration 23 g01215213

Torque Converter Output Speed Sensor

There is a transmission output speed sensor and a torque converter output speed sensor on the machine. The speed sensors are inputs of the power train ECM. These speed sensors are frequency sensors. Frequency sensors produce a signal (Hz) which varies as the condition changes. The sensor generates an approximate sine wave signal from the gear teeth as the gear teeth pass the sensor. The sensor produces a signal that equals one pulse per gear tooth. This signal is sent to the power train ECM. The power train ECM measures the frequency of the signal in order to determine the speed of the condition. The power train ECM receives signals from the speed sensors. The power train ECM uses the input from the speed sensors in order to determine the speed of the system. The power train ECM uses the input from the speed sensors in order to regulate transmission shifts. Each speed sensor has two connections to the power train ECM (+ and −).

The power train ECM sends the speed information to other electronic control modules via the CAT Data Link. Two transmission speed sensors measure transmission output speed. The power train ECM uses the pairs of speed sensors to determine the direction of rotation.

Note: The speed sensors are used to diagnose each other during normal operation. The power train ECM periodically checks the value from the speed sensor. If an incorrect value is found, the power train ECM will log a service code that indicates a fault for a speed sensor circuit.

Reference: For more information on diagnostic operations for the power train electronic control system, refer to Systems Operation, “Power Train Electronic Control System” for the machine that is being serviced.

Reference: For more information on the CAT Data Link, refer to the Service Manual module Systems Operation, “CAT Data Link” for the machine that is being serviced.

Reference: For more information on the power train electronic control module (ECM), refer to the Service Manual module Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Temperature Sensors (Transmission Oil and Axle Oil)

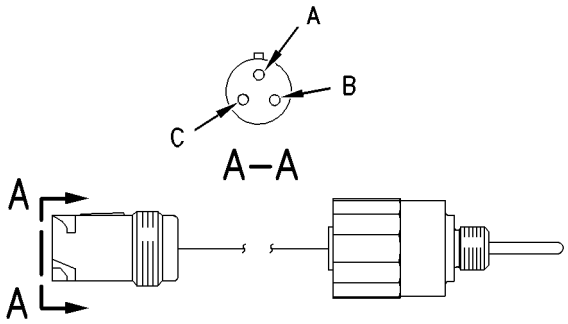


Illustration 24 g00851399

Temperature sensor (transmission oil and axle oil)

There is a transmission oil temperature sensor, a front axle oil temperature sensor, and a rear axle oil temperature sensor on the machine. All three temperature sensors are pulse width modulated sensors (PWM).

The power train ECM measures transmission oil temperature with the transmission oil temperature sensor. The power train ECM uses the oil temperature reading in order to adjust the shift times of the transmission. The power train ECM adjusts the shift times of the transmission in order to provide smooth shifts over the various ranges of the transmission oil temperature.

The machine is equipped with a front axle oil temperature sensor and a rear axle oil temperature sensor. These sensors are not connected to the power train ECM. The sensors are connected to the monitoring system of the machine.

Reference: For more information on the operation of the machine, refer to the Service Manual module Operation and Maintenance Manual for the machine that is being serviced.

Reference: For more information on the power train electronic control module (ECM), refer to the Service Manual module Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

Position Sensor (Left Pedal)

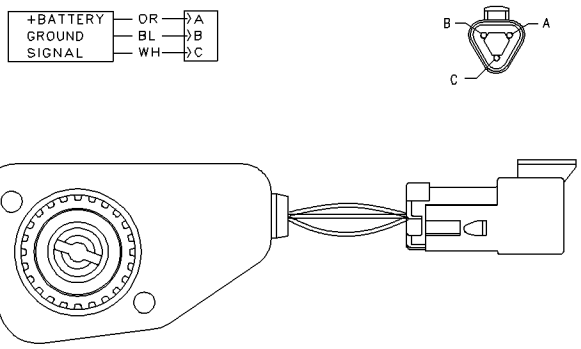


Illustration 25 g00779650

Position Sensor (Left Brake Pedal)

The position sensor (left brake pedal) sends an input to the ECM. The sensor will continuously update the power train ECM on the position of the left pedal. The left pedal position sends a change in the input signal to the power train ECM. The ECM records the change of position. Then, the ECM activates the appropriate solenoid valve.

The position sensor (left brake pedal) is a PWM sensor. The sensor continuously generates a PWM signal. The duty cycle varies in proportion to the position of the lever. The ECM receives the PWM signal from the position sensor. The ECM measures the duty cycle in order to determine the position of the lever. The frequency of the sensor signal is constant at 5000 Hz. The machine electrical system provides +battery voltage to the lever position sensor for operating power.

Pressure Sensor (Torque Converter Impeller Clutch Oil)

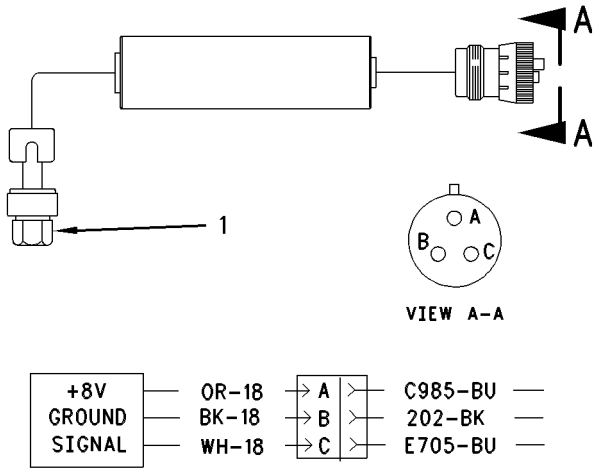


Illustration 26 g01200505

Pressure Sensor (Torque Converter Impeller Clutch Oil)

The pressure sensor (torque converter impeller clutch oil) sends an input to the power train ECM. The sensor will continuously update the ECM on the pressure of the torque converter impeller clutch oil.

The pressure sensor (torque converter impeller clutch oil) is a pulse width modulated sensor. The duty cycle of the sensor varies in proportion to the pressure of the torque converter impeller clutch oil. The ECM measures the duty cycle that is sent by the sensor in order to determine the pressure of the torque converter impeller clutch oil. The frequency of the sensor signal is constant at 5000 ± 1000 Hz. The machine electrical system provides operating power (8 VDC) to the pressure sensor.

i02404056

Solenoid Valves

SMCS Code: 3174

Transmission Clutch

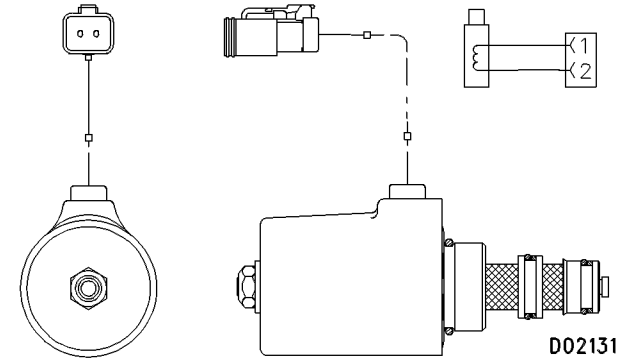


Illustration 27 g00021395

Solenoid Valve (Transmission Clutch)

The clutch solenoid valves for the transmission are outputs of the power train ECM. The power train ECM activates the appropriate clutch solenoid valves for the transmission. Clutch solenoid valves “1” and “2” are for direction. Clutch solenoid valves “3” , “4” , and “5” are for speed. For the movement of the machine, two clutch solenoid valves are activated. One clutch solenoid valve is for direction and one clutch solenoid valve is for speed. When the transmission is in neutral, only clutch solenoid valve “3” is activated. See table 16 for the status of the solenoid valves during shifting. When the transmission is neutralized, the solenoid valve for direction is deactivated and only the solenoid valve for present speed is activated. A solenoid valve is energized by a PWM signal that is sent by the power train ECM.

Table 16

Status of the Clutch Solenoid Valves		
Speed	**Direction**	**Activated Solenoids**
First Gear	Forward	5 and 2
Second Gear	Forward	4 and 2

(continued)

(Table 16, contd)

Status of the Clutch Solenoid Valves		
Speed	**Direction**	**Activated Solenoids**
Third Gear	Forward	3 and 2
Neutral	Neutral	3
First Gear	Reverse	5 and 1
Second Gear	Reverse	4 and 1
Third Gear	Reverse	3 and 1

The clutch solenoid valves have a connector with two contacts. Connector contact “1” receives power from the power train ECM. See table 17 for the connections on the power train ECM. The connector contact “2” of the solenoid valves are joined together. These contacts return to connector J2-3 of the power train ECM.

Table 17

Solenoid Valves (Transmission Clutch)		
Direction or Speed	**Solenoid**	**ECM Connector**
Forward Direction	2	J1-11
Reverse Direction	1	J1-17
First Gear	5	J2-8
Second Gear	4	J2-1
Third Gear	3	J2-7

Note: The solenoid coils are not designed for operation with a direct 24 volt DC signal. Activating the coils with a 24 volt DC signal will cause the life of the coils to be reduced. Use a 12 volt DC signal in order to activate the solenoid coils from a source that is not from the power train ECM.

Note: Engagement of the neutral clutch is delayed for two seconds. This delay occurs between the selection of neutral by the operator and the engagement of the neutral clutch. The clutch solenoid valves for the transmission are not energized during this delay. This condition is called the no clutch neutral function. See System Operation, “Power Train Electronic Control System” for more information on the no clutch neutral function.

Torque Converter

The lockup clutch solenoid valve and the impeller clutch solenoid valves are part of the valve body that is located on the torque converter.

Impeller Clutch Solenoid Valve

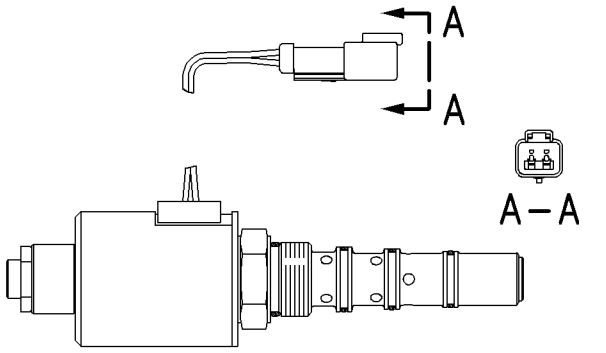


Illustration 28 g00855878

Impeller Clutch Solenoid Valve

The impeller clutch solenoid valve is an output of the power train ECM. The impeller clutch solenoid valve functions as a reducing valve. The impeller clutch solenoid valve modulates the hydraulic pressure of the impeller clutch. When the power train ECM increases the current to the solenoid valve, hydraulic pressure at the impeller clutch is reduced. When the current is zero, the impeller clutch pressure is maximum. The power train ECM varies the current (PWM signal) to the solenoid valve and the solenoid valve modulates the impeller clutch pressure.

The impeller clutch solenoid valve has a connector with two contacts. Connector “A” of the impeller clutch solenoid valve receives power from J2-19 of the power train ECM. Connector “B” of the impeller clutch solenoid valve returns the signal to J2-3 of the power train ECM.

Note: Do not switch the impeller clutch solenoid valves mechanically and do not switch the impeller clutch solenoid valves electrically.

Lockup Clutch Solenoid Valve

The lockup clutch solenoid valve is an output of the power train ECM. The lockup clutch solenoid valve functions as a proportional valve. The lockup clutch solenoid valve activates or the lockup clutch solenoid valve deactivates the lockup function (direct drive). When the power train ECM sends a high current signal to the solenoid valve, the power train ECM activates the lockup function. When the power train ECM does not send a current signal to the solenoid valve, the lockup function is deactivated.

The lockup clutch solenoid valve has a connector with two contacts. Connector “1” of the lockup clutch solenoid valve receives power from J2-13 of the power train ECM. Connector “2” of the lockup clutch solenoid valve returns the signal to J2-3 of the power train ECM.

Note: Do not switch the lockup clutch solenoid valves mechanically and do not switch the lockup clutch solenoid valves electrically.

i02404063

Cat Data Link

SMCS Code: 7610-DTN

The CAT Data Link is a communication link that is used for the movement of data between electronic controls. The CAT Data Link allows communication between the power train electronic control module (ECM) and the Caterpillar Monitoring System. The CAT Data Link is bidirectional. The CAT Data Link allows the power train ECM to input information. The CAT Data Link allows the power train ECM to output information. The CAT Data Link is not a visible component. The CAT Data Link consists of the following parts: internal circuits for power train ECM, the related harness wiring and the service tool connector. The CAT Data Link and the power train ECM are connected at pin-out J1-3 and pin-out J1-9.

The power train ECM and the Caterpillar Monitoring System use data that is sent back and forth on the CAT Data Link. The following information is some of the information that is shared:

- The power train ECM receives a service command from the Caterpillar Monitoring System. The service command can change the operating mode of the power train electronic control system. The power train ECM receives a service command from the Caterpillar Monitoring System in order to change the operating modes of the power train electronic control system. The service command can direct the power train ECM to read service codes that are stored in the ECM memory. The service command can direct the power train ECM to clear service codes that are stored in the ECM memory.
- The power train ECM receives the harness code input from the Caterpillar Monitoring System. The power train ECM determines the sales model of the machine from the harness code input.
- The power train ECM sends signals to the Caterpillar Monitoring System. The Caterpillar Monitoring System uses the signals to report on the status of the power train electronic control system. The Caterpillar Monitoring System alerts the operator of the status by illuminating the corresponding alert indicator.
- The power train ECM sends the parking brake status to the Caterpillar Monitoring System. The power train ECM sends the direction of the transmission to the Caterpillar Monitoring System. The power train ECM sends the status of transmission speed to the Caterpillar Monitoring System. The Caterpillar Monitoring System uses this information to display the direction of the transmission and the speed of the transmission. The Caterpillar Monitoring System uses this information in order to show the operator if the parking brake is engaged or disengaged.

Note: All electronic control modules that use the CAT Data Link have a module identifier (MID). These module identifiers are used on the 988G Wheel Loader:

Module Identifiers (MID)

Caterpillar Monitoring System	030
Engine ECM	036
Power Train ECM	081

Reference: For more information about theCaterpillar Monitoring System, refer to the Service Manual module Systems Operation, “Caterpillar Monitoring System” for the machine that is being serviced.

Reference: For more information on the power train electronic control module (ECM), refer to the Service Manual module Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

i02404070

Monitoring System (Power Train Functions)

SMCS Code: 7490

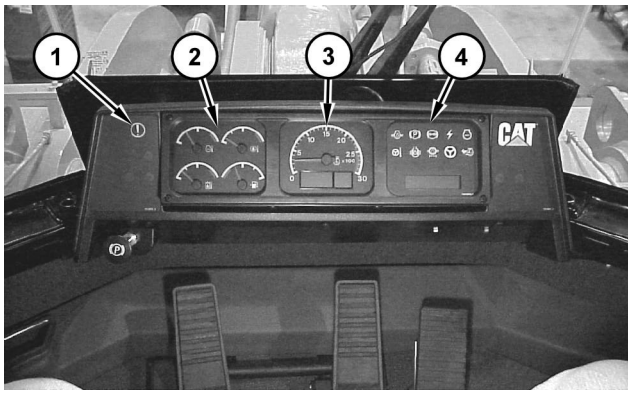


Illustration 29 g01200663

Components of the Caterpillar Monitoring System Panel

(1) Action Lamp
(2) Quad gauge electronic module
(3) Speedometer/tachometer module
(4) Alert indicators

The Caterpillar Monitoring System sends input signals to the power train electronic control module (ECM). The power train ECM sends output to the Caterpillar Monitoring System. The Caterpillar Monitoring System and the power train ECM communicate back and forth on the Cat Data Link.

The Caterpillar Monitoring System indicates the status of basic functions of the machine. This includes the power train system.

The power train ECM receives the harness code input from the Caterpillar Monitoring System. The power train ECM determines the sales model of the machine from the harness code input. The power train ECM receives service commands from the Caterpillar Monitoring System. The service commands can change the operating mode of the power train electronic control system. The service commands can direct the power train ECM to read service codes that are stored in the memory of the power train ECM. The service commands can direct the power train ECM to clear service codes that are stored in the memory of the power train ECM.

A Warning Category 1 alerts the operator that a machine function needs attention. In this category, only the alert indicators will flash.

A Warning Category 2 alerts the operator that a change in the operation of the machine should occur as soon as possible. This will reduce the excessive temperatures in one or more of the machine systems. This helps prevent potential damage to the machine.

A Warning Category 2 causes both action lamp (6) and the alert indicator to flash.

Note: Do not operate the machine if the alert indicator and the action lamp continue to flash after investigating the cause.

A Warning Category 3 alerts the operator that engine shutdown should occur as soon as possible. This helps prevent injury to the operator or potential damage to the machine.

A Warning Category 3 causes both action lamp (6) and the alert indicator to flash. A Warning Category 3 also causes the action alarm to sound.

Note: Do NOT operate the machine until the cause of the warning has been corrected.

For the power train system, the Caterpillar Monitoring System problems that can activate alert indicator (6) follow. **Problems that appear below in bold text indicate a possible Warning Category 3.**

- Parking Brake
- Secondary Steering
- Transmission Oil Temperature
- Axle Oil Temperature
- **Transmission Oil Filter**
- **Parking Brake**
- **Primary Steering**

Reference: For more information about the operation of the Caterpillar Monitoring System, refer to the Service Manual module for Systems Operation, Testing and Adjusting, SENR1394, “Caterpillar Monitoring System”.

Reference: For more information about the operation of the Caterpillar Monitoring System, refer to the Operation and Maintenance Manual for the machine that is being serviced.

i01646186

Transmission Hydraulic System

SMCS Code: 3030; 3101

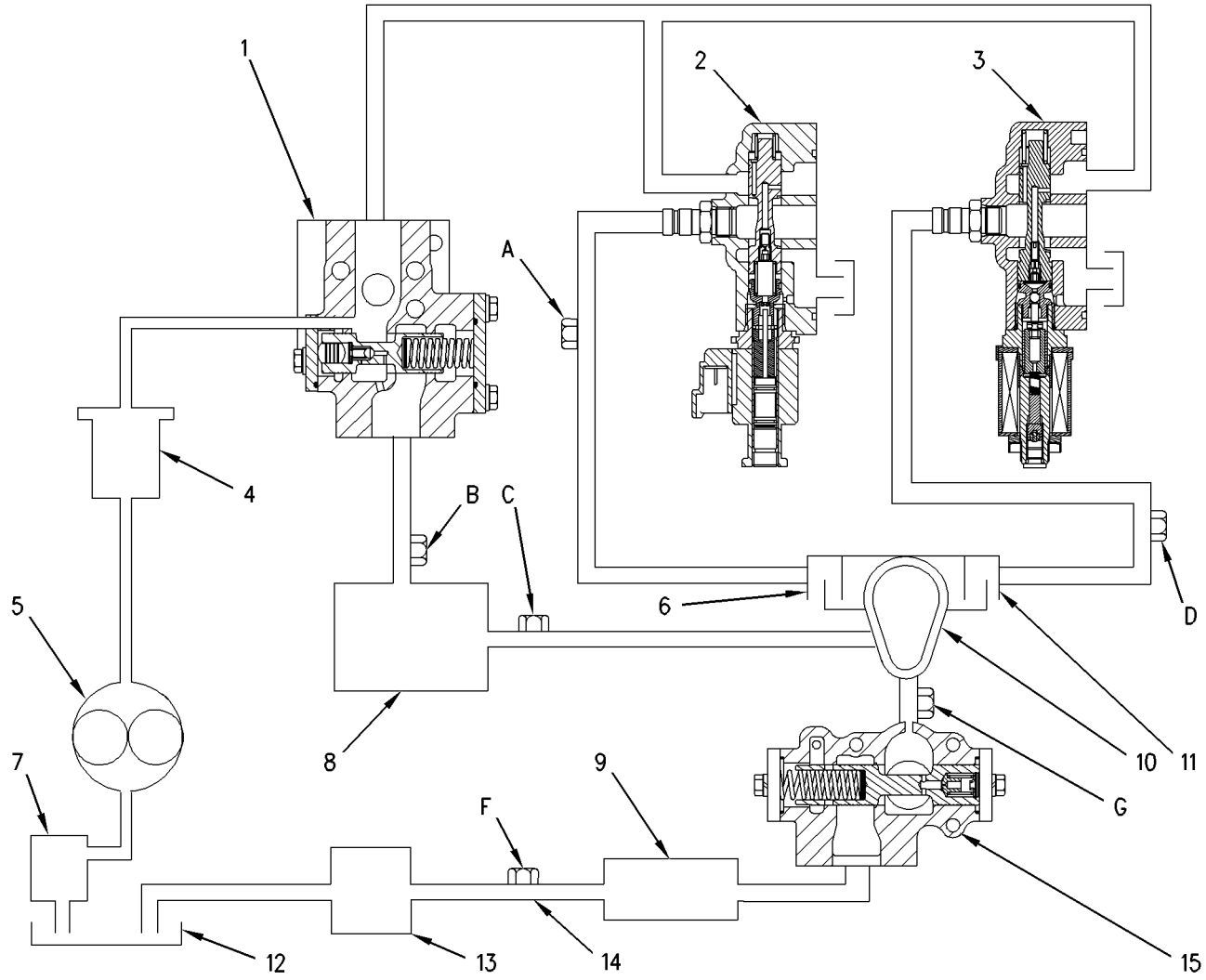


Illustration 30 g00858063

Hydraulic System Schematic

(1) Priority valve
(2) Modulating valve (lockup clutch)
(3) Modulating valve (impeller clutch)
(4) Oil filter
(5) Oil pump
(6) Lockup clutch
(7) Magnetic screen
(8) Transmission hydraulic control
(9) Oil cooler
(10) Torque converter
(11) Impeller clutch
(12) Reservoir in output transfer gear case
(13) Planetary lubrication
(14) Outlet line from oil cooler to planetary lubrication
(15) Torque converter outlet relief valve
(A) Pressure tap for lockup clutch
(B) Oil pump output pressure tap P1
(C) Torque converter inlet pressure tap P3
(D) Pressure tap for impeller clutch
(F) Lubrication pressure tap
(G) Torque converter outlet pressure tap

The transmission hydraulic system contains a common reservoir. The reservoir is at the bottom of output transfer gear case (12). The reservoir supplies oil for the operation of the torque converter and for the operation of the transmission. The reservoir also provides lubrication oil for the different components in the system.

Oil is pulled from the reservoir through magnetic screen (7) by transmission oil pump (5). The transmission oil pump is fastened to the rear of the torque converter cover. Transmission oil pump (5) sends pressure oil to transmission oil filter (4). The oil flows through the transmission oil filter. If there are any restrictions in the oil filter, a bypass valve in the filter housing allows the oil to flow around the filter.

The oil flows from the transmission oil filter to priority valve (1). The priority valve maintains a constant oil pressure to the modulating valves (2) and (3) during transmission shifts. Modulating valve (2) supplies oil to lockup clutch (6). Modulating valve (3) supplies oil to impeller clutch (11).

The remaining oil from the priority valve flows to transmission hydraulic control (8). The transmission hydraulic control regulates the oil pressure and the oil flow for the engagement of the transmission clutches. The transmission hydraulic control also provides the inlet oil to the torque converter.

Inlet oil for the operation of the torque converter flows through a hose to the torque converter. The converter inlet ratio valve limits the oil pressure to the torque converter. Oil leakage inside the torque converter lubricates the inside components. After the components are lubricated, the oil flows to the bottom of the torque converter housing. The oil then flows from the bottom of the torque converter housing to the reservoir in output transfer gear case (12).

Oil from the torque converter flows to torque converter outlet relief valve (15). Torque converter outlet relief valve (15) maintains the pressure inside the torque converter at a specific rate. The oil flows from the torque converter outlet relief valve to power train oil cooler (9).

After flowing through the power train oil cooler, the oil is at a lower temperature. This oil flows to the input transfer gears. The oil then flows to the transmission planetary group. This oil is for the lubrication of the inside components of the transmission and for the lubrication of the input transfer gears and the output transfer gears.

i01647464

Torque Converter and Pump Drive Housing

SMCS Code: 3101; 3105; 3108

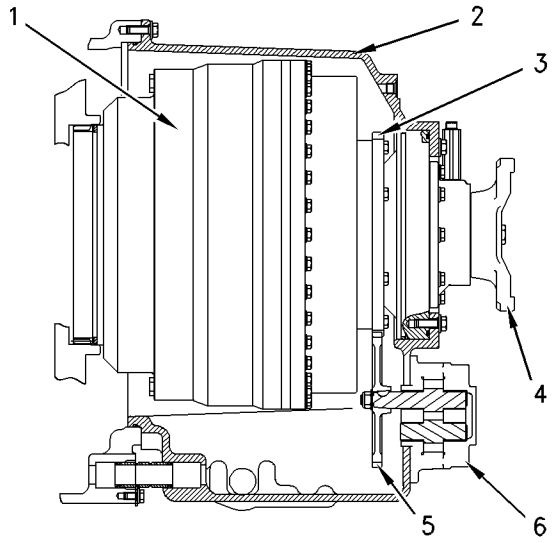


Illustration 31 g00851254

Torque Converter and Pump Drive Housing

(1) Torque converter
(2) Torque converter housing
(3) Drive gear
(4) Output yoke
(5) Drive gear (transmission oil pump)
(6) Transmission oil pump

Transmission oil pump (6) is mounted on torque converter housing (2). Torque converter housing (2) is mounted on the engine flywheel housing.

Gear (3) turns drive gear (5) for transmission oil pump (6). Torque converter (1) turns output yoke (4). Output yoke (4) for the torque converter sends power to the input drive shaft. The input drive shaft provides power for the transmission.

i02404439

Torque Converter (Lockup)

SMCS Code: 3101-L7

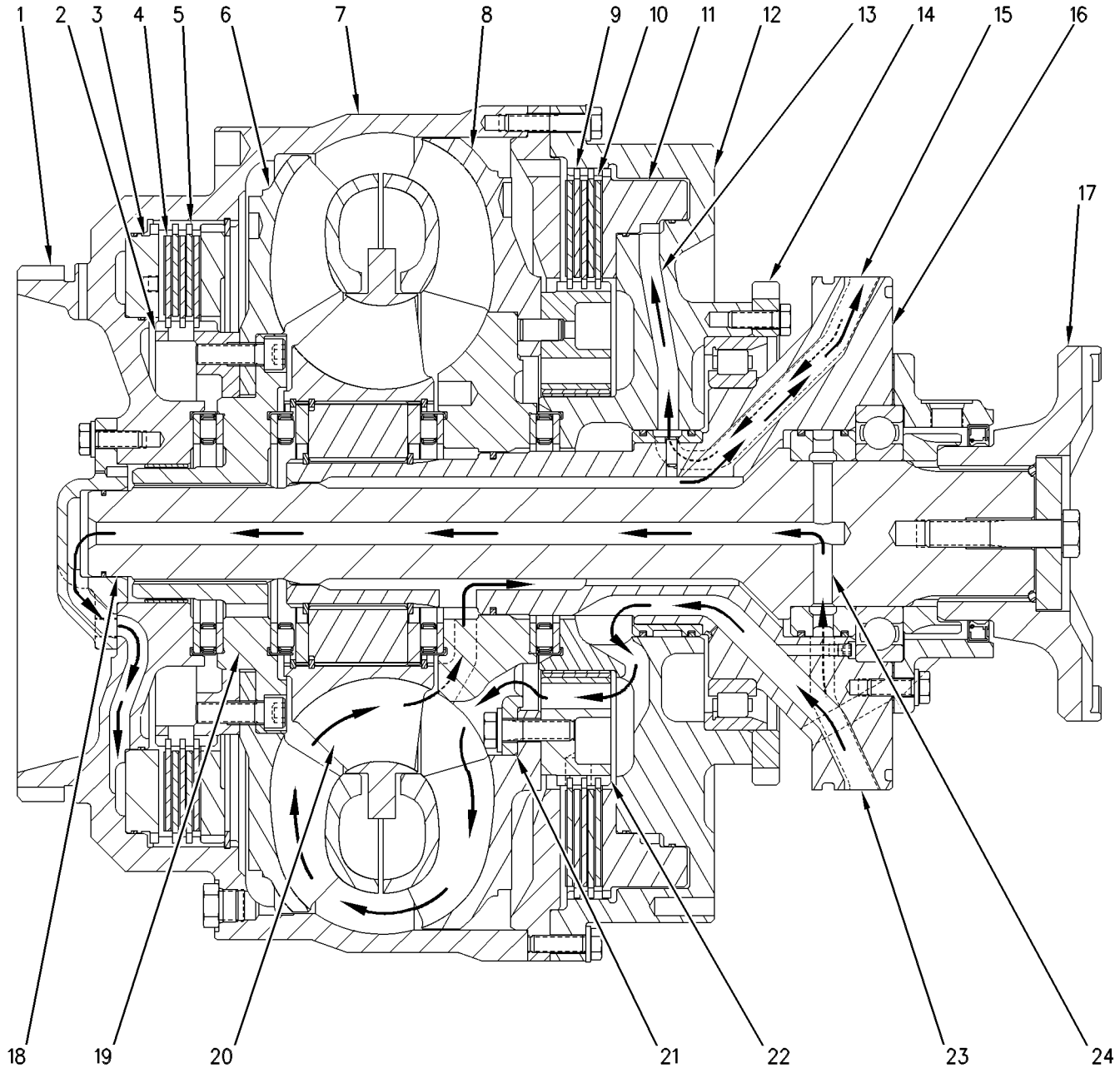


Illustration 32 g00376518

(1) Spline
(2) Adapter
(3) Lockup clutch piston
(4) Disc
(5) Plate
(6) Turbine
(7) Converter housing
(8) Impeller
(9) Plate
(10) Disc
(11) Impeller clutch piston
(12) Clutch housing
(13) Oil passage for Impeller clutch
(14) Oil pump drive gear
(15) Torque converter outlet passage for oil
(16) Carrier
(17) Output yoke
(18) Output shaft
(19) Hub
(20) Stator
(21) Hub

(22) Adapter (23) Torque converter inlet passage for oil (24) Oil passage for lockup clutch

This torque converter contains a lockup clutch and an impeller clutch. The lockup clutch provides a choice of either torque converter drive or direct drive. The impeller clutch enables the output torque of the converter to vary.

Spline (1) is a part of converter housing (7). Spline (1) is engaged with the splines on the engine flywheel. These splines turn the converter housing at engine speed. The converter housing contains the lockup clutch for the turbine. Clutch housing (12) is fastened to the converter housing. Oil pump drive gear (14) is fastened to the clutch housing.

Stator (20) is connected to carrier (16). Carrier (16) is fastened to the cover that is around the torque converter. Carrier (16) and stator (20) do not turn. The carrier helps to support the rotating components of the converter. The carrier also contains the passages that carry oil for the operation of the converter.

Converter housing (7), clutch housing (12), and oil pump drive gear (14) turn as a unit at the speed of the engine. Internal splines in clutch housing (12) turn plates (9) and piston (11). Clutch discs (10) are connected to adapter (22) with splines. Adapter (22) is fastened to impeller (8) and hub (21) with bolts.

Internal splines in converter housing (7) turn clutch plates (5) and piston (3). The splines on clutch discs (4) are meshed with adapter (2). Adapter (2) is fastened to turbine (6) and hub (19). Splines connect hub (19) to output shaft (18). The output shaft is connected to output yoke (17). The output yoke is fastened to a universal joint and to the drive shaft. The drive shaft connects to the input transfer gears of the transmission.

Oil from the transmission oil pump flows to the transmission oil filter. Oil then flows to the priority valve. The oil from the priority valve then flows to the solenoid valves of the torque converter clutches and the remainder flows to the transmission hydraulic control valve.

In the transmission hydraulic control valve, the oil flows around the modulating relief valve to the torque converter inlet ratio valve. Oil from the torque converter inlet ratio valve flows through a hose into inlet passage (23) in the carrier, and then into the torque converter. The oil then flows through hub (21) into impeller (8).

Torque Converter Operation

The oil that is inside of the torque converter flows from impeller (8) to turbine (6), and then to stator (20). The oil from stator (20) then flows to the impeller and to outlet passage (15) in carrier (16).

The torque converter is operated with pressurized oil. The maximum inlet pressure is controlled by the torque converter inlet ratio valve. The outlet pressure is controlled by the outlet relief valve and by downstream restrictions.

Oil flows through inlet passage (23) in carrier (16) to hub (21) and impeller (8). The rotation of the impeller gives force to the oil. The impeller sends the oil toward turbine (6). The force of the oil that hits the turbine blades causes the turbine to turn. The turbine turns output shaft (18).

The oil flows from the turbine in a direction that is reverse to the direction that is required for impeller (8). Stator (20) causes the oil to change flow direction into the impeller. Because the stator is held stationary by carrier (16), most of the oil is sent back to the impeller. The remainder of the oil flows through outlet passage (15) to the outlet relief valve.

The oil from the stator adds to the oil from the inlet passage to the impeller.

Lockup Clutch

When the lockup clutch is engaged, the converter is in direct drive. Direct drive provides the highest efficiency of the drive train. The lockup clutch solenoid valve controls the oil flow to the lockup clutch. The lockup clutch solenoid valve is positioned on the outer cover. The power train ECM activates the lockup clutch solenoid.

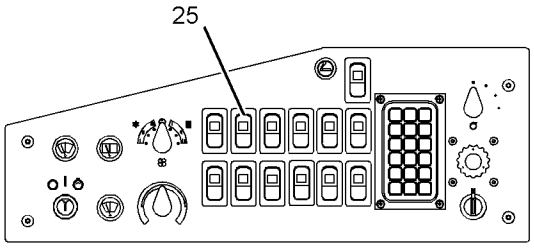


Illustration 33 g01201027

Right Side Console

(25) Lockup clutch switch.

The following conditions must be present in order for the power train ECM to activate the lockup clutch:

- Lockup clutch switch (25) on the right side of the console must be in the ON (enabled) position for the 990H Wheel Loader for all speeds.

- Lockup clutch switch (25) on the right side of the console must be in the ON (enabled) position for the 844H Wheel Tractor when the transmission is in first speed. The lockup clutch activates automatically in second speed and third speed.
- The torque converter output speed is greater than 1520 rpm.
- The machine has been at the present speed and at the present direction for at least 2 seconds.
- The left service brake pedal must not be depressed.

The lockup clutch is disengaged during a shift, and then engaged when the four conditions are met again in the new selected gear. The lockup clutch is also disengaged when the torque converter output speed drops below 1370 rpm.

The lockup clutch cannot be engaged when the output speed of the torque converter is greater than 2120 rpm. This helps to prevent overspeed of the engine.

Lockup Clutch Solenoid Valve

The lockup clutch solenoid valve is a three-way, proportional pressure control valve. When the power train ECM sends current to the solenoid, lockup clutch pressure is at the maximum. When the power train ECM sends zero current to the solenoid, the lockup clutch pressure is at the minimum.

Operation of the Lockup Clutch

When the power train ECM energizes the lockup clutch solenoid, oil flows to oil passage (24) in carrier (16). From the carrier, the oil flows through the oil passage in output shaft (18) to lockup clutch piston (3). The oil pressure on lockup clutch piston (3) forces the piston against clutch plates (5) and against clutch discs (4).

Clutch piston (3) and clutch plates (5) are connected to converter housing (7) with splines. Clutch discs (4) are connected to adapter (2) with splines. Adapter (2) is fastened to turbine (6) with bolts. The friction between clutch discs (4) and clutch plates (5) causes the turbine and the output shaft to rotate at the same speed as the converter housing.

Impeller Clutch

The impeller clutch is used to change the torque output of the torque converter. The impeller clutch allows the operator to use the left service brake pedal to reduce wheel spin. The impeller clutch also allows the operator to use the left service brake pedal to provide more engine power for the hydraulic system.

The impeller clutch is locked in the fully engaged position on the 844H Wheel Tractor only. This allows the maximum amount of torque transfer. The impeller clutch disengages during directional shifts in order to allow directional shifts at full throttle.

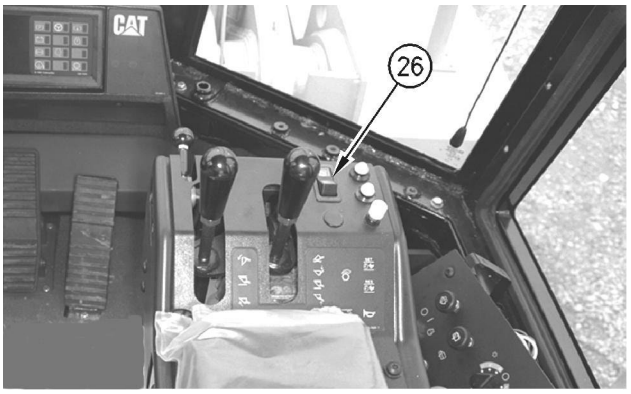


Illustration 34 g00376521

Right Hydraulic Console

(26) Reduced rimpull on/off switch

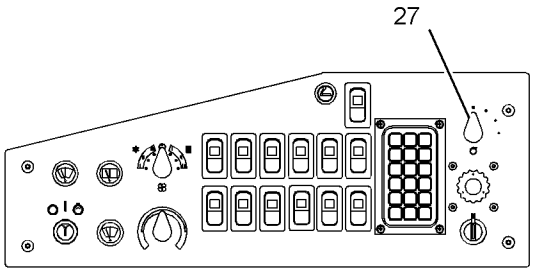


Illustration 35 g01201257

Right Side Console

(27) Reduced rimpull select switch

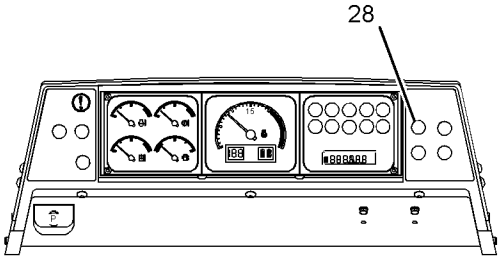


Illustration 36 g01201260

Right side front dash

(28) Reduced rimpull indicator lamp

Reduced rimpull on/off switch (26) and reduced rimpull select switch (27) are used to provide four levels of reduced rimpull. Reduced rimpull is enabled only when the transmission is in first speed forward or first speed reverse.

Reduced rimpull on/off switch (26) is a two-position rocker switch on the implement console. Reduced rimpull select switch (27) is located on the right hand console. In the MAXIMUM position, the reduced rimpull on/off switch commands maximum rimpull. Maximum rimpull will be provided regardless of the setting of the reduced rimpull select switch.

Reduced rimpull select switch (27) works with reduced rimpull on/off switch (26) in order to change the torque output of the torque converter. The power train ECM increases the amount of current to the impeller clutch solenoid valve in order to reduce rimpull. The position of the reduced rimpull select switch regulates the amount of current that is sent to the impeller clutch solenoid valve.

Reduced rimpull indicator lamp (28) is on when reduced rimpull on/off switch (26) is in the REDUCED position and the transmission is in first speed forward or first speed reverse. When the transmission is shifted to second speed or to third speed, the reduced rimpull indicator lamp will be off. Reduced rimpull is now disabled.

Reduced Rimpull Selection Control Settings	Estimated Percent Rimpull	Percent Command To Impeller Clutch
●	90	90
●	80	80
●	70	70
•	60	60

Illustration 37 g00857729

The impeller clutch modulates at each instance of a directional shift. The impeller clutch also absorbs energy during the directional shift. This reduces the amount of energy that is absorbed by the direction clutch, which results in an easier shift.

The oil flow to the impeller clutch is controlled by the impeller clutch solenoid valve. The impeller clutch solenoid valve is positioned on the outer cover. The power train ECM activates the impeller clutch solenoid.

The following conditions affect the operation of the impeller clutch:

- The position of the left service brake pedal
- Directional shifts and speed shifts
- Engine speed
- Direction of rotation of the torque converter output shaft and torque converter output speed
- Engagement of the Lockup Clutch
- Position of the reduced rimpull select switch
- Position of the reduced rimpull on/off switch

Left Service Brake Pedal

The left service brake pedal controls the amount of brake pressure that is used to apply the service brakes. The left service brake pedal also controls the amount of pressure that actuates the impeller clutch. The impeller clutch is positioned between the engine and the torque converter.

By using the left brake pedal, the operator may divert engine power to the implement hydraulic circuit without putting the transmission in the NEUTRAL position.

As the operator depresses the pedal, the impeller clutch pressure drops quickly to a working pressure.

The pressure is then modulated to a reduced pressure. This sequence occurs during the next ten degrees of pedal travel. Depressing the left pedal past this point applies the service brakes.

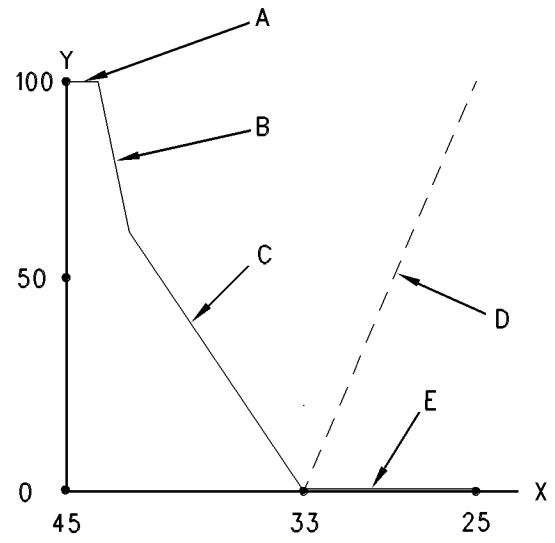


Illustration 38 g00376525

Typical Torque Converter Impeller Clutch

(X) Approximate pedal position in degrees
(Y) Approximate percent of impeller clutch pressure

Range (A) indicates the released position. In this range, the brake pedal does not apply the service brakes.

Range (B) indicates the first two degrees of pedal movement. In this range, the impeller clutch pressure is reduced to the maximum working pressure level. Range (B) is the approximate pressure range that is required to keep the impeller clutch from slipping.

Range (C) occurs approximately in the next ten degrees of pedal travel. The impeller clutch pressure is modulated from the maximum working pressure to the minimum impeller clutch pressure.

Range (D) indicates the percent of service brake pressure. Range (E) indicates the impeller clutch pressure.

Engine Speed

When the engine speed drops below 1400 rpm, the power train ECM overrides the setting of the left service brake pedal. The power train ECM reduces the impeller clutch pressure. The impeller clutch pressure is reduced to a holding pressure at 1200 rpm. This improves the response of the machine and the response of the engine when the machine is accelerating from a low idle speed.

Reverse Output Shaft Rotation

When the torque converter output shaft rotates in the opposite direction in excess of 500 rpm, the power train ECM overrides the setting of the left service brake pedal. The power train ECM then increases the impeller clutch pressure. This condition could occur if the left service brake pedal is used to allow the machine to roll backward on a grade with the transmission in a forward gear. This function helps to prevent possible high temperatures in the impeller clutch.

Impeller Clutch Shift Modulation

The power train ECM overrides the setting of the left service brake pedal and the power train ECM reduces the impeller clutch pressure during directional shifts of the transmission. These functions help to provide an easier directional shift.

When a directional shift is detected, the power train ECM reduces the circuit pressure for the impeller clutch to a holding pressure. When the transmission clutches engage, the circuit pressure for the impeller clutch increases to an intermediate pressure for .3 seconds. The circuit pressure for the impeller clutch then increases to maximum pressure after .3 seconds.

The torque converter output speed sensor and the engine speed sensor are used to determine when the transmission clutches have locked up.

Engagement of the Lockup Clutch

When the lockup clutch is engaged, the impeller clutch pressure is maintained at a holding pressure.

Impeller Clutch Solenoid Valve

The impeller clutch solenoid valve is a three-way control valve which modulates pressure proportionally. When the power train ECM increases the amount of current to the solenoid, the impeller clutch pressure is reduced. When the power train ECM decreases the amount of current to zero, the pressure in the impeller clutch is at the maximum.

Operation of the Impeller Clutch

When the power train ECM does not energize the impeller clutch solenoid valve, oil flows to passage (13) from carrier (16). Oil in passage (13) forces clutch piston (11) against clutch plates (9) and clutch discs (10).

Clutch piston (11) and clutch plates (9) are connected to clutch housing (12) with splines. Clutch discs (10) are connected to adapter (22) with splines. Adapter (22) is fastened to impeller (8) with bolts. The friction between clutch discs (10) and clutch plates (9) causes the impeller to rotate at the same speed as converter housing (7). This is the maximum torque output in torque converter drive.

As the amount of current flow to the solenoid is increased, oil pressure to clutch piston (11) is decreased. The friction between the clutch plates and the clutch discs decreases. This causes the impeller to slip. When the impeller slips, less oil is forced to the turbine. With less force on the turbine, there is less torque at the output shaft.

When the amount of current flow to the solenoid is at the maximum, there is minimum oil pressure against clutch piston (11). The clutch plates and the clutch discs now have only a small amount of friction and the impeller forces only a small amount of oil to the turbine. There is a minimum amount of torque at the output shaft.

i01646317

Modulating Valve (Torque Converter Impeller Clutch)

SMCS Code: 3139-VC

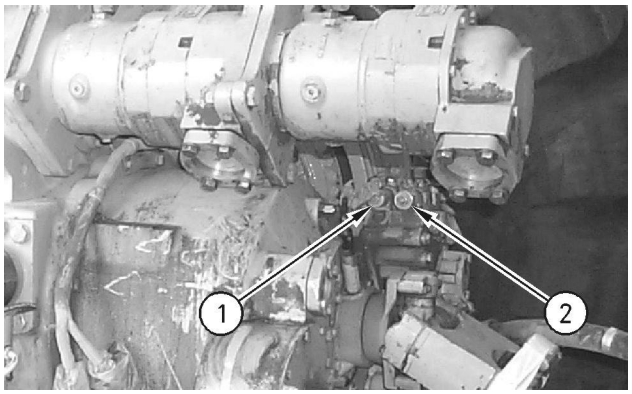


Illustration 39 g00850927

Location of the Modulating Valve for the Impeller Clutch

(1) Modulating valve for the lockup clutch
(2) Modulating valve for the impeller clutch

The modulating valve for the impeller clutch (2) is located on the output side of the torque converter. The valve is positioned next to the modulating valve for the torque converter lockup clutch.

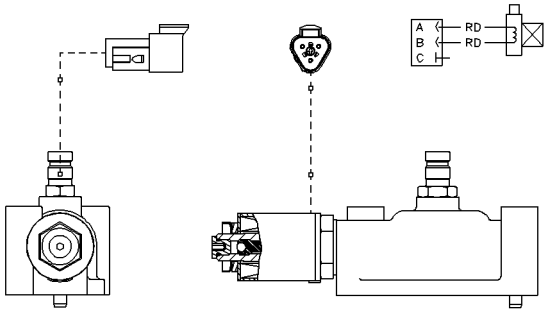


Illustration 40 g00670987

Modulating Valve for the Torque Converter Impeller Clutch

The modulating valve for the impeller clutch modulates the torque converter impeller clutch pressure in response to the position of the torque converter pedal and the various operating conditions.

The modulating valve for the impeller clutch solenoid is an output of the power train electronic control module (ECM). The modulating valve for the impeller clutch solenoid is a proportional solenoid valve. The valve is used by the power train ECM to directly modulate the oil pressure that is sent to the impeller clutch. The current to the clutch solenoid varies as the operator changes the position of the torque converter pedal. The distance that is travelled by the solenoid plunger (valve) is proportional to the electrical current of the solenoid. The position of the solenoid plunger (valve) controls the oil pressure of the impeller clutch. The amount of current that is sent to the clutch solenoid modulating valve regulates the amount of oil pressure that is supplied to the impeller clutch. When the power train ECM sends the maximum current to the clutch solenoid modulating valve, the oil pressure in the clutch is at the minimum. If current is not sent to the modulating valve for the impeller clutch, the oil pressure in the clutch is at the maximum.

The modulating valve for the impeller clutch is also affected by the following items: the transmission speed switch, the transmission direction switch, the torque converter output speed and direction, the transmission output speed, reduced rimpull on/off switch (if equipped) and reduced rimpull selection switch (if equipped).

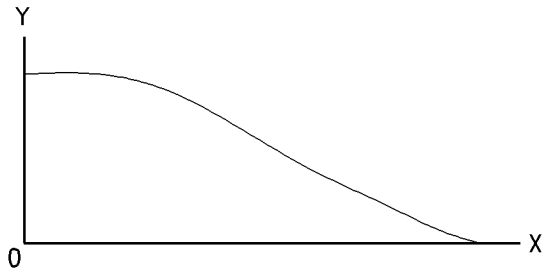


Illustration 41 g00670988

Relationship between the Current and Pressure

(X) Current to the impeller clutch solenoid
(Y) Pressure at the impeller clutch

The necessary amount of pressure that is required to adjust the impeller clutch is determined. The power train ECM then determines the proper amount of electrical current that will be sent to the solenoid. During normal operation, the control for the impeller clutch consists of several different strategies. During each control loop of the software, each strategy produces a command for the desired pressure . The amount of pressure that is sent to the solenoid valve is determined by a two level priority procedure. This oil pressure will adjust the impeller clutch.

Reference: For information on troubleshooting the transmission, refer to the Service Manual module for Troubleshooting, “Transmission Troubleshooting” of the machine that is being serviced.

Reference: For information on troubleshooting the torque converter, refer to the Service Manual module for Troubleshooting, “Torque Converter Troubleshooting” of the machine that is being serviced.

Reference: For information on calibrating the clutch solenoid modulating valves, refer to the Service Manual module for Testing and Adjusting, “Calibration” of the machine that is being serviced.

Reference: For more information on the power train electronic control module (ECM), refer to the Service Manual module for Systems Operation, “Electronic Control Module (Power Train)” for the machine that is being serviced.

i01646256

Modulating Valve (Torque Converter Lockup Clutch)

SMCS Code: 3139-VC

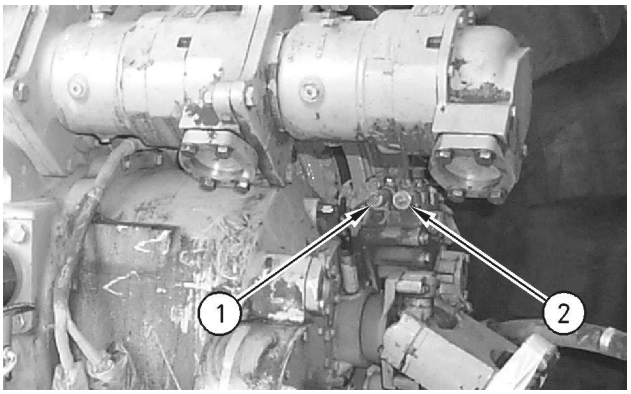


Illustration 42 g00850927

Location of the Modulating Valve for the Lockup Clutch

(1) Modulating valve for the lockup clutch
(2) Modulating valve for the impeller clutch

The modulating valve for the torque converter lockup clutch is located on the output side of the torque converter. The valve is positioned between the modulating valve for the impeller clutch and the torque converter housing.

The modulating valve for the torque converter lockup clutch engages the lockup clutch. The valve also disengages the lockup clutch in response to a variety of operating conditions . The lockup clutch will provide better machine performance during load and carry applications. The lockup clutch also provides better performance during light to medium dozing.

The modulating valve for the torque converter lockup clutch is an output of the power train electronic control module (ECM). The ECM will analyze the proper control data. When the ECM determines that the conditions are correct, the ECM will energize the valve. Once the modulating valve has been energized, the lockup clutch is engaged. This allows the output shaft of the torque converter to turn at a speed that is consistent with the engine output. The engagement of the torque converter lockup clutch basically provides a direct transfer of power from the engine output to the torque converter output.

Operation of the lockup clutch can be affected by the following items: the transmission speed switch, the transmission direction switch, the torque converter output speed and the engine speed.

The ECM has parameters that will enable the modulating valve. The modulating valve will then engage the lockup clutch. When the output speed of the torque converter rises above 1520 rpm, the ECM will signal the modulating valve to engage the lockup clutch. The ECM also has parameters that will disengage the lockup clutch. If the output speed of the torque converter falls below 1370 rpm, the ECM will signal the modulating valve to disengage the lockup clutch. There are other input conditions that may cause the power train electronic control module (ECM) to signal the lockup clutch to disengage.

The modulating valve basically controls the flow of oil to the torque converter lockup clutch.

Reference: For information on calibrating the clutch solenoid modulating valves, refer to the Service Manual module Testing and Adjusting, “Calibration” of the machine that is being serviced.

Reference: For more information on the power train electronic control module (ECM), refer to the Service Manual module Systems Operation, “Electronic Control Module (Power Train)” of the machine that is being serviced.

i00802326

Transmission Oil Pump

SMCS Code: 3066

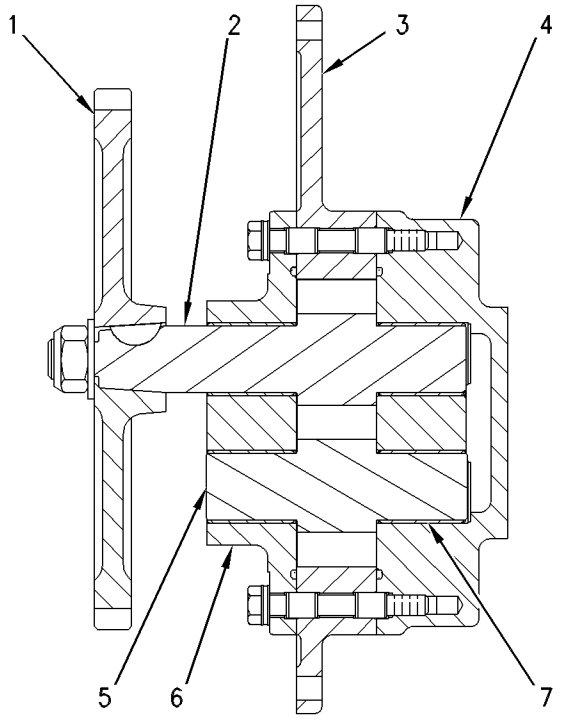


Illustration 43 g00378645

Oil Pump Construction

(1) Gear. (2) Gear. (3) Body. (4) Manifold. (5) Gear. (6) Cover. (7) Bearings (four).

The oil pump is a single-section gear pump. The oil pump is positioned on the output end of the torque converter.

The main components of the oil pump are cover (6), manifold (4), gears (2) and (5), and body (3).

Drive gear (2) is connected to gear (1). Gear (1) is driven by the torque converter.

During operation, oil is pulled from the reservoir in the output transfer gear case. This oil is pulled through the magnetic screen to an opening in manifold (4). The oil flows to the lower part of body (3). The oil fills the spaces between the teeth of gears (2) and (5). Oil is pushed from body (3) as the gears turn. The oil flows through the outlet passage in manifold (4) to an oil line. The oil then flows to the transmission oil filter.

i02404205

Oil Filter (Power Train)

SMCS Code: 3004; 3067

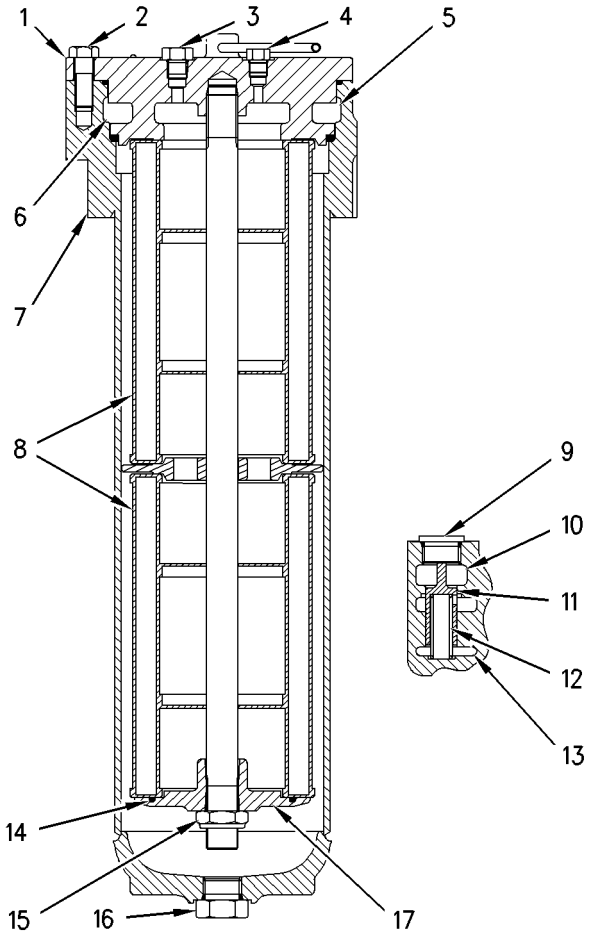


Illustration 44 g00850809

Oil Filter Construction

(1) Cover
(2) Bolt
(3) Plug
(4) Plug
(5) Oil inlet passage
(6) Oil outlet passage
(7) Filter housing
(8) Filter elements
(9) Plug
(10) Passage
(11) Bypass valve
(12) Bypass valve spring
(13) Passage
(14) Seal
(15) Nut
(16) Plug
(17) Retainer

Pressure oil from the oil pump flows into filter housing (7) through inlet passage (5). The oil fills the space between filter elements (8) and the inside of housing (7). During normal operation, the oil flows through filter elements (8) to passage (13). The oil then flows through outlet passage (6) to the remainder of the hydraulic system. The filter elements stop any debris that is in the oil.

If the filter elements become full of debris, then the restriction to the oil flow will cause an increase in pressure inside the filter. The pressure oil fills passage (10). This causes bypass valve (11) to move against the force of spring (12). The oil then flows past the open bypass valve and through outlet passage (6) to the remainder of the hydraulic system. When the oil does not flow through the filter elements, the debris in the oil will cause damage to other components in the hydraulic system.

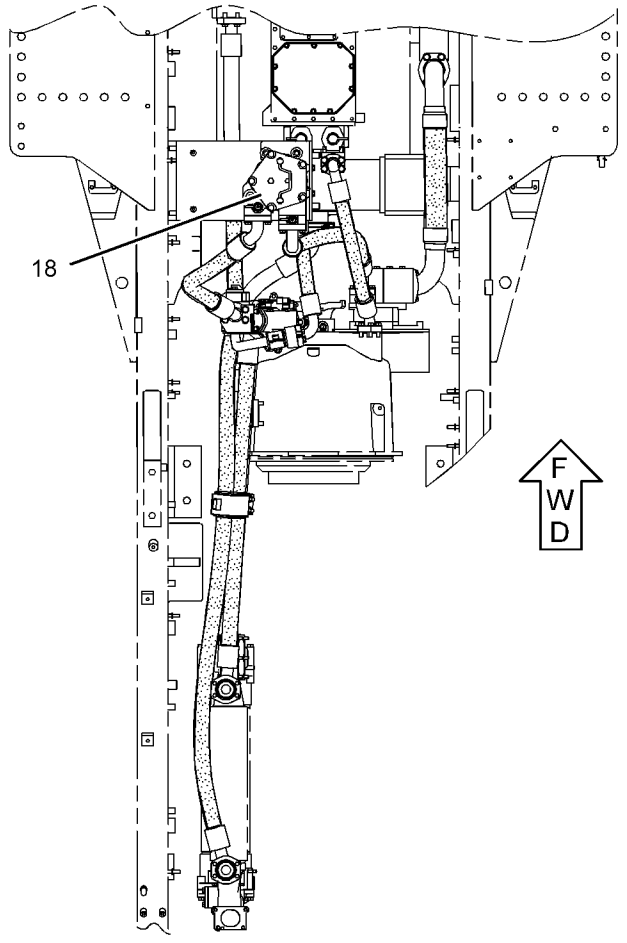


Illustration 45 g01200826

Oil Filter Location

(18) Oil filter.

Correct maintenance must be used to ensure that filter elements (8) do not become full of debris. This would stop the flow of clean oil to the hydraulic system.

During normal operation, the end of bypass valve (11) is in contact with a switch plunger. This keeps the filter bypass switch for the transmission in the OFF position.

Bypass valve (11) moves away from the switch plunger when the bypass valve opens. The switch plunger moves away from the switch contacts. The switch plunger then opens the circuit. This indicates that the filter elements are plugged and that the bypass valve is open. At this time, a Warning Category 3 will appear on the Caterpillar Monitoring System.

The warnings occur only when the oil in the system is at normal operating temperature.

i00803364

Transmission Magnetic Screen

SMCS Code: 3030-MGS; 3159-MGS

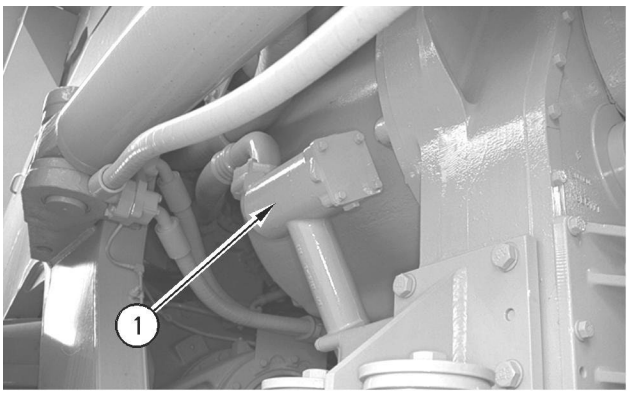


Illustration 46 g00379732

Center Right Side of Machine

(1) Magnetic screen housing.

The magnetic screen is inside housing (1) for the magnetic screen. The magnetic screen is fastened to the case of the output transfer gears. All of the oil flows through the magnetic screen before flowing to the transmission oil pump.

The magnetic screen has a metal screen and magnetic screen tube assembly. Oil enters the magnetic screen tube assembly at the bottom. The oil flows through the center of the magnetic screen tube assembly. The oil then flows through holes in the tube which are between the magnets. The magnets are installed on the tube with the same magnetic ends next to each other. As the oil flows over the magnets, metal particles are stopped. The metal particles are held by the magnets. Other debris that is in the oil is stopped by the metal screen as the oil flows to the oil pump through the screen.

i01646017

Transmission Lubrication

SMCS Code: 3030

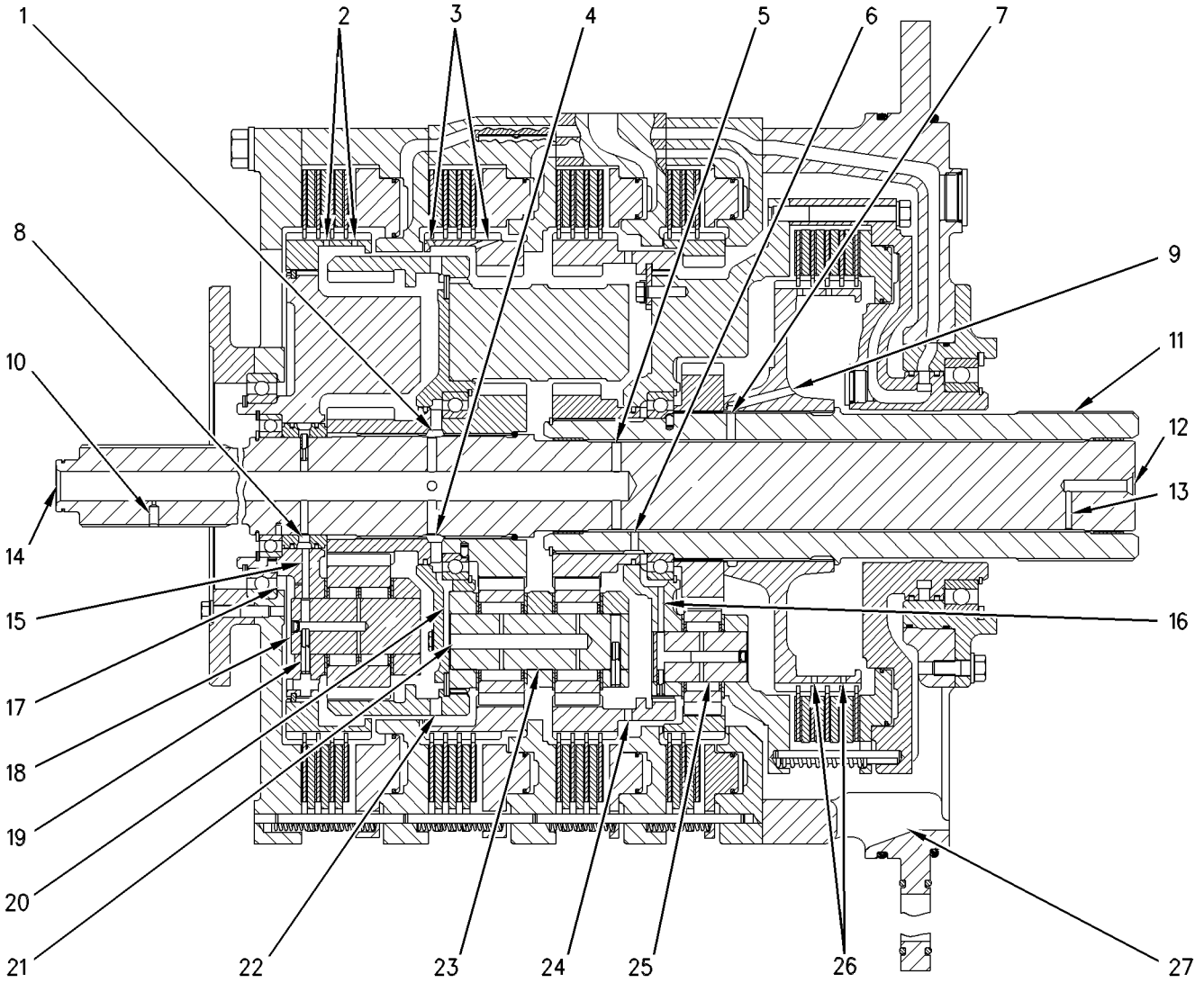


Illustration 47 g00379880

Transmission Lubrication

(1) Oil passage
(2) Oil holes
(3) Oil holes
(4) Oil passage
(5) Oil passage
(6) Oil passage
(7) Oil passage
(8) Oil passage
(9) Oil passage
(10) Oil passage to input transfer gears
(11) Output shaft
(12) Oil passage to output transfer gears
(13) Oil passage
(14) Main oil passage
(15) Oil passage
(16) Oil passage
(17) Oil passage
(18) Number 1 planetary shaft
(19) Pin
(20) Oil passage
(21) Oil passage
(22) Oil passage
(23) Number 2 and Number 3 planetary shaft
(24) Oil passage to reservoir
(25) Number 4 planetary shaft
(26) Oil holes
(27) Drain to reservoir

All of the outlet oil from the transmission oil cooler flows to a manifold on the input gear housing. Oil flows through the manifold to main oil passage (14) in the transmission input shaft.

Lubrication oil flows to the input transfer gears and to the output transfer gears. This oil flows through a passage in the manifold on the input transfer gear housing.

Oil flows through passage (10) in order to lubricate the splines on the transmission input shaft.

The oil from passage (8) flows to passage (15) in the Number 1 carrier. Some of the oil flows through passage (17) in order to lubricate the bearing on the Number 1 carrier. The remainder of the oil flows to a passage in Number 1 planetary shaft (18). Number 1 planetary shaft (18) has drilled passages that allow some of the oil to flow to the bearings.

From the passage in the Number 1 planetary shaft, oil flows through a drilled passage in pin (19) to holes (2) in the Number 1 ring gear. Holes (2) allow oil to flow to the Number 1 clutch discs and plates.

The oil from passage (1) flows to passage (4) in the Number 1 sun gear. Some of the oil lubricates the bearing on the Number 2 sun gear. Some of the oil flows to passage (20). Passage (20) directs the oil to a passage in Number 2 planetary shaft (23) and Number 3 planetary shaft (23). Planetary shaft (23) has drilled passages that allow the oil to flow to the bearings.

The remainder of the oil from passage (20) flows to the drilled passage (21) in the Number 2 carrier and in the Number 3 carrier. The oil flows from passage (21) to passage (22) in the coupling gear. Passage (22) allows the oil to flow to holes (3) in the Number 2 ring gear. The holes in the ring gear allow the oil to flow to the Number 2 clutch discs and plates.

The oil from passage (5) flows to the space between the transmission input shaft and transmission output shaft (11). The oil travels along the splines toward the output end of the transmission.

Some of the oil flows through passage (6) to the bearing on output shaft (11). The remainder of the oil from passage (6) flows to passage (16) in the Number 4 carrier. The oil in passage (16) flows to a passage in Number 4 planetary shaft (25). Planetary shaft (25) has drilled passages that allow the oil to flow to the bearings.

Some of the oil that travels along the splines of output shaft (11) flows to passage (7). The oil then flows through passage (9) to holes (26) in the rotating hub. The holes in the rotating hub allow the oil to flow to the Number 5 clutch discs and plates.

The remainder of the oil that travels along the splines of output shaft (11) flows to passage (13). Passage (13) directs oil to passage (12).

The splines on the output shaft and on the shaft for the parking brake receive lubrication oil through passage (12).

The oil that is sent for lubricating the clutches and for cooling the clutches drains to the bottom of the transmission case. The return oil from the input transfer gears also drains to the bottom of the transmission case. An elbow is connected to the bottom of the transmission case. The oil in the bottom of the transmission case flows through the elbow to the main oil reservoir in the output transfer gear case.

i01659954

Transmission Hydraulic Control

SMCS Code: 3073

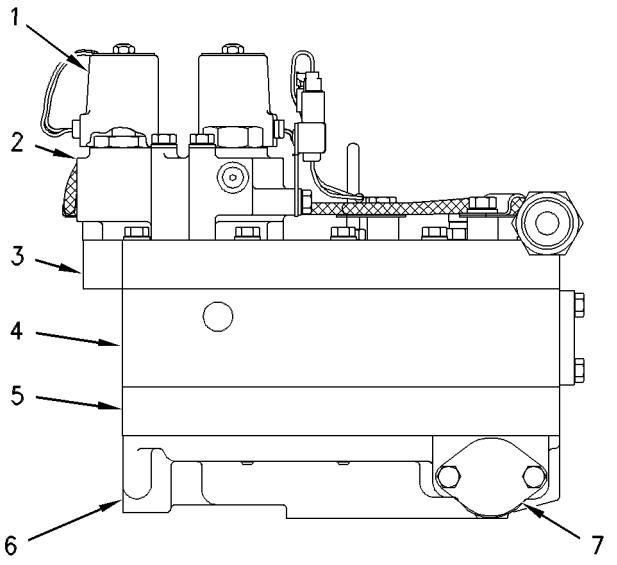


Illustration 48 g00104490

Transmission Hydraulic Control (Side View)

(1) Solenoids
(2) Control solenoid manifold
(3) Top manifold
(4) Selector and pressure control valve
(5) Plate
(6) Selector valve body
(7) Cover

The transmission hydraulic control controls the oil pressure to the torque converter, to the transmission clutches, and to the lubrication circuits. The transmission hydraulic control also controls the flow of oil to the clutches. The transmission hydraulic control is installed on the top of the transmission planetary group. The control consists of the following components: solenoids (1), manifold (2), top manifold (3), selector and pressure control valve (4), plate (5) and selector valve body (6). The speed selector spool for second speed is behind cover (7).

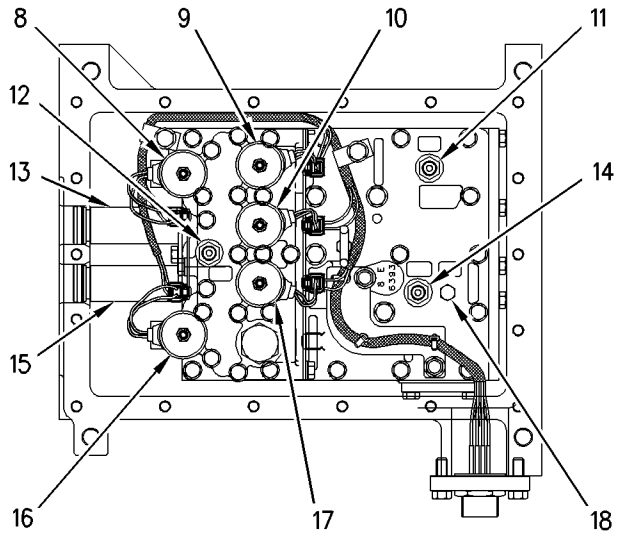


Illustration 49 g00856659

Transmission Hydraulic Control (Top View)

(8) Number 3 clutch solenoid
(9) Number 4 clutch solenoid
(10) Number 5 clutch solenoid
(11) P1 pressure tap
(12) P3 pressure tap
(13) Oil tube for inlet from pump
(14) P2 pressure tap
(15) Oil tube for outlet to torque converter
(16) Number 2 clutch solenoid
(17) Number 1 clutch solenoid
(18) Plug for load piston

Inlet oil for the operation of the hydraulic control flows from the transmission oil filter. This oil flows in through tube (13) to the selector and pressure control valve.

Oil for the operation of the torque converter flows through tube (15) and through an oil line to the torque converter.

The clutch solenoids direct pump oil to the ends of the selector spools. The selector spools move in order to send oil to the clutch. This causes the clutch to engage.

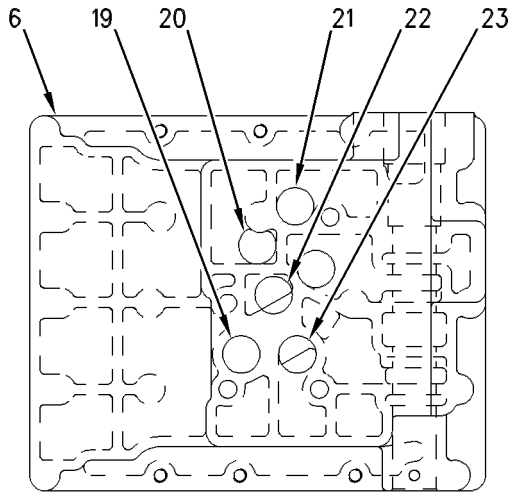


Illustration 50 g00104492

Transmission Hydraulic Control (Bottom View)

(6) Selector valve body
(19) Passage to Number 4 clutch
(20) Passage to Number 2 clutch
(21) Passage to Number 1 clutch
(22) Passage to Number 3 clutch
(23) Passage to Number 5 clutch

Oil to the clutches is sent through openings (19), (20), (21), (22), and (23) in the selector valve body. The selector valve body is attached to the top of the planetary group.

i01645992

Selector and Pressure Control Valve (Transmission)

SMCS Code: 3073

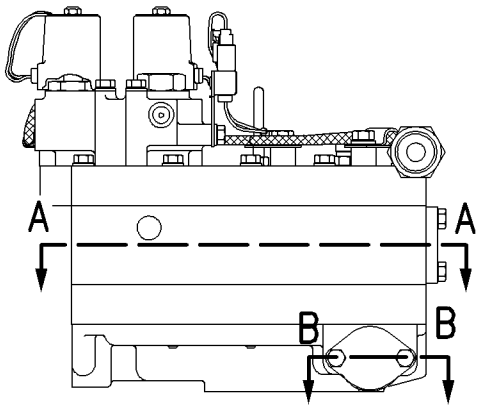


Illustration 51 g00661316

Transmission Hydraulic Control

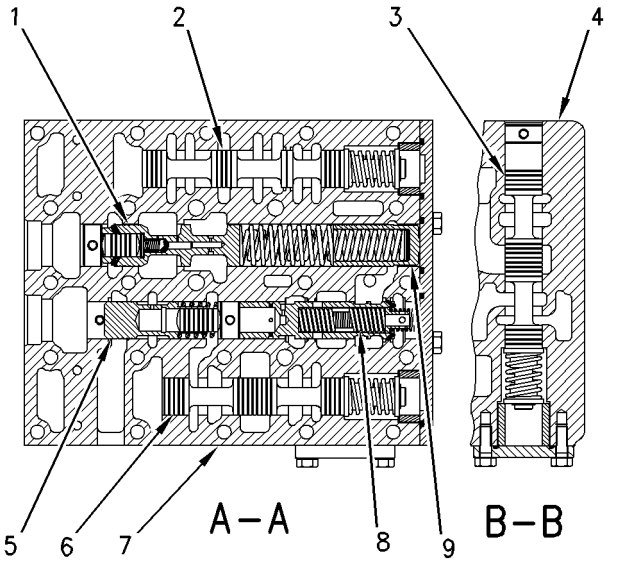


Illustration 52 g00661345

Selector and Pressure Control Valve

(1) Modulation relief valve
(2) First speed and third speed selection spool
(3) Second speed selection spool
(4) Selector valve body
(5) Converter inlet ratio valve
(6) Direction selection spool
(7) Selector and pressure control valve body
(8) Pressure differential valve
(9) Load piston

The following items are inside the top cover of the transmission: selector and pressure control valve body (7) and selector valve body (4).

Selector spools (2), (3), and (6) are moved when oil pressure is applied to one end of the spool. Each solenoid controls the oil pressure to the end of one spool. If no pressure is going to the end of a spool, then that end is opened to the drain. The power train ECM activates the solenoids in order to control the speed of the transmission and the direction of the transmission.

Table 18

Valve	Function
(1) Modulation relief valve.	This valve controls the maximum pressure in the system.
(2) First speed and third speed selection spool.	This valve directs oil to the Number 3 clutch or to the Number 5 clutch.
(3) Second speed selection spool.	This valve directs oil to the Number 4 clutch.
(5) Converter inlet ratio valve.	This valve limits the maximum pressure to the torque converter.

(continued)

(Table 18, contd)

(6) Direction selection spool.	This valve directs oil to a direction clutch.
(8) Pressure differential valve.	This valve keeps a pressure differential between the speed clutches and the direction clutches.
(9) Load piston.	This valve controls the rate of pressure increase in the clutches.

i01645636

Transmission Hydraulic Control Operation

SMCS Code: 3073

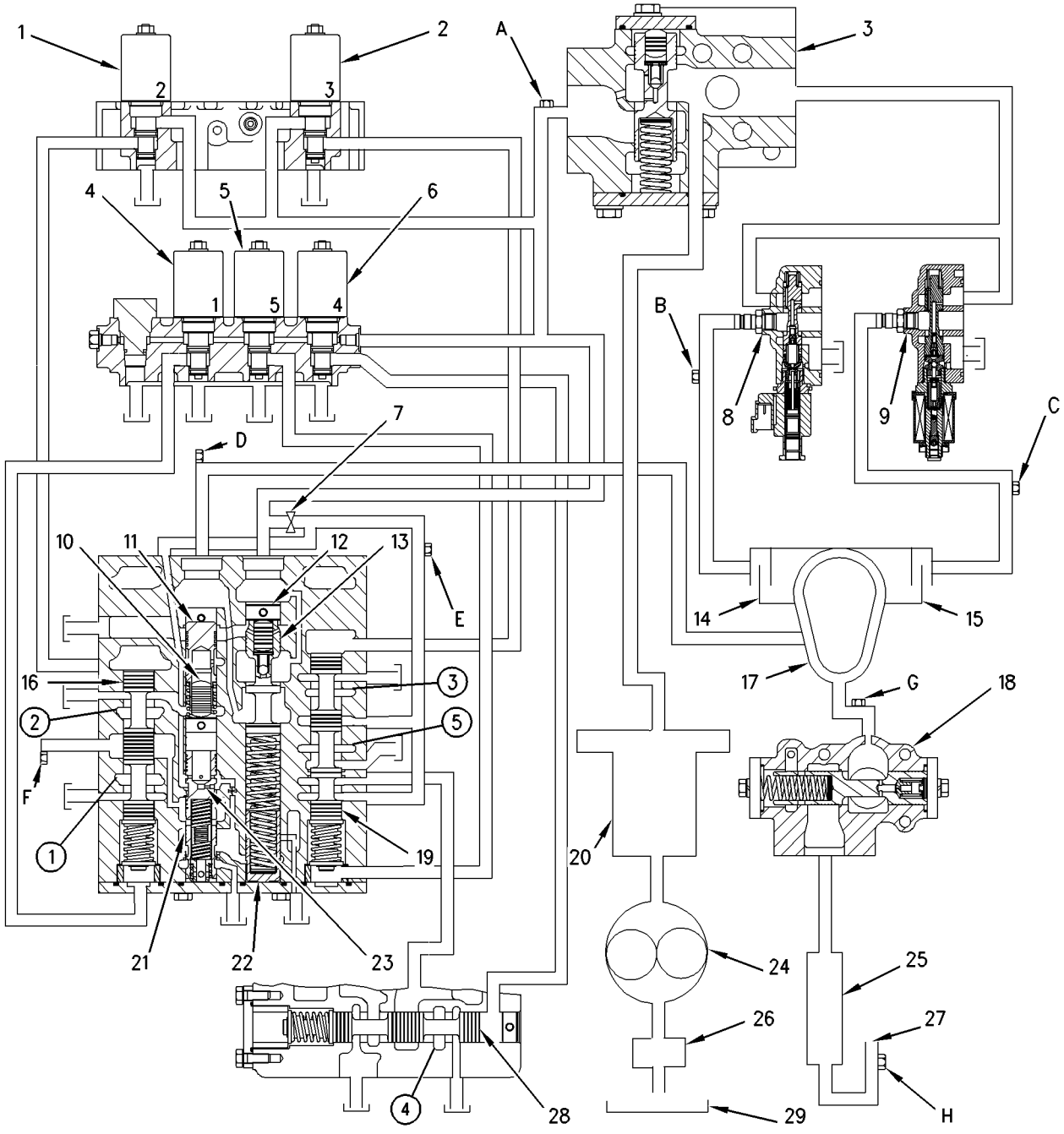


Illustration 53 g00850541

Transmission Hydraulic Controls in the NEUTRAL position and with the Engine Stopped.

(1) Number 2 clutch solenoid
(2) Number 3 clutch solenoid
(3) Priority valve
(4) Number 1 clutch solenoid
(5) Number 5 clutch solenoid
(6) Number 4 clutch solenoid
(7) Flow control orifice
(8) Lockup clutch solenoid valve
(9) Impeller clutch solenoid valve
(10) Slug
(11) Converter inlet ratio valve
(12) Slug

(13) Modulating relief valve
(14) Lockup clutch
(15) Impeller clutch
(16) Direction selection spool
(17) Torque converter
(18) Torque converter outlet relief valve
(19) Selector spool for first speed and for third speed
(20) Transmission oil filter
(21) Pressure differential valve
(22) Load piston
(23) Flow control orifice
(24) Transmission oil pump
(25) Oil cooler
(26) Magnetic screen
(27) Lubrication passage for transmission
(28) Selector spool for second speed
(29) Reservoir
(A) Pressure tap for the oil pump
(B) Pressure tap for lockup clutch
(C) Pressure tap for impeller clutch
(D) Torque converter inlet pressure tap P3
(E) Speed clutch pressure tap P1
(F) Direction clutch pressure tap P2
(G) Torque converter outlet pressure tap
(H) Transmission lubrication pressure tap

When the engine is started, the transmission oil pump (24) pulls oil from reservoir (29) through magnetic screen (26). The pump sends the oil through transmission oil filter (20) to priority valve (3). Some of the oil from the priority valve flows to lockup clutch solenoid valve (8) and to impeller clutch solenoid valve (9). The remainder of the oil flows to the selector and pressure control valve. The selector and pressure control valve is part of the transmission hydraulic control.

Starting the Engine with the Transmission in NEUTRAL

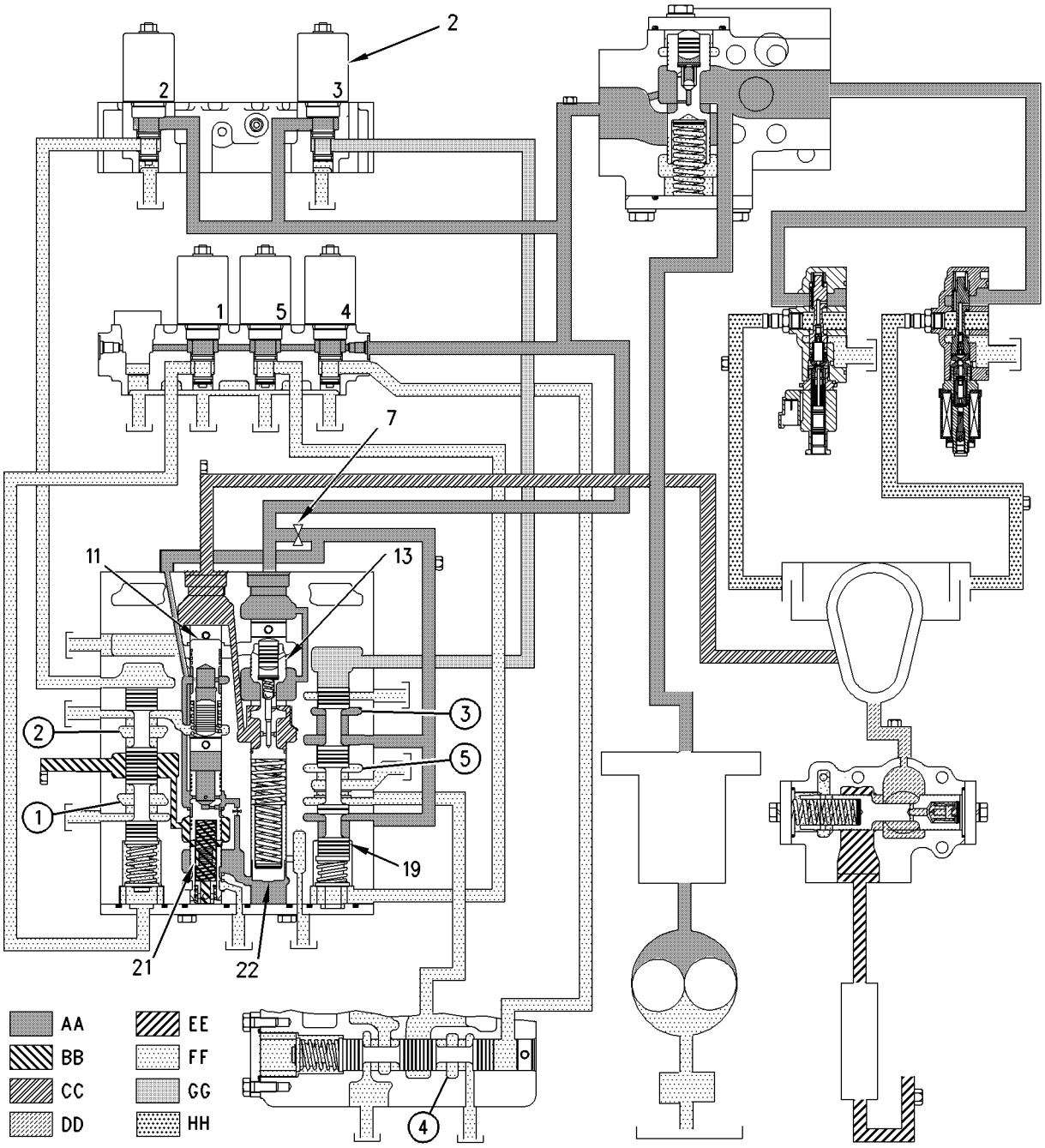


Illustration 54 g00850543

Transmission Hydraulic Controls with a Running Engine in the NEUTRAL position

(2) Number 3 clutch solenoid
(7) Flow control orifice
(11) Converter inlet ratio valve
(13) Modulating relief valve
(19) Selector spool for first speed and for third speed
(21) Pressure differential valve
(22) Load piston
(AA) Speed clutch oil P1
(BB) Direction clutch oil P2
(CC) Converter inlet oil P3
(DD) Converter outlet oil
(EE) Lubrication oil
(FF) Return oil
(GG) Pilot oil
(HH) Torque converter clutch oil

When the STIC transmission direction control switch is in the NEUTRAL position, solenoid (2) is activated. The solenoid moves a spool and oil is directed to the end of spool (19). Spool (19) moves down and pump oil flows around the spool to the Number 3 clutch.

The Number 3 clutch is now applied. All of the remaining clutches are open to the reservoir.

The oil from pump (24) flows through flow control orifice (7). The oil then flows to Number 3 clutch, converter inlet ratio valve (11), and pressure differential valve (21).

The oil to pressure differential valve (21) flows through a small orifice in the valve spool. This oil starts to fill the chamber at the top end of the spool. The pressure in the chamber at the top of valve spool (21) increases.

The increase in pressure moves the valve downward against the force of the springs. The movement of the valve spool closes a passage from the area behind the bottom end of load piston (22) and behind the reservoir. At this time, pressure differential valve (21) is in the position that is shown in the schematic. This allows the pressure in the system to increase.

While the pressure in the chamber at the top of pressure differential valve (21) increases, the valve moves downward. This opens the direction clutch circuit to the flow of pump oil. The valve also closes the bottom end of valve (21) to the reservoir. The pressure in the direction clutch circuit increases. The increase is felt in the spring chamber of valve (21).

When the pressure in the direction clutch circuit is at the maximum, the combination of the pressure in the spring chamber and the force of the springs moves valve (21) upward. The valve moves upward until the flow of pump oil to the direction clutch circuit is stopped. At this time, the movement of the valve spool stops. Now, the valve spool moves down and the valve spool moves up. This keeps a constant pressure in the direction clutch circuit.

Oil from the pump also flows to modulating relief valve (13). This fills the chamber around the modulating relief valve. The oil flows through an orifice in the valve spool. This oil opens the poppet valve at the top of the valve spool. This allows oil to fill the slug chamber at the top of the valve spool.

When the Number 3 clutch is full of oil, the pressure in the speed clutch circuit begins to increase. The increase is felt in the slug chamber at the top of modulating relief valve (13). When the pressure in the speed clutch circuit is at the initial setting of the modulating relief valve, the modulating relief valve moves down. This allows extra oil to go to the torque converter. At the same time, pump oil flows through an orifice. The oil goes through the orifice to the area that is between the bottom of load piston (22) and the cover on the selector and pressure control valve body. This area is closed to the reservoir by the position of differential valve (21). The rate of flow to the area behind load piston (22) is restricted by the orifice.

The pressure that is felt by the modulating relief valve (13) is also felt behind load piston (22). This is because of the pressure increase in the speed clutch circuit. The orifice in the supply passage causes the oil to flow to the area behind the load piston at a specific rate. As the modulating relief valve moves toward the bottom, the load piston moves toward the top. This causes the pressure in Number 3 clutch to increase gradually.

This gradual increase in pressure is modulation. The load piston moves more toward the top against the force of the springs. This occurs until the area behind the load piston is open to a drain passage. At this time, modulation stops. As the oil flows out of the drain passage, oil continues to fill the area behind the load piston. This keeps the load piston in a position without any further movement.

The operation of the load piston and the operation of the modulating relief valve keeps the system pressure at a constant rate.

Pump oil also flows through flow control orifice (7) to converter inlet ratio valve (11). The pump oil flows through an orifice in the valve spool. The oil then fills the slug chamber. The pressure presses against the diameter of the slug.

The oil pressure that is going to the torque converter is felt against the top of valve spool (11). This pressure presses against the whole diameter of the valve spool.

The pressure on the top of the valve spool (11) that is necessary to move the valve spool downward is less than the pressure in the slug chamber that is necessary to move the valve spool upward.

When the inlet pressure that is going to the torque converter rises to the maximum, the valve spool (11) moves downward. This allows the extra oil to flow to the reservoir. When the pressures are balanced again, the valve spool moves upward.

All of the oil that is not used by the clutches flows to the torque converter ratio valve.

Shifting from the NEUTRAL position to the FIRST SPEED FORWARD position with a Running Engine

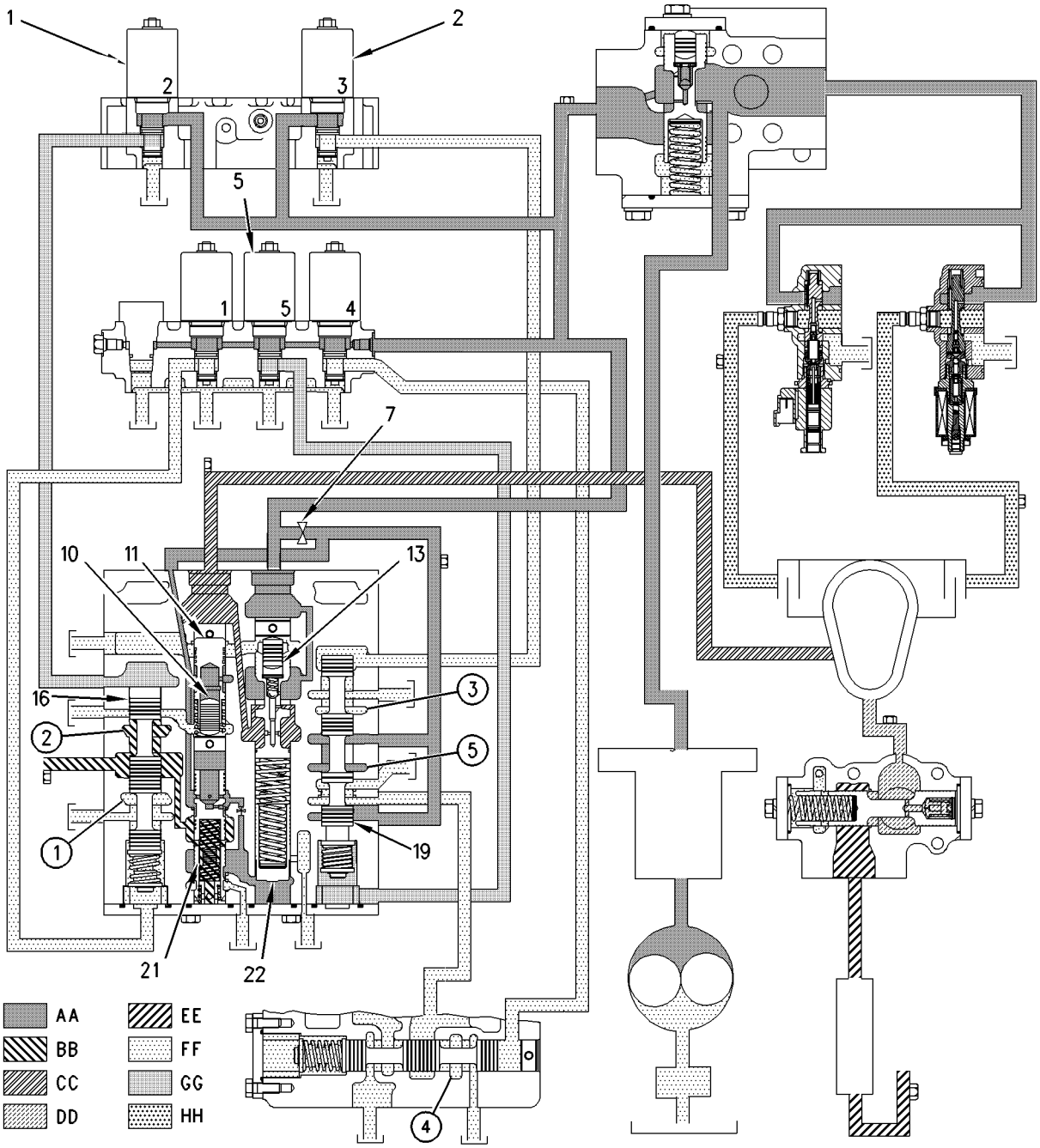


Illustration 55 g00850544

Transmission Hydraulic Controls in the FIRST SPEED FORWARD position

(1) Number 2 clutch solenoid
(2) Number 3 clutch solenoid
(5) Number 5 clutch solenoid
(7) Flow control orifice
(10) Slug
(11) Converter inlet ratio valve
(13) Modulating relief valve
(16) Direction selection spool
(19) Selector spool for first speed and for third speed
(21) Pressure differential valve
(22) Load piston
(AA) Speed clutch oil P1
(BB) Direction clutch oil P2
(CC) Converter inlet oil P3
(DD) Converter outlet oil
(EE) Lubrication oil
(FF) Return oil
(GG) Pilot oil
(HH) Torque converter clutch oil

When the transmission is moved to the FIRST SPEED FORWARD position, solenoids (1) and (5) are activated and solenoid (2) is deactivated. Solenoid (1) moves a spool. Solenoid (1) also directs oil to the top end of direction spool (16). Spool (16) moves downward and pump oil flows around the spool. The pump oil then flows to the Number 2 clutch.

Solenoid (5) moves a spool. Solenoid (5) also directs oil to the bottom of speed selection spool (19). Solenoid (2) is deactivated. Solenoid (2) also directs oil from the top end of speed selection spool (19) to the reservoir. Spool (19) moves upward and pump oil flows around the spool to the Number 5 clutch.

When the shift to first speed forward is made, the Number 3 clutch is opened to the reservoir. The pressure in the system decreases. Springs move modulating relief valve (13) upward. Springs also move pressure differential valve (21) upward until the large orifice at the top end of valve (21) is closed to pump oil by the valve body.

As the pressure differential valve (21) moves upward, the chamber behind load piston (22) opens to the reservoir. This allows the springs to move the load piston downward. The speed clutch oil starts to fill the Number 5 clutch.

When the Number 5 clutch is full of oil, the pressure in the speed clutch circuit starts to increase. The increase is felt in the slug chamber of modulating relief valve (13) and in the chamber at the top of pressure differential valve (21).

The oil to pressure differential valve (21) starts to fill the chamber at the top of the valve spool through the small orifice.

When the pressure in the Number 5 clutch is approximately 380 kPa (55 psi) pressure differential valve (21) starts to move down. The movement of the valve spool opens the Number 2 clutch to pump oil. The movement of the valve spool also closes a passage from the chamber behind load piston (22) to the reservoir.

When the Number 2 clutch is full of oil, the pressure increases in the direction clutch circuit. The increase is felt in the spring chamber of pressure differential valve (21). The combination of the pressure in the spring chamber and the force of the springs moves the valve spool upward against the speed clutch pressure at the top of the valve spool.

As the pressure increases in the speed clutch circuit, the pressure increases in the chamber at the top of pressure differential valve (21).

The increase in pressure moves the valve spool downward against the force of the springs. This opens the Number 2 clutch to the flow of pump oil.

As the pressure increases in the Number 2 clutch, the pressure increases in the spring chamber of pressure differential valve (21). The combination of the increased pressure in the spring chamber and the force of the springs moves the valve spool upward. This stops the flow of oil to the Number 2 clutch. This function continues until the pressure in the Number 2 clutch is at the maximum. At this time, the combination of the pressure in the spring chamber and the force of the springs moves the spool upward until the flow of oil to the clutch is stopped. Now, the valve spool moves down and the valve spool moves up. This keeps a constant pressure in the Number 2 clutch. This pressure is less than the speed clutch pressure by approximately 380 kPa (55 psi). This difference is caused by the force of the springs of the pressure differential valve.

Oil from the pump also flows to modulating relief valve (13). This oil fills the chamber around the valve spool. The oil flows through an orifice in the valve spool. The oil then opens the poppet valve at the top end of the valve spool. This allows the oil to fill the slug chamber at the top of the valve spool.

The rate of the pressure increase in the speed clutch circuit is controlled by modulating relief valve (13) and by load piston (22).

As the pressure increases in the Number 5 clutch, modulating relief valve (13) moves downward and load piston (22) moves upward. The orifice in the supply passage to the load piston causes the oil to flow at a specific rate. The oil flows to the area behind the load piston. As the modulating relief valve moves downward and the load piston moves upward, the pressure gradually increases in the Number 5 clutch. This gradual increase in pressure is known as modulation.

The load piston (22) moves more toward the top against the force of the springs. The load piston moves until the area behind the load piston is open to a drain passage. At this time, modulation stops. As the oil flows out of the drain passage, oil continues to fill the area behind the load piston. This keeps the load piston in the same position. After the pressures in the clutches are at the maximum, modulating relief valve (13) allows the extra oil to flow to the torque converter.

The operation of the load piston (22) and of the modulating relief valve (13) keeps the system pressure at a constant rate.

Pump oil also flows through flow control orifice (7) to converter inlet ratio valve (11). The pump oil flows through an orifice in the valve spool. This oil then fills the slug chamber. This pressure presses against the diameter of the slug.

The oil pressure to the torque converter is felt against the top of valve spool (11). The pressure presses against the entire diameter of the valve spool.

The pressure on the top of the valve spool (11) that is necessary to move the valve spool downward is less than the pressure in the slug chamber that is necessary to move the valve spool upward.

When the inlet pressure to the torque converter increases to the maximum, the valve spool (11) moves down. This allows the extra oil to flow to the reservoir. When the pressures are balanced again, the valve moves upward.

All of the oil that is not used by the clutches flows to the torque converter ratio valve.

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Transmission Planetary

SMCS Code: 3160

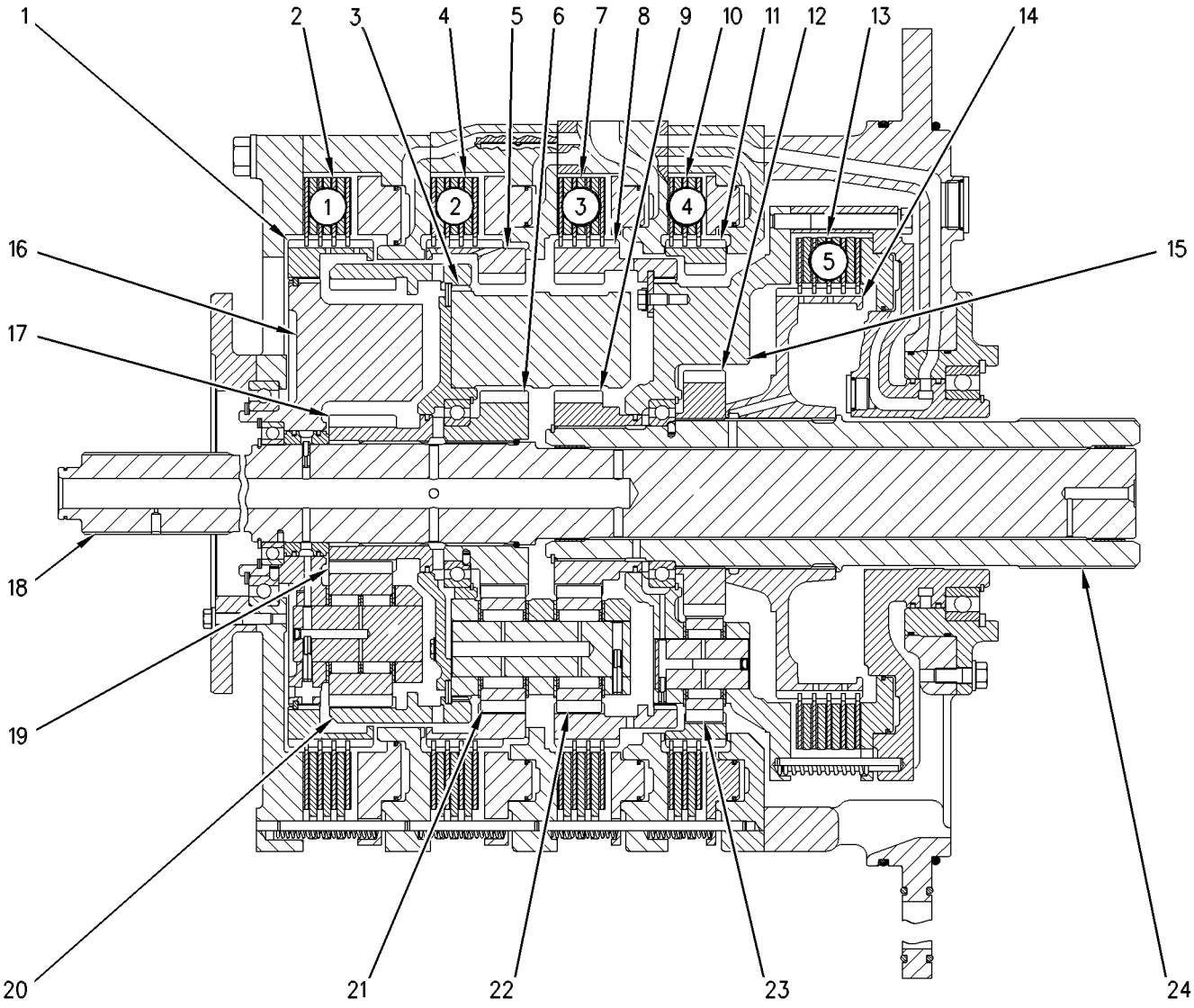


Illustration 56 g00382932

Transmission Components

(1) Coupling gear
(2) Number 1 clutch
(3) Number 2 and Number 3 carrier
(4) Number 2 clutch
(5) Number 2 clutch ring gear
(6) Number 2 sun gear
(7) Number 3 clutch
(8) Number 3 clutch ring gear
(9) Number 3 sun gear
(10) Number 4 clutch
(11) Number 4 clutch ring gear
(12) Number 4 sun gear
(13) Number 5 clutch
(14) Rotating hub
(15) Number 4 carrier
(16) Number 1 carrier
(17) Number 1 sun gear
(18) Input shaft
(19) Number 1 planetary gears
(20) Number 1 clutch ring gear
(21) Number 2 planetary gears
(22) Number 3 planetary gears
(23) Number 4 planetary gears
(24) Output shaft

The transmission is fastened between the input transfer gear case and the output transfer gear case. Input power to the transmission comes from the input transfer gears.

The transmission has five hydraulically activated clutches that provide three forward speeds and three reverse speeds. Speed and direction are selected by moving switches on the STIC. The Number 1 clutch and the Number 2 clutch are the closest clutches to the input end of the transmission. These two clutches are the direction clutches. The Number 1 clutch is the Reverse direction clutch. The Number 2 clutch is the Forward direction clutch.

The Number 3 clutch, the Number 4 clutch, and the Number 5 clutch are the speed clutches. The Number 3 clutch provides the Third speed. The Number 4 clutch provides the Second speed. The Number 5 clutch provides the First speed.

The Number 5 clutch is the only clutch that rotates when the clutch is engaged.

A speed clutch must be engaged first and a direction clutch must then be engaged so that power may be sent through the transmission. The table provides the combination of the clutches for each forward speed and for each reverse speed.

Table 19

Speed Range and Direction	Energized Solenoids	Engaged Clutches
Third Speed Forward	3 and 2	3 and 2
Second Speed Forward	4 and 2	4 and 2
First Speed Forward	5 and 2	5 and 2
Neutral	3	3
First Speed Reverse	5 and 1	5 and 1
Second Speed Reverse	4 and 1	4 and 1
Third Speed Reverse	3 and 1	3 and 1

First Speed Forward

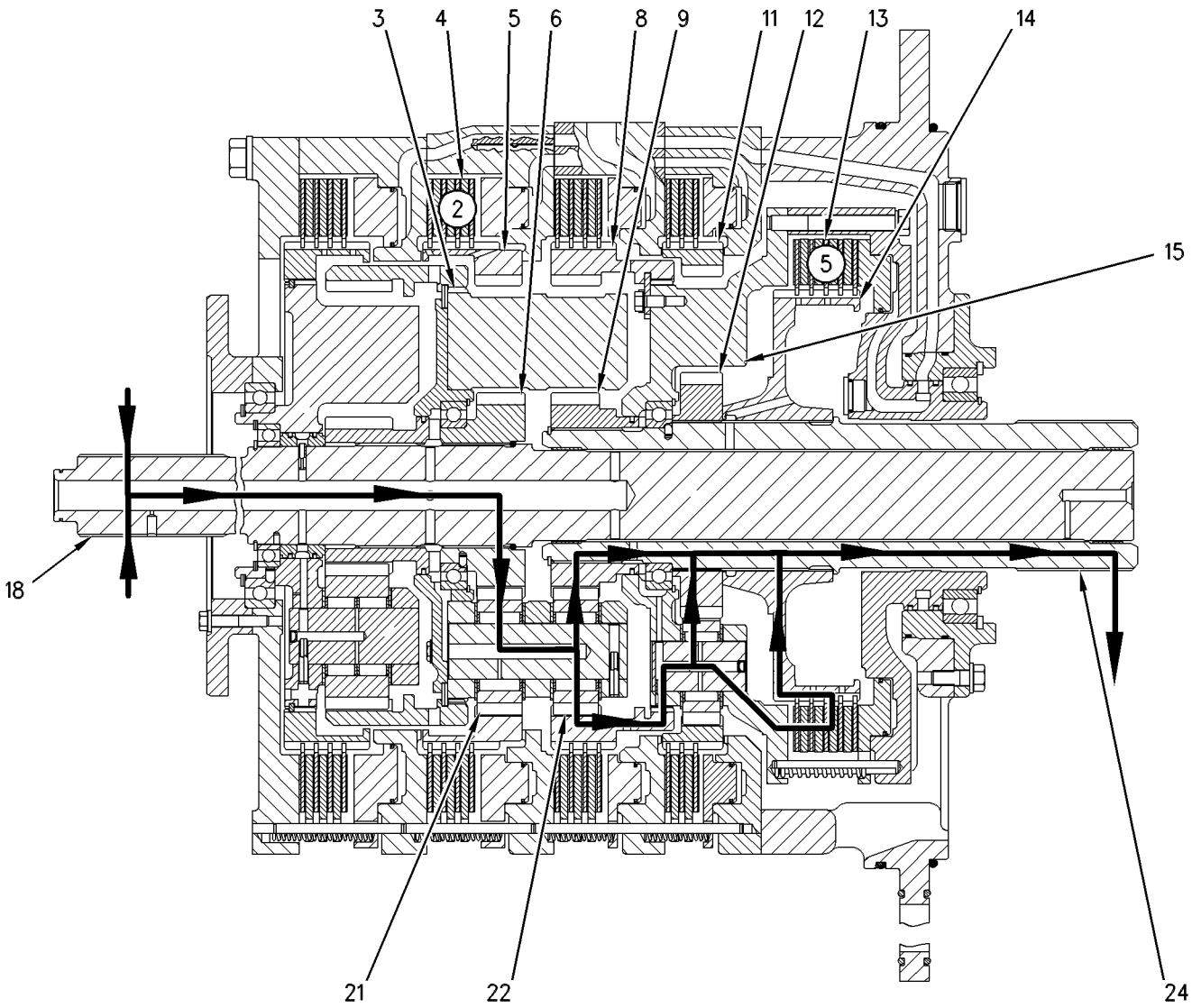


Illustration 57 g00382933

Power Flow in First Speed Forward with the Number 2 Clutch and the Number 5 Clutch Engaged.

(3) Number 2 and Number 3 carrier
(4) Number 2 clutch
(5) Number 2 clutch ring gear
(6) Number 2 sun gear
(8) Number 3 clutch ring gear
(9) Number 3 sun gear
(11) Number 4 clutch ring gear
(12) Number 4 sun gear
(13) Number 5 clutch
(14) Rotating hub
(15) Number 4 carrier
(18) Input shaft
(21) Number 2 planetary gears
(22) Number 3 planetary gears
(24) Output shaft

When the transmission is in first speed forward, Number 5 clutch (13) and Number 2 clutch (4) are engaged. The Number 2 clutch holds ring gear (5) stationary. The Number 5 clutch connects rotating hub (14) to Number 4 carrier (15).

Input shaft (18) turns Number 2 sun gear (6). The Number 2 sun gear turns planetary gears (21). Because ring gear (5) is held stationary by the Number 2 clutch, planetary gears (21) move around the inside of the ring gear. The movement of planetary gears (21) causes Number 2 carrier (3) and Number 3 carrier (3) to turn in the same direction as input shaft (18).

As carrier (3) turns, planetary gears (22) turn ring gear (8) and sun gear (9). Sun gear (9) turns output shaft (24).

Ring gear (8) turns carrier (15). Carrier (15) is connected to rotating hub (14) by the engagement of Number 5 clutch (13). This allows power to travel from carrier (15) to sun gear (12) and to ring gear (11). The power then flows through Number 5 clutch to rotating hub (14). Sun gear (12) and rotating hub (14) are fastened to output shaft (24).

As a result, the torque to output shaft (24) is divided between Number 3 sun gear (9), Number 4 sun gear (12), and rotating hub (14). From the output shaft, power flows through the output transfer gears to the differentials.

Second Speed Forward

Refer to Illustration 56 for the location of the components, as described below. Refer to Illustration 57 for a typical description of power flow in the forward direction.

When the transmission is in second speed forward, Number 4 clutch (10) and Number 2 clutch (4) are engaged. The Number 2 clutch holds ring gear (5) for the Number 2 clutch stationary. The Number 4 clutch holds ring gear (11) for the Number 4 clutch stationary. Input shaft (18) turns Number 2 sun gear (6). Number 2 sun gear turns Number 2 planetary gears (21).

Because ring gear (5) is held stationary by the Number 2 clutch, planetary gears (21) move around the inside of the ring gear. The movement of planetary gears (21) causes Number 2 carrier (3) and Number 3 carrier (3) to turn in the same direction as input shaft (18). As the Number 2 carrier and the Number 3 carrier turn, Number 3 planetary gears (22) turn. The Number 2 planetary gears turn ring gear (9) for the Number 3 clutch and Number 3 sun gear (9). Number 3 sun gear (9) turns output shaft (24). Ring gear (8) turns Number 4 carrier (15).

Because ring gear (11) is held stationary by the Number 4 clutch, planetary gears (23) move around the inside of the ring gear. The movement of planetary gears (23) causes Number 4 sun gear (12) to turn. The Number 4 sun gear turns output shaft (24).

As a result, the torque to output shaft (24) is divided between Number 3 sun gear (9) and Number 4 sun gear (12). From the output shaft, power travels through the output transfer gears to the differentials.

Third Speed Forward

Refer to Illustration 56 for the location of the components, as described below. Refer to Illustration 57 for a typical description of power flow in the forward direction.

When the transmission is in third speed forward, Number 3 clutch (7) and Number 2 clutch (4) are engaged. The Number 2 clutch holds ring gear (5) for the Number 2 clutch stationary. The Number 3 clutch holds ring gear (8) for the Number 3 clutch stationary. Input shaft (18) turns Number 2 sun gear (6). Number 2 sun gear turns Number 2 planetary gears (21).

Because ring gear (5) is held stationary by the Number 2 clutch, planetary gears (21) move around the inside of the ring gear. The movement of planetary gears (21) causes Number 2 carrier (3) and Number 3 carrier (3) to turn in the same direction as input shaft (18).

The movement of Number 2 carrier (3) and Number 3 carrier (3) causes Number 3 planetary gears (22) to move around the inside of ring gear (8) because ring gear (8) is held stationary by the Number 3 clutch. The movement of planetary gears (22) causes Number 3 sun gear (9) to turn. The Number 3 sun gear turns output shaft (24). From the output shaft, power travels through the output transfer gears to the differentials.

Third Speed Reverse

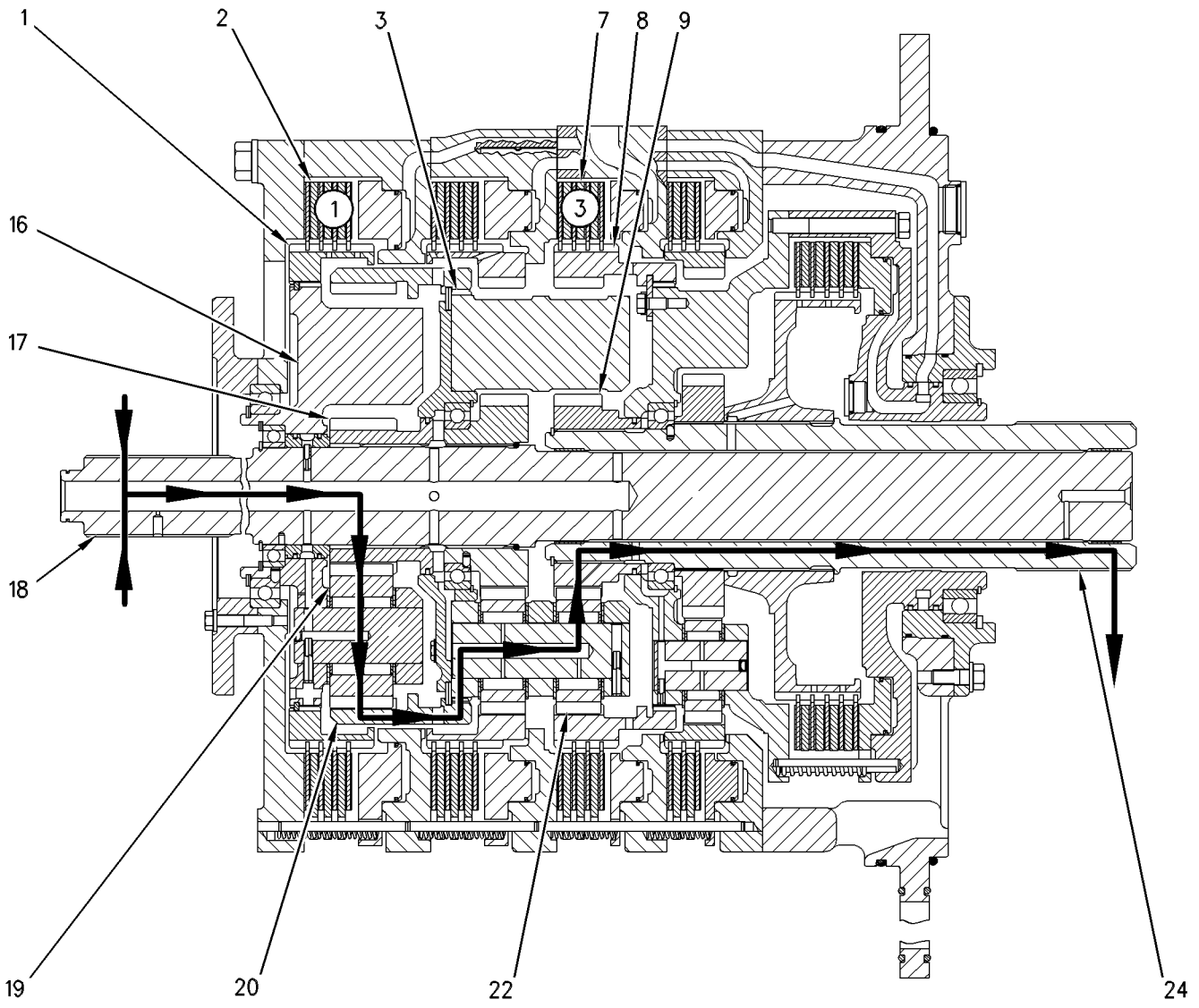


Illustration 58 g00382935

Power Flow in Third Speed Reverse with the Number 1 Clutch and the Number 3 Clutch Engaged.

(1) Coupling gear
(2) Number 1 clutch
(3) Number 2 and Number 3 carrier
(7) Number 3 clutch
(8) Number 3 clutch ring gear
(9) Number 3 sun gear
(16) Number 1 carrier
(17) Number 1 sun gear
(18) Input shaft
(19) Number 1 planetary gears
(20) Number 1 clutch ring gear
(22) Number 3 planetary gears
(24) Output shaft

When the transmission is in third speed reverse, Number 3 clutch (7) and Number 1 clutch (2) are engaged. The Number 1 clutch holds coupling gear (1) stationary. The Number 3 clutch holds ring gear (8) stationary. Input shaft (18) turns Number 1 sun gear (17). Number 1 sun gear turns Number 1 planetary gears (19). Number 1 carrier (16) is a direct mechanical connection with coupling gear (1).

Because coupling gear (1) is held stationary by the Number 1 clutch, Number 1 carrier (16) is also held stationary. The movement of Number 1 planetary gear (19) causes ring gear (20) to turn in the opposite direction as input shaft (18). Ring gear (20) is a direct mechanical connection with Number 2 carrier (3) and Number 3 carrier (3).

The movement of Number 2 carrier (3) and Number 3 carrier (3) causes Number 3 planetary gears (22) to move around the inside of the ring gear. This occurs because ring gear (8) is held stationary by the Number 3 clutch. The movement of planetary gears (22) causes Number 3 sun gear (9) to turn. The Number 3 sun gear turns output shaft (24). From the output shaft, power travels through the output transfer gears to the differentials.

Second Speed Reverse

Refer to Illustration 56 for the location of the components, as described below. Refer to Illustration 58 for a typical description of power flow in the reverse direction.

When the transmission is in second speed reverse, Number 4 clutch (10) and Number 1 clutch (2) are engaged. The Number 1 clutch holds coupling gear (1) stationary. The Number 4 clutch holds ring gear (11) for the Number 4 clutch stationary. Input shaft (18) turns Number 1 sun gear (17). The Number 1 sun gear turns Number 1 planetary gears (19). Number 1 carrier (16) is a direct mechanical connection with coupling gear (1).

Because coupling gear (1) is held stationary by the Number 1 clutch, Number 1 carrier (16) is also held stationary. The movement of Number 1 planetary gears (19) causes ring gear (20) to turn in the opposite direction as input shaft (18). Ring gear (20) is a direct mechanical connection with Number 2 carrier (3) and Number 3 carrier (3). As the Number 2 carrier and the Number 3 carrier turn, Number 3 planetary gears (22) turn. The Number 3 planetary gears turn ring gear (8) for the Number 3 clutch and Number 3 sun gear (9). Number 3 sun gear (9) turns output shaft (24). Ring gear (8) turns Number 4 carrier (15).

Because ring gear (11) is held stationary by the Number 4 clutch, planetary gears (23) move around the inside of the ring gear. The movement of planetary gears (23) causes Number 4 sun gear (12) to turn. The Number 4 sun gear turns output shaft (24).

As a result, the torque to output shaft (24) is divided through Number 3 sun gear (9) and Number 4 sun gear (12). From the output shaft, power travels through the output transfer gears to the differentials.

First Speed Reverse

Refer to Illustration 56 for the location of the components, as described below. Refer to Illustration 58 for a typical description of power flow in the reverse direction.

When the transmission is in first speed reverse, Number 5 clutch (13) and Number 1 clutch (2) are engaged. The Number 1 clutch holds coupling gear (1) stationary. The Number 5 clutch connects rotating hub (14) and Number 4 carrier (15).

Input shaft (18) turns Number 1 sun gear (17). The Number 1 sun gear turns planetary gears (19). Number 1 carrier (16) is a direct mechanical connection with coupling gear (1). Because coupling gear (1) is held stationary by the Number 1 clutch, Number 1 carrier (16) is also held stationary. The movement of Number 1 planetary gears (19) causes ring gear (20) to turn in the opposite direction as input shaft (18). Ring gear (20) is a direct mechanical connection with Number 2 carrier (3) and Number 3 carrier (3).

As carrier (3) turns, planetary gears (22) turn ring gear (8) and sun gear (9). Sun gear (9) turns output shaft (24).

Ring gear (8) turns carrier (15). Carrier (15) is connected to rotating hub (14) by the engagement of the Number 5 clutch. This allows power to travel from carrier (15) to sun gear (12) and to ring gear (11). The power then travels through the Number 5 clutch to rotating hub (14). Sun gear (12) and rotating hub (14) are fastened to output shaft (24).

As a result, the torque to output shaft (24) is divided between Number 3 sun gear (9), Number 4 sun gear (12), and rotating hub (14). From the output shaft, power travels through the output transfer gears to the differentials.

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Input Transfer Gears

SMCS Code: 3159-IV

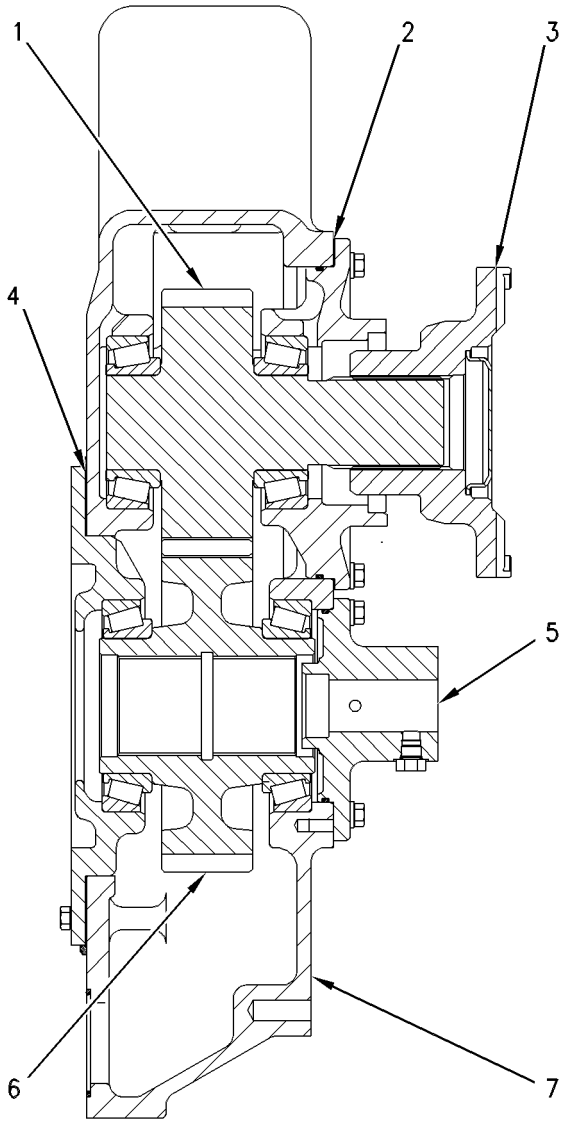


Illustration 59 g00382937

Input Transfer Gears

(1) Drive gear. (2) Shims. (3) Yoke assembly. (4) Shims. (5) Manifold. (6) Driven gear. (7) Case.

The input transfer gears are at the input side of the transmission. The upper drive shaft connects the torque converter to yoke assembly (3).

Yoke assembly (3) is connected to drive gear (1) by splines. Drive gear (1) is engaged with driven gear (6). Driven gear (6) is connected to the input shaft of the transmission with splines.

The flow of power through the input transfer gears is from yoke assembly (3) to drive gear (1). The power then flows from drive gear (1) to driven gear (6). From driven gear (6), power flows to the transmission input shaft.

Shims (2) are used to adjust the end play of drive gear (1).

Shims (4) are used to adjust the end play of driven gear (6).

Reference: Refer to the Service Manual module for Systems Operation, “Input Transfer Gear and Output Transfer Gear Lubrication” for the theory of operation for the lubrication of the input transfer gears.

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Output Transfer Gears

SMCS Code: 3159-OJ

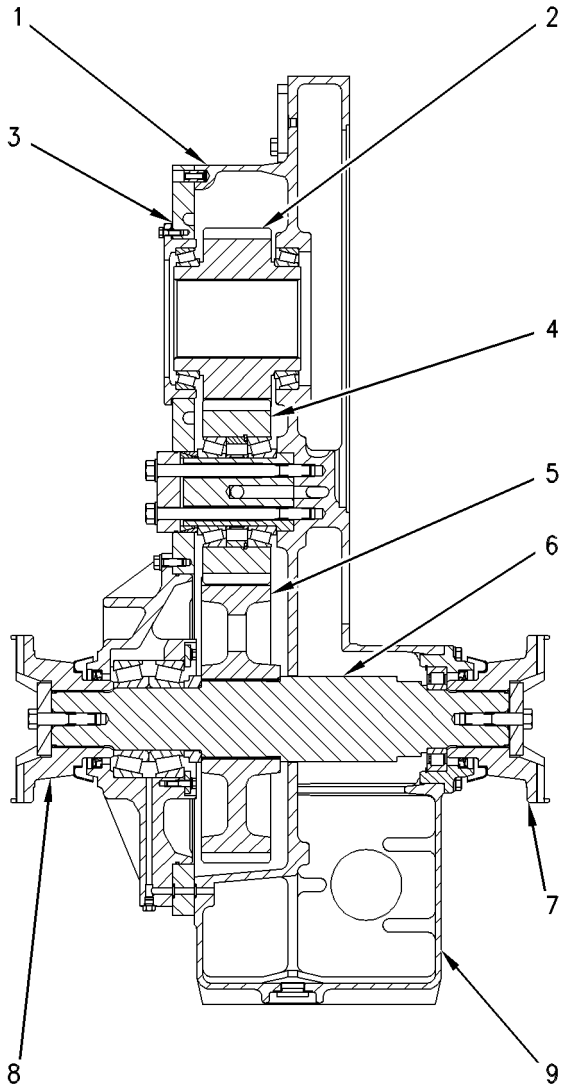


Illustration 60 g00104569

Output Transfer Gears

(1) Case. (2) Drive gear. (3) Shims. (4) Idler gear. (5) Gear. (6) Shaft. (7) Yoke assembly. (8) Yoke assembly. (9) Oil reservoir.

The output transfer gears are at the output side of the transmission. The transmission output shaft is connected to drive gear (2) by splines.

Drive gear (2) is engaged with idler gear (4). Idler gear (4) is engaged with driven gear (5). Driven gear (5) is connected to shaft (6) by splines. Yoke assemblies (7) and (8) are connected to shaft (6) by splines. Yoke assembly (7) is connected to the short drive shaft that goes to the rear differential. Yoke assembly (8) is connected to the drive shaft that goes to the bearing cage and to the front differential.

The flow of power in the output transfer gears goes from the transmission output shaft to drive gear (2). The power then flows from drive gear (2) to idler gear (4). From idler gear (4), the power flows to driven gear (5). The power then flows from the driven gear to shaft (6).

At shaft (6), the flow of power divides. Some of the power goes from yoke assembly (7) through a drive shaft to the rear differential. Some of the power goes from yoke assembly (8) through a drive shaft and through the bearing cage to the front differential.

Shims (3) are used to adjust the end play of gear (2).

Reference: Refer to the Service Manual module for Systems Operation, “Input Transfer Gear and Output Transfer Gear Lubrication” for the theory of operation for the lubrication of the input transfer gears.

i00808074

Input Transfer Gear And Output Transfer Gear Lubrication

SMCS Code: 3159-OJ; 3159-IV

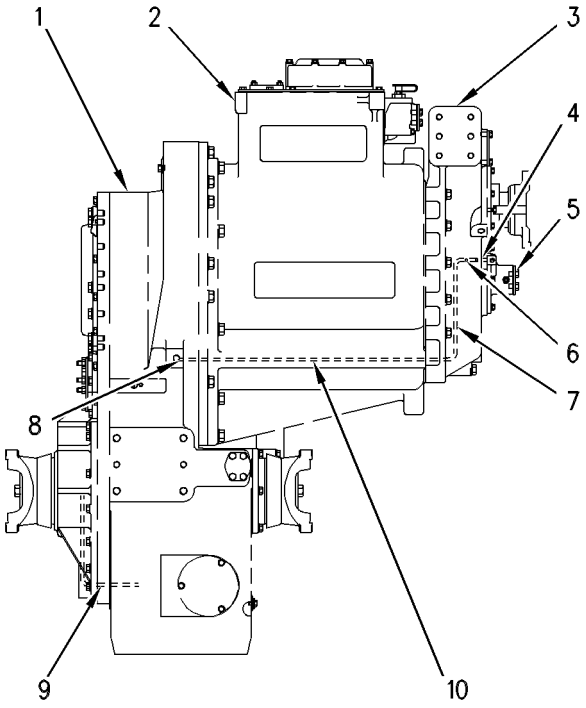


Illustration 61 g00383893

Transfer Gear Lubrication

(1) Output transfer gear. (2) Transmission. (3) Input transfer gear. (4) Passage. (5) Manifold. (6) Holes. (7) Tube. (8) Tube. (9) Passage. (10) Tube.

Oil from the transmission oil cooler enters manifold (5) and flows into the input shaft of the transmission. The remainder of the oil flows through passage (4) in the manifold to tube (7) in input gear housing (3).

Tube (7) connects oil passages from the front of input gear housing (3) to the rear of the housing. Tube (7) has two holes (6) that spray oil on the two gears as the gears mesh. The oil cools the gears. The oil also lubricates the gears.

The oil flows through tube (7) to the inlet at the base of input gear housing (3). The oil flows through a tube (10) in transmission housing (2) to a passage in output transfer gear housing (1). Tube (8) at the end of the passage in the output transfer gear housing supplies oil to the two reservoirs.

One reservoir is behind the idler gear. This reservoir supplies oil to drilled holes in the fixed shaft to supply oil to the idler gear bearings. The other reservoir is behind the drive gear for the secondary steering pump. A tube carries oil from the reservoir to the center of the drive gear for the secondary steering pump. This oil lubricates the bearings for the drive gear and the splines for the secondary steering pump.

Output transfer gear housing (1) is the oil reservoir for the transmission circuit. Passage (9) allows lubrication oil from the output shaft bearings to drain to the reservoir. A hose connects the torque converter housing to the output transfer gear housing. All of the drain oil from the input gears and the transmission flows through openings in the bottom of the housings to the output transfer gear housing.

i01645359

Differential

SMCS Code: 3258

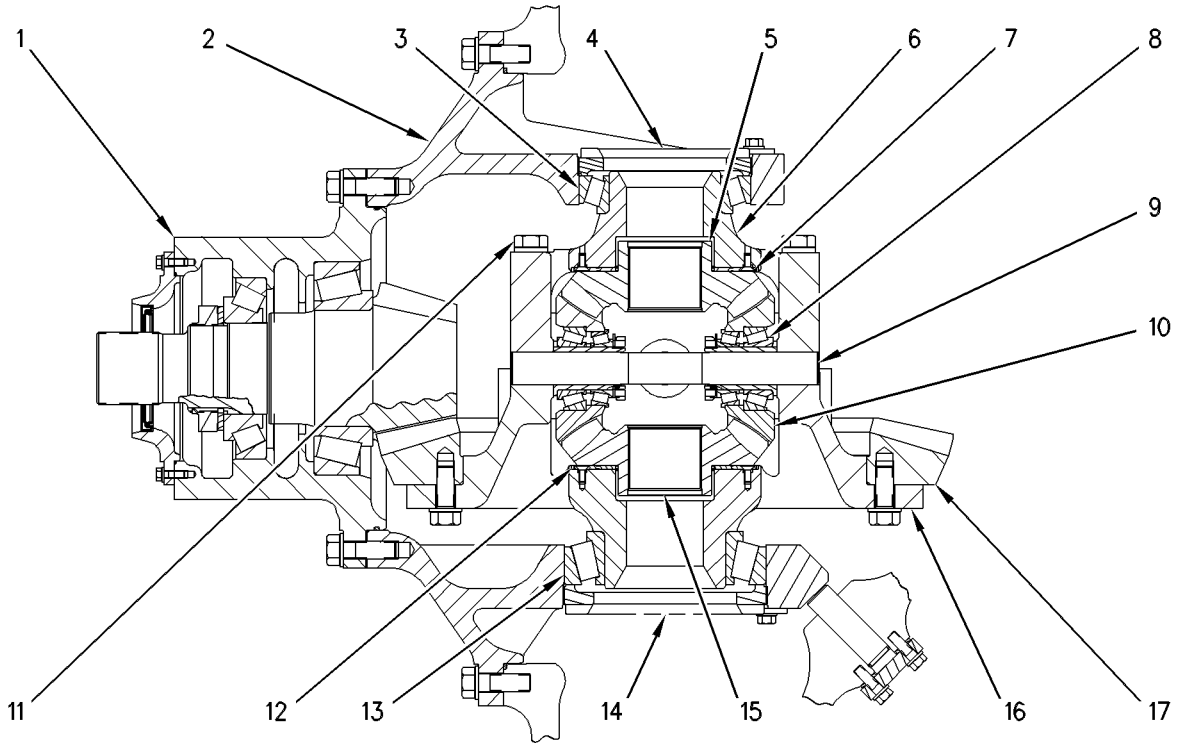


Illustration 62 g00384857

Differential and Bevel Gear Group

(1) Bevel gear group
(2) Differential carrier
(3) Bearing cup and cone
(4) Adjustment ring
(5) Side gear
(6) Differential group
(7) Thrust washer
(8) Bearings
(9) Spider
(10) Pinions
(11) Bolt
(12) Thrust washer
(13) Bearing cup and cone
(14) Adjustment ring
(15) Side gear
(16) Case
(17) Bevel gear

A differential divides the power that is sent to the wheels. This essentially balances the power that is sent to the wheels. During a turn, the inside wheel turns at a slower rate than the outside wheel. The differential allows the inside wheel to rotate at a slower rate in relation to the outside wheel. The differential still sends the same amount of torque to each wheel.

Bevel pinion (18) is connected to a yoke assembly. The yoke assembly is connected to a universal joint from the output transfer gears. Pinion (18) is connected to the yoke assembly by splines. Pinion (18) is engaged with bevel gear (17). Bevel gear (17) is fastened to differential group (6). Differential carrier (2) is fastened to the axle housing.

Differential group (6) has a case (16). Bevel gear (17) is fastened to case (16). The case is divided into two parts, and the two parts are held together by bolts (11). The following components are inside of the case: side gear (5), spider (9), four pinions (10) and side gear (15). Spider (9) is installed between the two parts of the case. When the case is turned, the spider turns.

Pinions (10) are installed on the spider. The pinions are engaged with the teeth of side gears (5) and (15). The axle shafts are connected to the side gears by splines.

Side gears (5) and (15) turn against thrust washers (7) and (12). Pinions (10) turn on bearing assemblies (8).

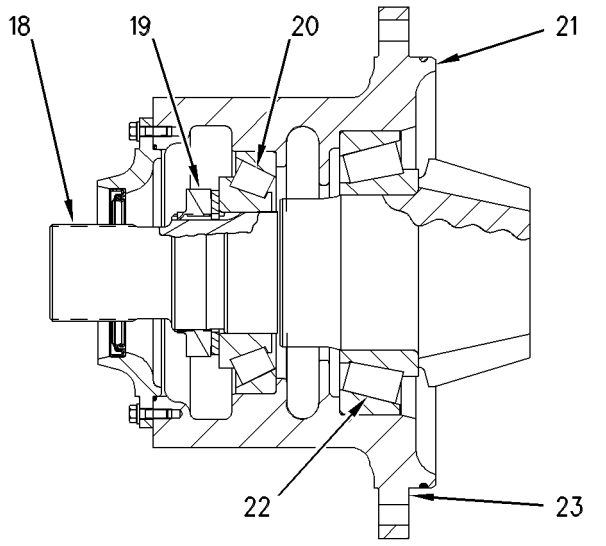


Illustration 63 g00384858

Bevel Gear Group

(18) Pinion
(19) Nut
(20) Bearing
(21) Housing
(22) Bearing
(23) Shims

Nut (19) is used to adjust the end play (bearing preload) of bearings (20) and (22) for pinion (18).

Shims (23) are used to adjust the tooth contact (wear pattern) between pinion (18) and bevel gear (17).

Rings (4) and (14) are used to adjust the free movement (backlash) between pinion (18) and bevel gear (17). The rings are also used to adjust the bearing preload of bearings (3) and (13).

The inside components of the differential receive lubrication from the oil that is thrown around the inside of the differential. Flat surfaces on spider (9) allow oil to flow to the bearings. The supply for lubrication oil is a reservoir in the axle housing.

Straight Forward or Straight Reverse Operation

When the machine moves in a straight direction with the same amount of traction under each drive wheel, the same amount of torque that is on each axle holds the pinions so that the pinions do not turn on the spider.

Pinion (18) turns bevel gear (17). Bevel gear (17) turns case (16). Case (16) turns spider (9). Spider (9) turns side gears (5) and (15) through pinions (10). Pinions (10) do not turn on the spider. The side gears turn the axle shafts. The same amount of torque is sent to each wheel.

This provides the same effect as connecting both of the drive wheels to one axle shaft.

Operation during a Forward Turn or Operation during a Reverse Turn

When the machine is turning, the inside wheel is more resistant than the outside wheel to the turn. This resistance causes different torques on the opposite sides of the differential. The outside wheel turns more easily than the inside wheel. The outside wheel starts to turn faster than the inside wheel.

Pinion (18) turns bevel gear (17). Bevel gear (17) turns case (16). Case (16) turns spider (9). Spider (9) turns side gears (5) and (15) through pinions (10). Because one side gear requires more force than the other side gear in order to turn, pinions (10) turn around the spider. As the pinions turn, the pinions move around the side gears. This allows the outside wheel to turn faster than the inside wheel.

The same amount of torque is sent to the inside wheels and to the outside wheels. This torque is only equal to the amount that is necessary to turn the outside wheel.

Loss of Traction (Wheel Slippage)

When one wheel has more traction than the other wheel, the differential operates in the same manner as if the machine is turning. The same amount of torque is sent to both wheels. This torque is only equal to the amount that is necessary to turn the wheel with the least resistance.

i01544555

Final Drive and Wheel

SMCS Code: 4051

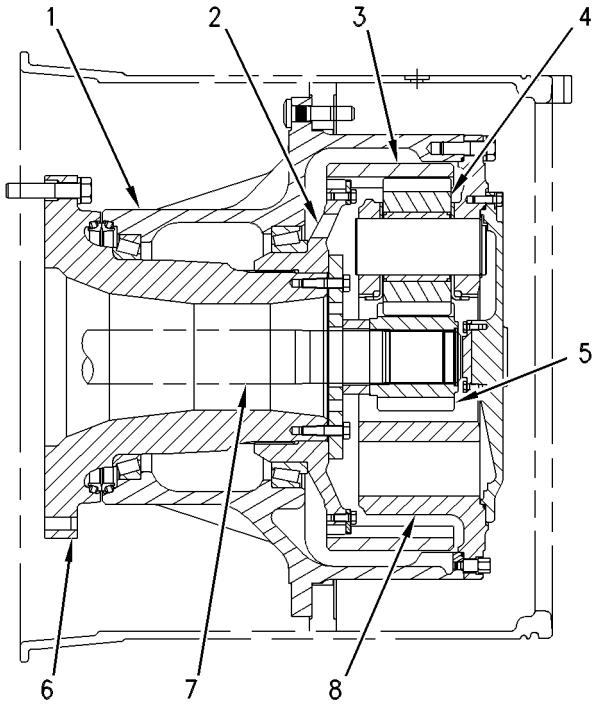


Illustration 64 g00390577

Final Drive Components

(1) Wheel assembly. (2) Hub. (3) Ring gear. (4) Planetary gears. (5)Sun gear. (6) Spindle housing. (7) Axle shaft. (8) Planetary carrier.

Each final drive has the same components. A final drive provides the last speed reduction and the torque increase in the power train.

Ring gear (3) is fastened to hub (2). Hub (2) is connected to spindle housing (6) by splines. Spindle housing (6) is fastened to the axle housing. Ring gear (3), spindle housing (6), and hub (2) are held stationary.

Axle shaft (7) is connected to the differential by splines. Sun gear (5) is connected to axle shaft (7) by splines. Sun gear (5) is engaged with planetary gears (4). Planetary gears (4) are held in planetary carrier (8). Planetary carrier (8) is fastened to wheel assembly (1).

Power from the differential turns axle shaft (7). Axle shaft (7) turns sun gear (5). Sun gear (5) turns planetary gear (4). Because ring gear (3) is held by hub (2), the planetary gears move around the inside of ring gear (3). The movement of the planetary gears cause planetary carrier (8) to turn. The planetary carrier is turned in the same direction as sun gear (5) but at a slower speed. The planetary carrier turns wheel assembly (1).

Each final drive has an oil reservoir. Oil is added to the final drive through a filler plug on the outside cover. Oil is removed from the final drive through a drain plug.

The components of the final drives are lubricated from the oil that is inside of the final drives. The oil in the final drives is the same oil that is in the differentials.

i07423384

Axle Oil Cooler

SMCS Code: 1365; 1408

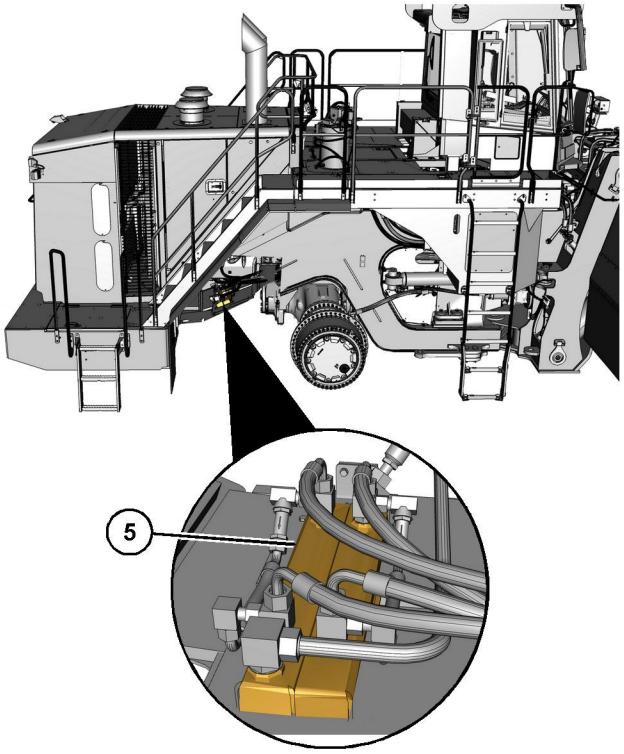


Illustration 65 g06340170

Axle Oil Cooler (partial view)

(5) Axle Oil Cooler

The axle oil cooler (5) is located near the rear of the machine just behind the rear axle. The axle oil cooler is mounted to a bracket that is attached between the rear frame rails, below the engine. The axle oil cooler is an oil-to-oil cooler that transfers the heat from the axle oil to the oil returning from the hydraulic oil cooler.

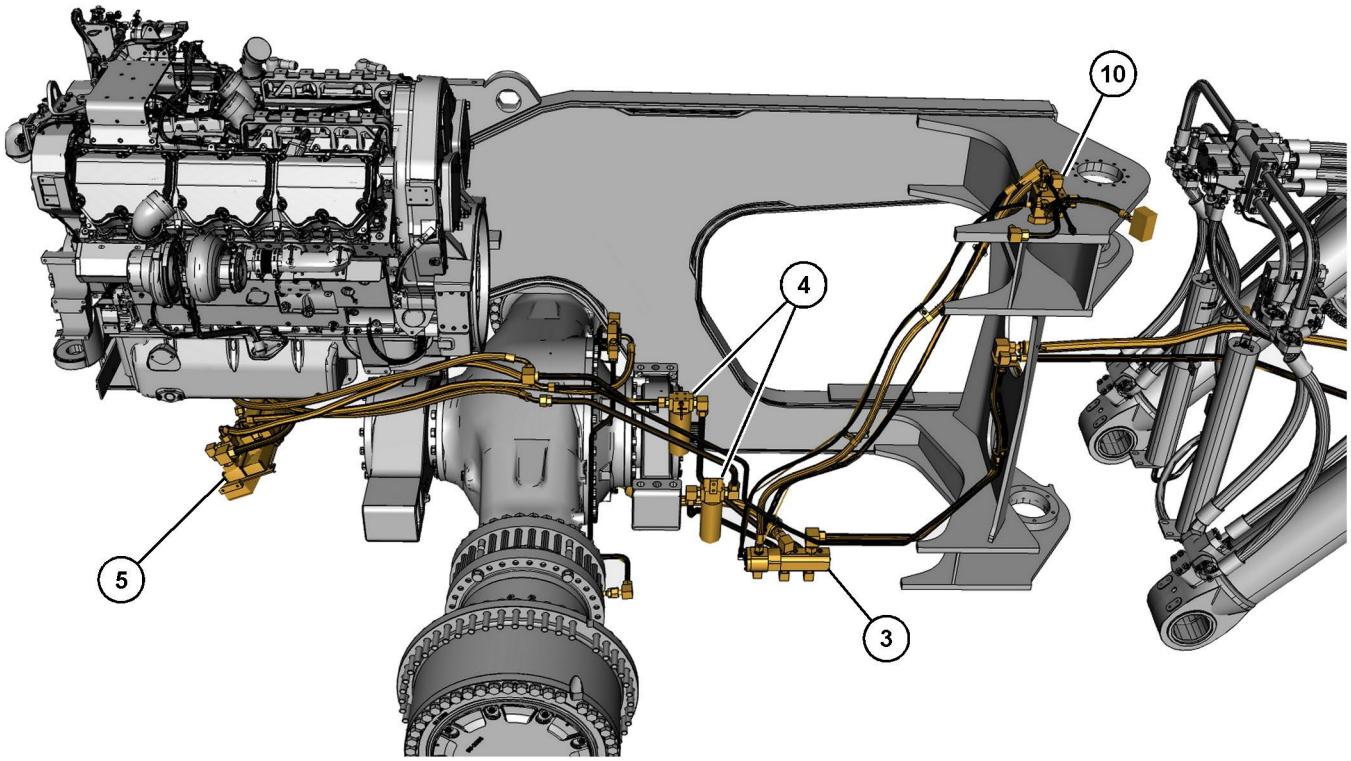


Illustration 66 g06340114

Axle oil cooling group

(3) Axle oil cooling pump
(4) Axle oil filters
(5) Axle oil cooler
(10) Diverter valve

The axle oil cooling pump (3) circulates the oil through the axle, axle oil filters (4) and the axle oil cooler (5).

The cooling pumps pull the high temperature oil from the differential case and send the oil to the oil coolers. The oil coolers remove the heat and return the oil to the axles. The cooler oil enters the axles at each end of the differential case.

Oil from the hydraulic fan return circuit flows through the axle oil coolers to cool the axle oil.

The power train ECM monitors the axle oil temperature through the front and rear axle oil temperature sensors. The diverter valve (10) diverts oil from the steering pilot/axle oil cooling pump to the steering pilot system when the axle oil is cold.

The diverter valve is located on the inboard side of the right frame rail. When diverter solenoid is energized, oil from the steering pilot/axle oil cooling pump is directed to the tank. When the diverter solenoid is de-energized, oil from the steering pilot/axle oil cooling pump flows to the axle oil cooling motor to drive the pump.

Axle Oil Cooling System (Energized)

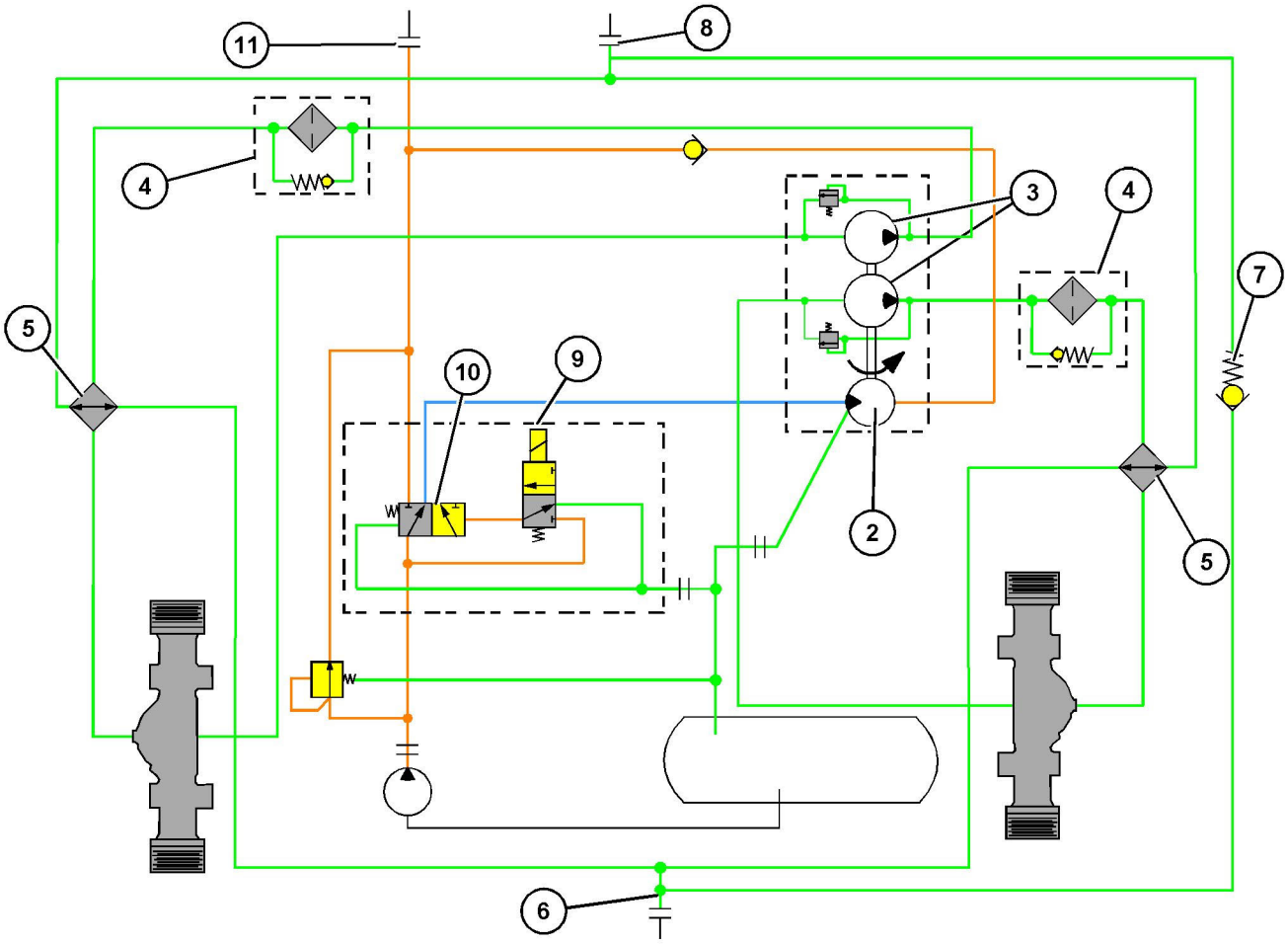


Illustration 67 g06333628

Diverter Solenoid Energized

(1) Steering pilot / axle oil cooling pump
(2) Axle oil cooling motor
(3) Axle oil cooling tandem pumps
(4) Axle oil filter
(5) Axle oil cooler
(6) Passage to hydraulic oil cooler
(7) Bypass valve
(8) Passage to implement fan / tank
(9) Diverter solenoid
(10) Diverter valve
(11) Passage to steering pilot system

Shown is a schematic of the front and rear axle oil cooling systems. Each axle cooling system cools the oil in the respective axle. The steering pilot/axle oil cooling pump (1) provides oil to rotate axle oil cooling motor (2), which drives axle oil cooling tandem pumps (3). The axle oil cooling pump circulates oil through the axle oil filter (4) and the axle oil cooler (5).

When the operator applies the service brakes, friction generates heat in the brake plates and discs. Also, heavy loads generate heat in the differential. The cooling pumps pull the high temperature oil from the differential case and send the oil to the oil coolers. The oil coolers remove the heat and return the oil to the axles. The cooler oil enters the axles at each end of the differential case

Oil from the hydraulic oil cooler flows through the axle oil coolers to cool the axle oil. If an axle oil cooler becomes plugged, the oil from the hydraulic oil cooler flows through a bypass valve (7) and through passage (8) to the implement / fan hydraulic tank.

The powertrain ECM monitors the axle oil temperature using the axle oil temperature sensors. The diverter solenoid (9) is controlled by the powertrain ECM.

The following three conditions cause the diverter solenoid to be energized, bypassing the axle oil cooler:

- The axle oil temperature is less than 60° C (140° F)

- When an engine start is initiated, the diverter solenoid will be energized for approximately 20 seconds. After the 20 seconds, the diverter solenoid will return to the appropriate state depending on other machine conditions.
- If the machine key switch is ON and the engine is not running.

Axle Oil Cooling System (De-energized)

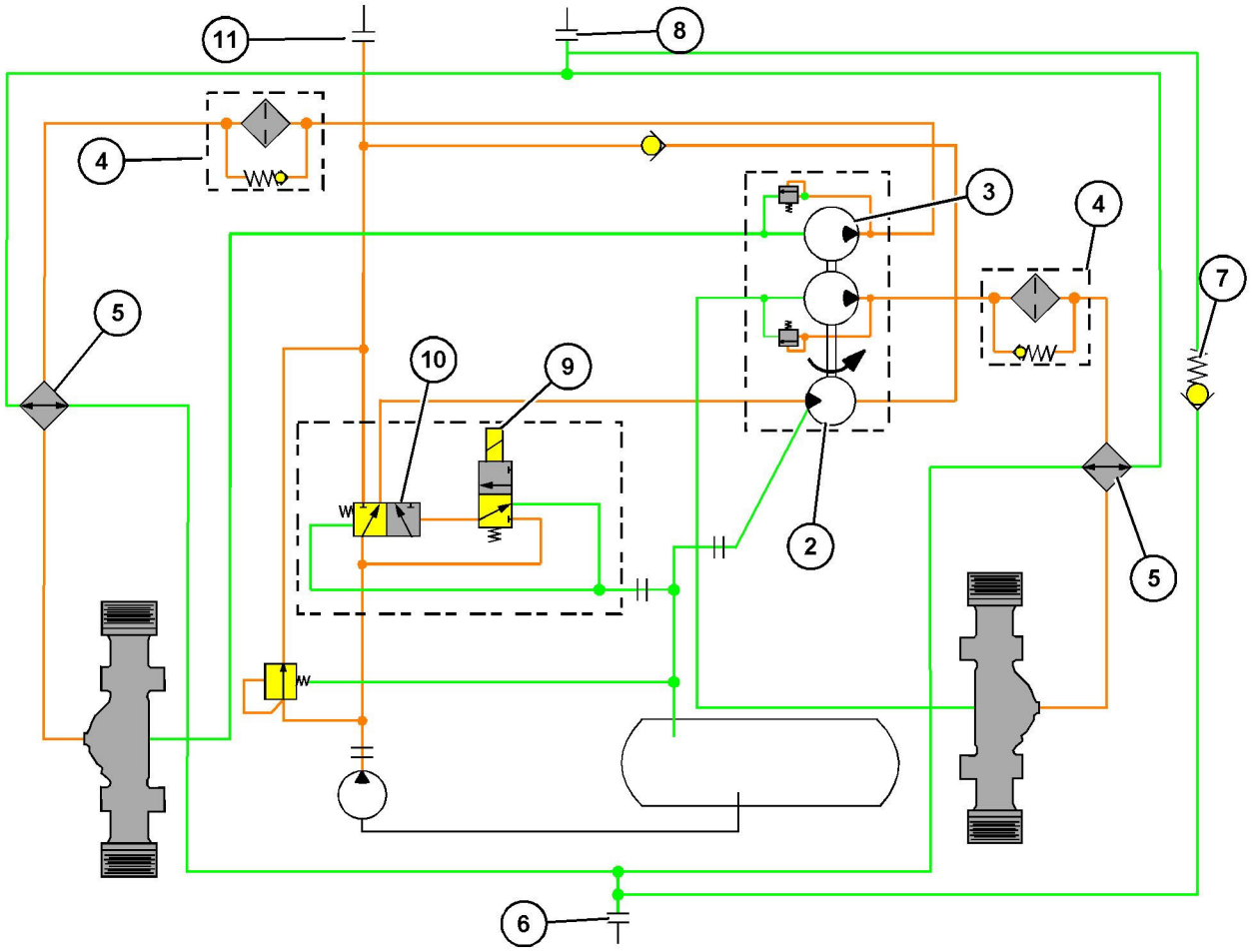


Illustration 68 g06333637

Diverter Solenoid De-energized

(1) Steering pilot / axle oil cooling pump
(2) Axle oil cooling motor
(3) Axle oil cooling tandem pumps
(4) Axle oil filter
(5) Axle oil cooler
(6) Passage to hydraulic oil cooler
(7) Bypass valve
(8) Passage to implement fan / tank
(9) Diverter solenoid
(10) Diverter valve
(11) Passage to steering pilot system

When the axle oil temperature increases above 70° C (158° F), the diverter solenoid (9) is de-energized by the powertrain ECM. When the solenoid is de-energized, the diverter valve directs oil to the hydraulic tank. The diverter valve shifts and directs the oil from the steering pilot / axle oil cooling pump (1) to the axle cooling motor (2), which drives the axle cooling pump (3).

i02405748

Oil Coolers and Cooling System Operation

SMCS Code: 1350; 1353; 1365; 1374; 1375; 1378

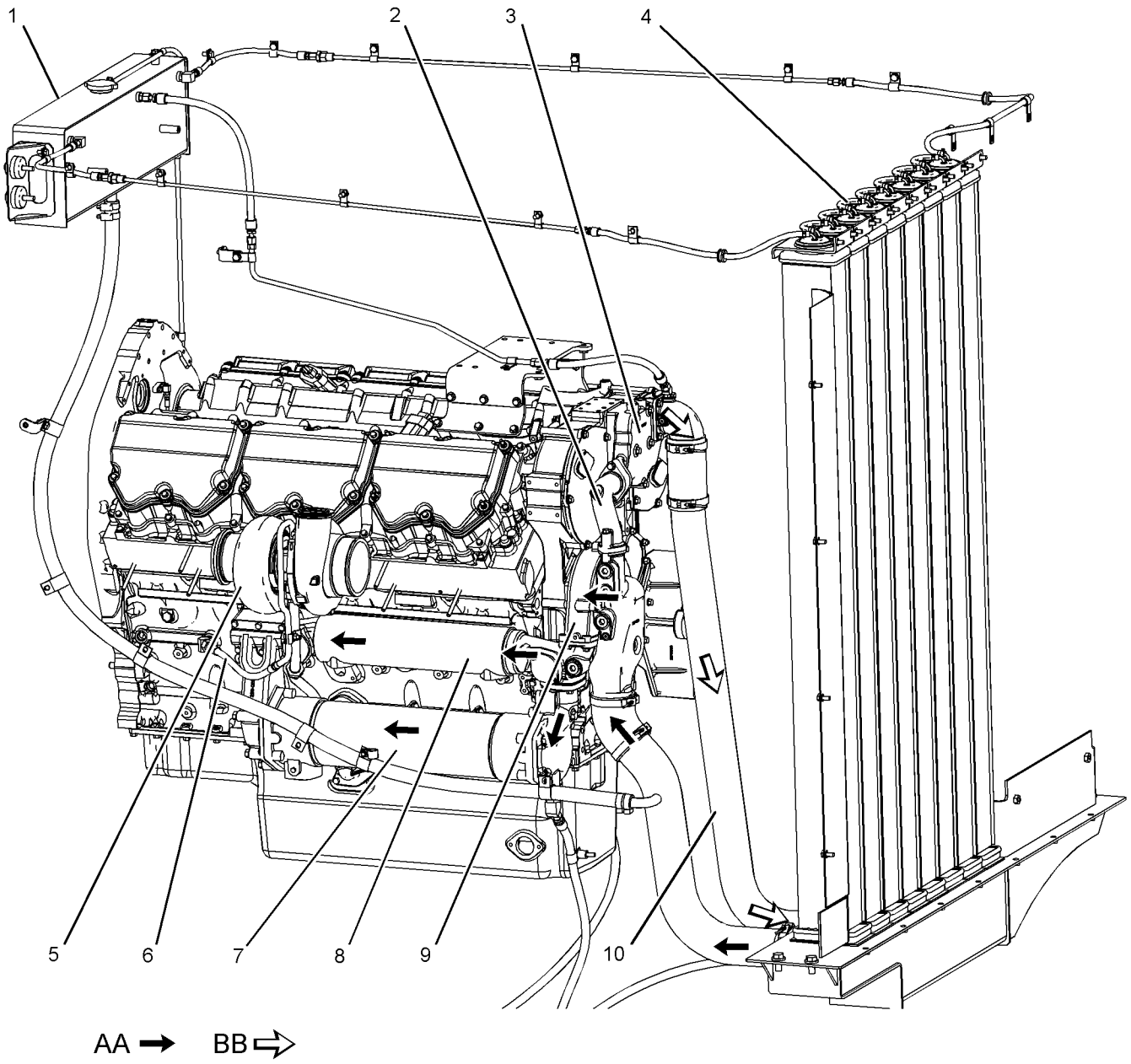


Illustration 69 g01201765

Cooling System

(1) Radiator top tank
(2) Bypass
(3) Water regulator
(4) Radiator cores
(5) Turbocharger
(6) Turbocharger Oil Lines Gp
(7) Transmission oil cooler
(8) Engine oil cooler
(9) Water pump
(10) Inlet tube (radiator)
(AA) Unregulated coolant
(BB) Regulated coolant

Water pump (9) draws coolant directly from radiator (4). The coolant is pumped through the engine oil cooler (8) and the transmission oil cooler (7). From these oil coolers, coolant flows through the engine block.

The coolant goes around the cylinder liners, through the water directors and into the cylinder heads. The water directors send the flow of coolant around the valves and the passages for exhaust gases in the cylinder heads. The coolant then goes to the front of the cylinder heads and into water regulator housing (3). When the coolant is inside of housing (3), two water temperature regulators control the direction of coolant flow within housing (3).

When the coolant temperature is below 81 °C (178 °F), water temperature regulator (3) will be closed. The path for the coolant return to radiator (4) is blocked. The coolant flows through regulator housing (3). Then, the coolant is fed back to the inlet of water pump (9).

As the coolant temperature reaches 82° ± 1°C (180° ± 2°F), water temperature regulator (3) starts to open. Coolant begins to flow to tube (10). When the coolant temperature reaches 92 °C (198 °F), the coolant is at normal operating temperature. Water temperature regulator (3) is fully open and the flow of coolant to bypass (2) is blocked. The path for the coolant to radiator (4) through the tube (10) is open. The temperature of the returned coolant will be reduced as the coolant flows through radiator (4).

Note: Water temperature regulator (3) is an important part of the cooling system. Water temperature regulator (3) divides the coolant flow between radiator (4) and bypass (2). Normal operating temperature is maintained. If the water temperature regulator is not installed in the system, the flow of coolant is not regulated. Most of the coolant will go through the bypass (2) and bypass radiator assembly (4). The engine, the transmission, and the hydraulic oil may overheat during high ambient temperatures.

Coolant for the Turbocharger

Turbocharger (5) has one inlet and one outlet. Turbocharger Oil Lines Gp (6) is connected to the turbocharger at these ports. Pressurized engine oil flows from the crankcase of the engine into turbocharger (5) through Turbocharger Oil Lines Gp (6). This engine oil is used for lubrication of the bearings in the turbocharger and for cooling of the turbocharger. The oil then drains through Turbocharger Oil Lines Gp (6) into the oil pan on the bottom of the engine.

Radiator Assembly

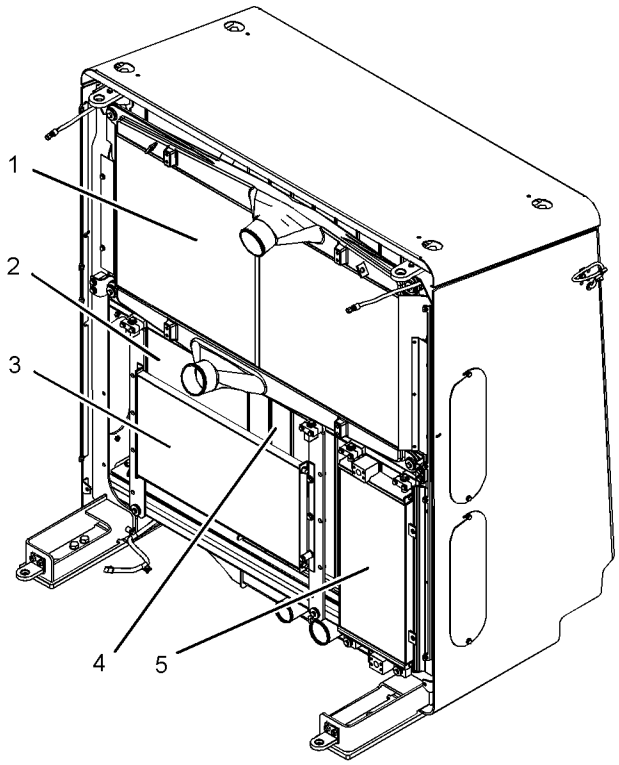


Illustration 70 g01201927

Radiator Assembly (Front View)

(1) Aftercooler
(2) Hydraulic oil cooler
(3) refrigerant condenser
(4) Radiator
(5) Hydraulic oil cooler for the steering system and the hydraulic fan system

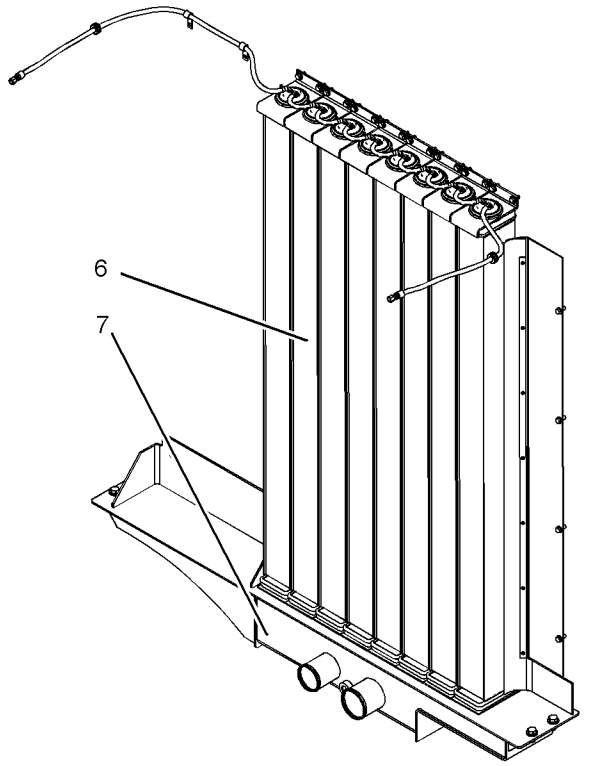


Illustration 71 g01201957

Radiator Cores (Front View)

(6) Radiator Cores
(7) Radiator bottom tank

The radiator assembly is the source of coolant for the cooling system. The radiator is made up of the following two sections: Radiator bottom tank (7) and Radiator core assemblies (6).

Also, the radiator assembly includes the air aftercooler (1), refrigerant condenser (3), radiator core assemblies (4), hydraulic oil cooler (2), and the hydraulic oil cooler for the steering system and the hydraulic fan system (5).

Reference: For additional information about the refrigerant condenser, refer to the Service Manual module Systems Operation, SENR5664, “Air Conditioning and Heating R-134a All Caterpillar Machines ”.

Reference: For additional information about cooling the hydraulic system, refer to the Service Manual module Systems Operation, “Hydraulic Fan System” for the machine that is being serviced.

The radiator bottom tank is divided into two sections. The rear section accepts the return coolant from the water regulator housing. The return coolant flows into the rear section of the bottom tank.

Radiator core (6) is made up of one row of eight tubes in the front and one row of eight tubes in the rear with a connection between the paths at the top of each core. As the coolant flows into the rear section of the bottom tank, the coolant is pushed up the core through the row of eight tubes in the rear. As the coolant gets to the top of the core, the coolant flows through the crossover tubes. Then, the coolant flows through the row of eight tubes in the front of the radiator core assembly. Then, the coolant flows into the front section of the bottom tank.

As the coolant flows through the radiator cores in both directions and the air is pulled around the radiator core, the temperature of the coolant is reduced.

Transmission Oil Cooler

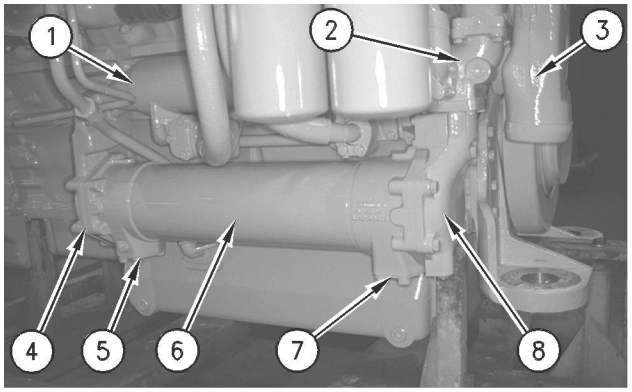


Illustration 72 g00379759

Rear Left Side of the Machine

(1) Engine oil cooler. (2) Bonnet. (3) Water pump. (4) Bonnet. (5) Oil inlet. (6) Transmission oil cooler. (7) Oil outlet. (8) Bonnet.

Engine coolant from water pump (3) flows through bonnets (2) and (8) to oil cooler (6). The coolant flows through long tubes inside the oil cooler to bonnet (4). The coolant then flows through bonnet (4) to the engine cylinder block.

Transmission oil with high temperatures and hydraulic system oil with high temperatures flow from the torque converter outlet to the oil cooler. This oil flows through oil cooler inlet (5) to the inside of the cooler. In this procedure, heat is removed from the oil and the heat is transferred to the coolant in the tubes. The engine coolant is then cooled by the cooling system of the engine.

After the oil flows around the tubes, the oil flows to the other end of the oil cooler. The oil then flows out of the oil cooler through oil cooler outlet (8). This oil has a lower temperature than the inlet oil. The oil now flows through a line in order to lubricate the planetary group.

Air to Air Aftercooler

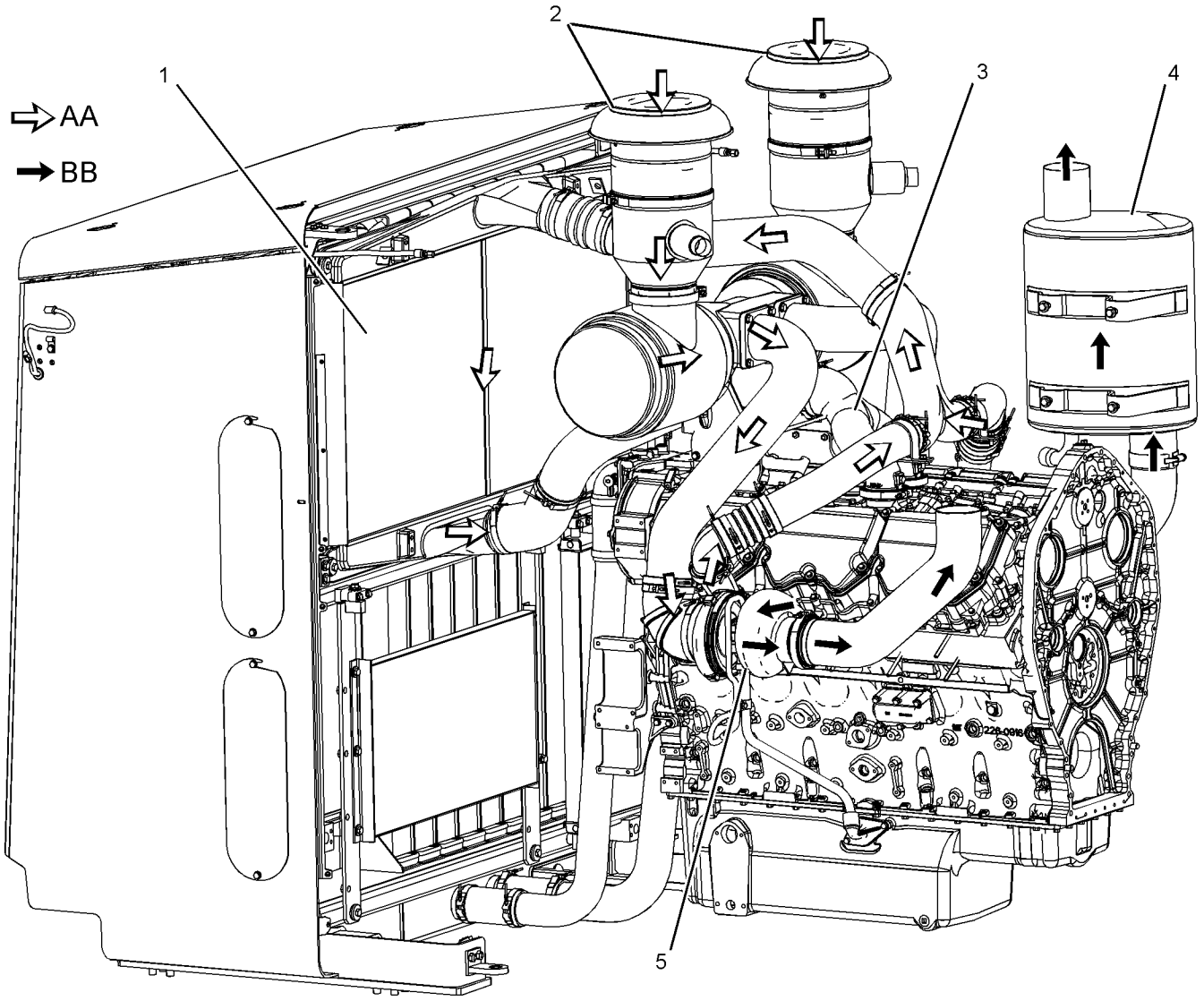


Illustration 73 g01202027

Air to Air Aftercooler

(1) Aftercooler
(2) Air cleaners
(3) Cooled air enters the air intake manifold on top of the engine.
(4) Muffler
(5) Turbocharger
(AA) Inlet air
(BB) Exhaust gases

The air-to-air aftercooler system (ATAAC system) provides cooled air to air intake manifold (3) on top of the engine. Air is drawn in through air cleaners (2) and into turbocharger (5). The air is sent through the tube into aftercooler core (1). From core (1), the air flows into the air intake manifold (3) on the top of the engine. The air flow from the inlet port into the cylinders is controlled by inlet valves. Each cylinder has inlet valves and exhaust valves in the cylinder head. The inlet valves open when the piston moves downward on the inlet stroke. When the inlet valves open, cooled compressed air from the inlet port within the inlet manifold is pulled into the cylinder. The inlet valves close when the piston begins to move up on the compression stroke. The air in the cylinder is compressed and the fuel is injected into the cylinder when the piston is near the top of the compression stroke. Combustion begins when the fuel mixes with the air. The force of combustion pushes the piston downward on the power stroke. The exhaust valves open and the exhaust gases are pushed through the exhaust port.

Exhaust gases from the exhaust manifold flow into the turbine side of the turbocharger (5). The high pressure exhaust gases cause the turbocharger turbine wheel to rotate. The turbine wheel is connected to the shaft that drives the compressor wheel. Exhaust gases from turbocharger (5) pass through the exhaust outlet , through a muffler (4), and through an exhaust stack.

The efficiency of the engine will increase due to the cooler inlet air. This helps to provide lowered fuel consumption and increased horsepower output. The air circulates through the intake manifold and flows back to turbocharger (5). From turbocharger (5), the air flows out of the system through muffler (4).

Reference: For additional information about the turbocharger, refer to the Service Manual module Systems Operation, Testing and Adjusting, “Air Inlet and Exhaust System” for the engine that is being serviced.

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RENR8811-05 (en-us)
August 2018

Troubleshooting
Testing and Adjusting

990H Wheel Loader and , 844H Wheel Dozer
Power Train

BTW 1-UP (Machine)
BWX 1-UP (Machine)

i06558969

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Troubleshooting Section

Introduction

i05571890

General Information

SMCS Code: 4800; 7000

The diagnostics for the electronic control module (ECM) can be accessed through the Cat ® Monitoring System or the Cat Electronic Technician (Cat ET). Troubleshooting a system requires additional information from:

- Troubleshooting, “Using Caterpillar Monitoring System to Determine Diagnostic Codes”
- Troubleshooting, “Using Caterpillar Electronic Technician (ET) to Determine Diagnostic Codes”
- Parts Manual

As a guide, a simplified system schematic is included at the end of this manual. For a complete schematic refer to the machine Electrical Schematic.

Perform continuity checks at the harness connectors to locate harness failures.

At the connectors of the components, always check the ground circuit. Less than 5 ohms of resistance is required between the ground contacts of the connector and the frame ground. Excessive ground resistance that is greater than 5 ohms can cause incorrect diagnosing of problems.

During troubleshooting, inspect all connections before any component is replaced. If these connections are not clean and tight, permanent electrical problems or intermittent electrical problems can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

When performing wiring harness tests, do not puncture the wire insulation. Use test leads such as the 7X-1710 Multimeter Probe to troubleshoot the harness without damaging the wire insulation.

If damaged wire insulation is found during troubleshooting, repair the damage. Seal the damaged wires with 8T-0065 RTV Silicone Sealant. Cover the sealant with two layers of 1P-0810 Tape.

Failure of an electrical component can cause the failure of other components. Correct the cause of an electrical failure before replacing a component.

When removing the harness from any ECM, use the single screw in the center of the harness connector.

i01660974

Service Tools

SMCS Code: 0785

The following service tools should be used to aid in troubleshooting the electrical system.

Table 1

Service Tools	
Part Number	**Part**
	CAT Electronic Technician
6V-7070 9U-7330	Digital Multimeter
8T-3224	Needle Tip Group
7X-1710	Multimeter Probe Group
8T-8726	Adapter Cable Assembly
6V-3000	Connector Repair Kit (Sure Seal)
9U-7246	Connector Repair Kit (Deutsch DT)
4C-3406	Connector Repair Kit (Deutsch)
4C-8195	Control Service Tool (Switch Box)

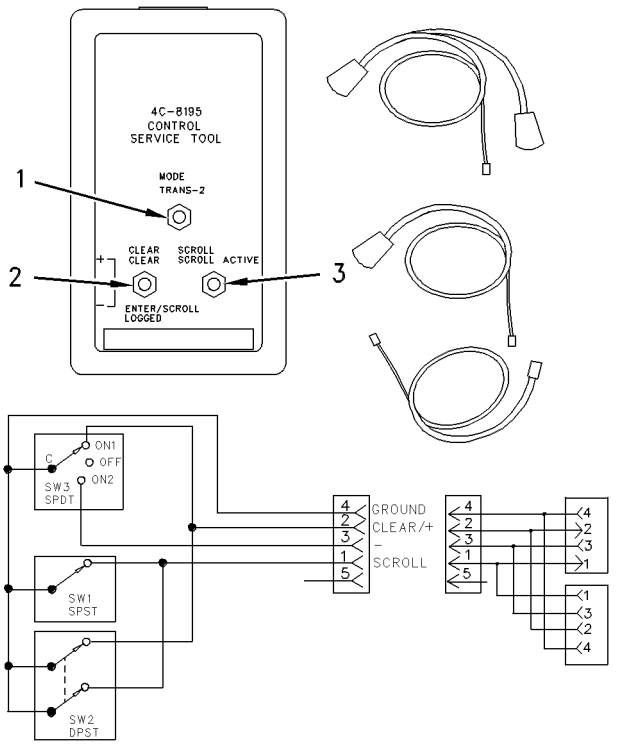


Illustration 1 g00429878

4C-8195 Control Service Tool

(1) Mode switch. (2) Clear switch. (3) Scroll switch.

The 4C-8195 Control Service Tool is helpful for the service person to make the proper electrical connections at the Caterpillar Monitoring System service connector during troubleshooting. Three connectors are wired in parallel so that the service tool is usable on the different types of machine harnesses.

Actuating the mode switch scrolls through the display modes of the Caterpillar Monitoring System. Actuate the scroll switch in order to scroll through the display while you are in the service mode or while you are in the numeric readout mode. Actuate the clear switch while you are in the service mode and you will clear the fault that is being continuously shown. All the values that are extreme will be cleared when you actuate the clear switch. The values will be cleared in the tattletale mode.

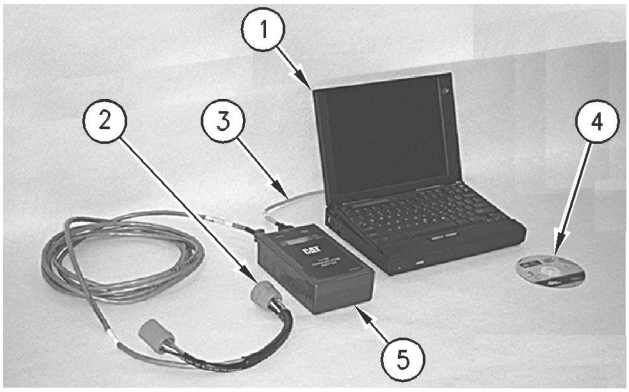


Illustration 2 g00280782

Connections for the Electronic Technician (ET)

The components that are needed in order to use the CAT Electronic Technician in order to determine diagnostic codes are listed:

(1) An IBM-COMPATIBLE personal computer with an installed current version of Caterpillar Electronic Technician software
(2) 139-4166 Data Link Cable or 7X-1570 Data Link Cable
(3) 7X-1425 Cable and 4C-6805 Adapter
(4) Special Publication, JEBD3003, Special Publication, JERD2124, Special Publication, JERD2129 ; Caterpillar Electronic Technician software
(5) 7X-1700 Communication Adapter Tool with Special Publication, NEXG4323, “Communications Adapter Software”

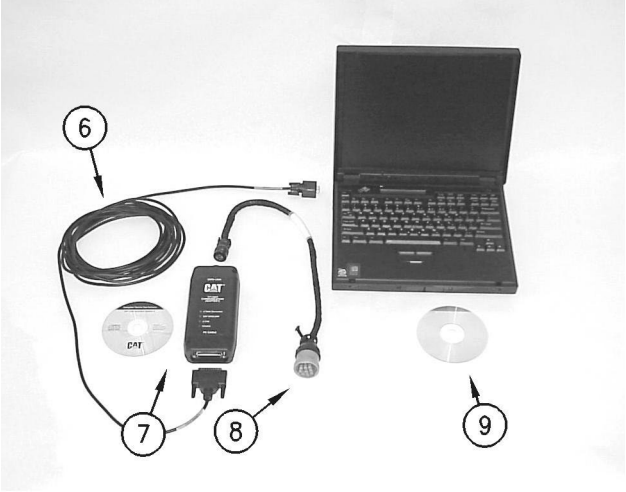


Illustration 3 g00774942

Connections for the Communication Adapter II and the Electronic Technician (ET)

The components that are needed in order to use the Communication Adapter II and the CAT Electronic Technician in order to determine diagnostic codes are listed:

(6) Cable
(7) 171-4400 Communication Adapter ii
(8) Service diagnostic cable.
(9) Current version of Caterpillar Electronic Technician software and an IBM-COMPATIBLE personal computer

Reference: See Special Publication, NEHS0758, “Communications Adapter II User's Manual Contains Software”.

Note: Caterpillar Electronic Technician (ET) is a software program that can be used on an IBM compatible personal computer.

In order to use the Caterpillar Electronic Technician (ET), order the following materials: Special Publication, JERD2124, “ET Single Use Program License”, Special Publication, JEHP1026, “Information and Requirements Sheet”, 7X-1425 Data Link Cable and the Data Subscription and Special Publication, JERD2142, “Data Subscription”. The Special Publication, JEHP1026, “Information and Requirements Sheet” lists the required hardware and the features of the ET.

The Electronic Technician (ET) is not required in order to determine the diagnostic codes. The Electronic Technician (ET) is not required in order to clear the diagnostic codes. However, the process of determining the diagnostic codes is easier and faster by using the ET. The ET can also display information on the history of a diagnostic code and the parameter status of diagnostic codes. These features allow the ET to be a useful tool for troubleshooting.

The Electronic Technician (ET) is used to communicate to the electronic control module over the data link by connecting to the diagnostic connector of the machine. For more information and the locations of the connectors, see Troubleshooting, “Electrical Components and Connector Locations” and the Electrical System Schematic in your machine's Service Manual.

For instructions on servicing Sure Seal connectors, see Special Instruction, SMHS7531. For instructions on servicing Deutsch DT connectors, see Special Instruction, SEHS9615.

Use the digital multimeter for making continuity checks or for measuring voltage. For instructions about the use of the 6V-7070 Digital Multimeter, see Special Instruction, SEHS7734. The 7X-1710 Multimeter Probe measures the voltage at the connectors without disconnecting the connectors. The probe cables are pushed into the back of the connector along the wire. The 8T-8726 Adapter Cable has a three pin DT breakout. The adapter cable is used for measurements in the sensor circuits.

Note: Except for harness tests, using continuity testers such as the 8T-0500 Continuity Tester or voltage testers such as the 5P-7277 Voltage Tester is not recommended for today's Caterpillar electrical circuits.

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Connector Locations

SMCS Code: 7553-546-WW

General Information

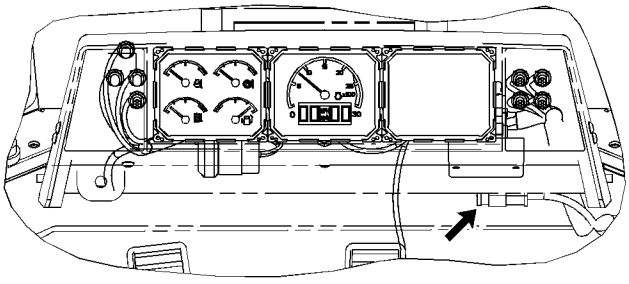


Illustration 4 g01275894

Location of the harness code connector

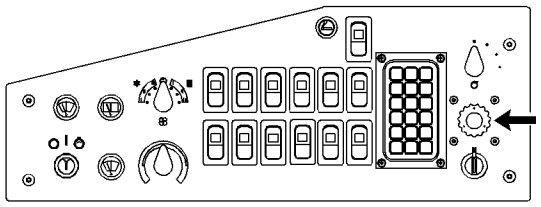


Illustration 5 g01275896

Location of the diagnostic service tool connector

The harness code connector is located under the dash on the right side. The diagnostic service tool connector is located on the control panel on the right side of the cab.

The power train electronic control module (ECM) is located in the right rear corner of cab.

The Electrical System Schematic, Parts Manual, and Operation and Maintenance Manual for the machine that is being serviced should be used to locate electrical components and connectors.

The following information is a guide to reading the tables on the back of the Electrical System Schematic.

- The “Component Location” table uses white circles to mark the locations in the profile of the machine and in the area views. Alphabetical letters in the “Machine Location” column indicate a general area of the machine. Refer to the corresponding footnote at the end of the table for a description of the location.
- The “Harness Connector Location” table uses white circles to mark the locations in the general view and in the area views. Alphabetical letters in the “Machine Location” column indicate a general area of the machine. Refer to the corresponding footnote at the end of the table for a description of the location.

Reference: For more information on the operation of the machine, refer to the Service Manual module Operation and Maintenance Manual, “844H Wheel Dozer and 990H Wheel Loader”.

Reference: For more information on the operation of the electrical components of the machine, refer to the appropriate Parts Manual for your machine.

Connectors for Power Train ECM

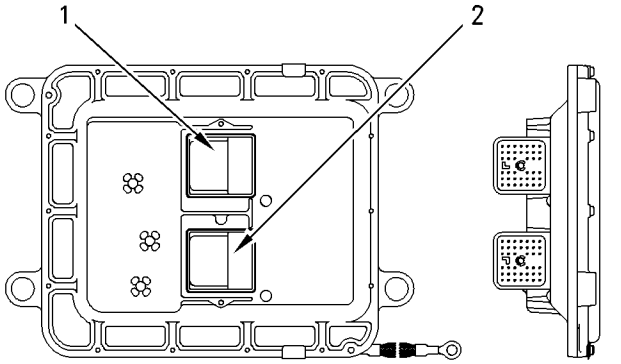


Illustration 6 g00684507

Power Train ECM
(1) Connector J1. (2) Connector J2.

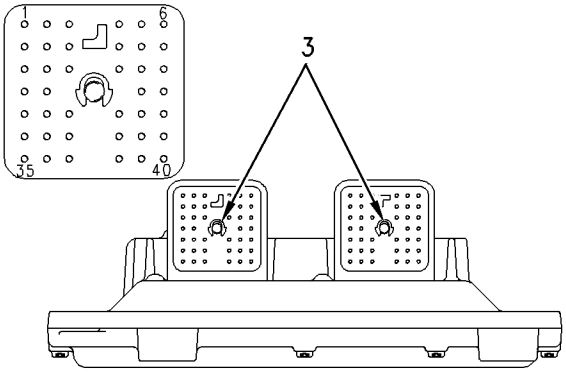


Illustration 7 g00684512

Power Train ECM
(3) Screw.

To remove the machine harness from the power train ECM, use screw (3) in the center of the harness connector.

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Diagnostic Capabilities

SMCS Code: 7610-DTN

Caterpillar Monitoring System

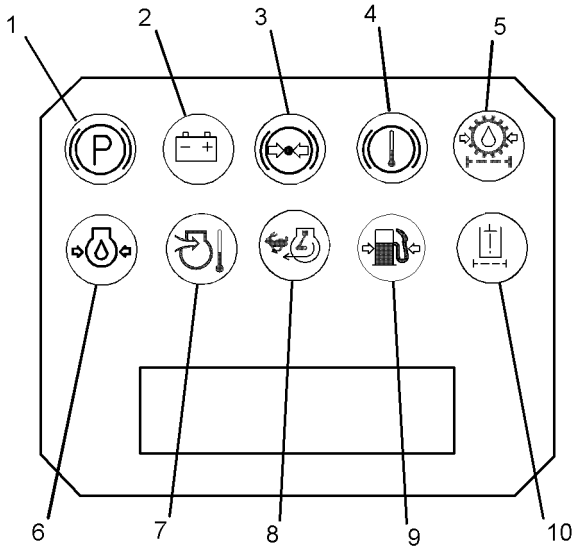


Illustration 8 g01137853

Alert Indicators for the 844H, 990H

(1) Parking Brake. (2) Electrical System Voltage. (3) Brake Oil Pressure. (4) Axle Temperature. (5) Transmission Filter (Bypassed). (6) Engine Oil Pressure (Low). (7) Inlet Manifold Air Temperature (High). (8) Engine Overspeed. (9) Fuel Pressure. (10) Hydraulic Filter (Bypassed).

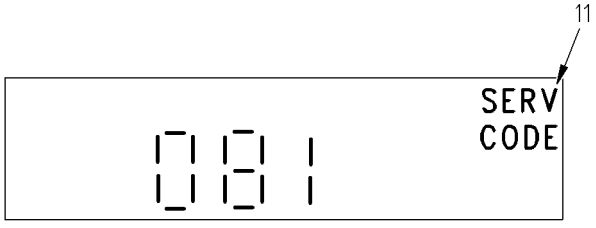


Illustration 9 g00847084

(11) Service Code Indicator “SERV CODE” .

The ECM uses the main display module on the Caterpillar Monitoring System for showing diagnostic information to service personnel. Diagnostic information concerning the ECM is sent on the Cat Data Link to the Caterpillar Monitoring System. Service personnel must be familiar with the Caterpillar Monitoring System in order to troubleshoot the ECM. 250 mm (9.8425 inch)

For troubleshooting the ECM, service personnel must place the Caterpillar Monitoring System in the Service Mode (mode 3). See Troubleshooting, “Using Caterpillar Monitoring System To Determine Diagnostic Codes”.

Caterpillar Electronic Technician (Cat ® ET)



Illustration 10 g00777826

Caterpillar Electronic Technician (Cat ® ET) is a software program that is used to access data. The service technician can use the Cat ® ET to perform maintenance work on the machine. Some of the options that are available with the Cat ® ET are listed below:

- View active and logged diagnostic codes.
- Viewing active and logged event codes
- View the status of parameters.
- Clear active diagnostic codes and clear logged diagnostic codes
- Perform calibration of machine systems.
- Program the ECM (Flash) using the “WINflash” program. See Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program”.
- Print reports.

The following list contains some of the diagnostic functions and programming functions that are performed by the service tools.

- The failures of the ECM system are displayed.
- The status of most of the inputs and the outputs are displayed.
- The settings for the ECM are displayed.
- Display the status of the input and output parameters in real time.
- Display the clock hour of the internal diagnostic clock.
- The number of occurrences and the clock hour of the first occurrence and the last occurrence is displayed for each logged diagnostic code.
- The definition for each logged diagnostic code and each event is displayed.
- Load new FLASH software.
- Active diagnostic codes are displayed.
- Logged diagnostic codes are displayed.

Diagnostic Codes

An Electronic Control Module (ECM) monitors the circuitry between the ECM and the electrical components of the system. The ECM also monitors operating conditions. If the ECM detects a problem, a code is generated. There are two categories of codes:

- Diagnostic Codes
- Event Codes

A diagnostic code indicates an electrical problem has been found in the wiring or in an electrical component.

A logged diagnostic codes are provided to monitor diagnostic codes that are intermittent.

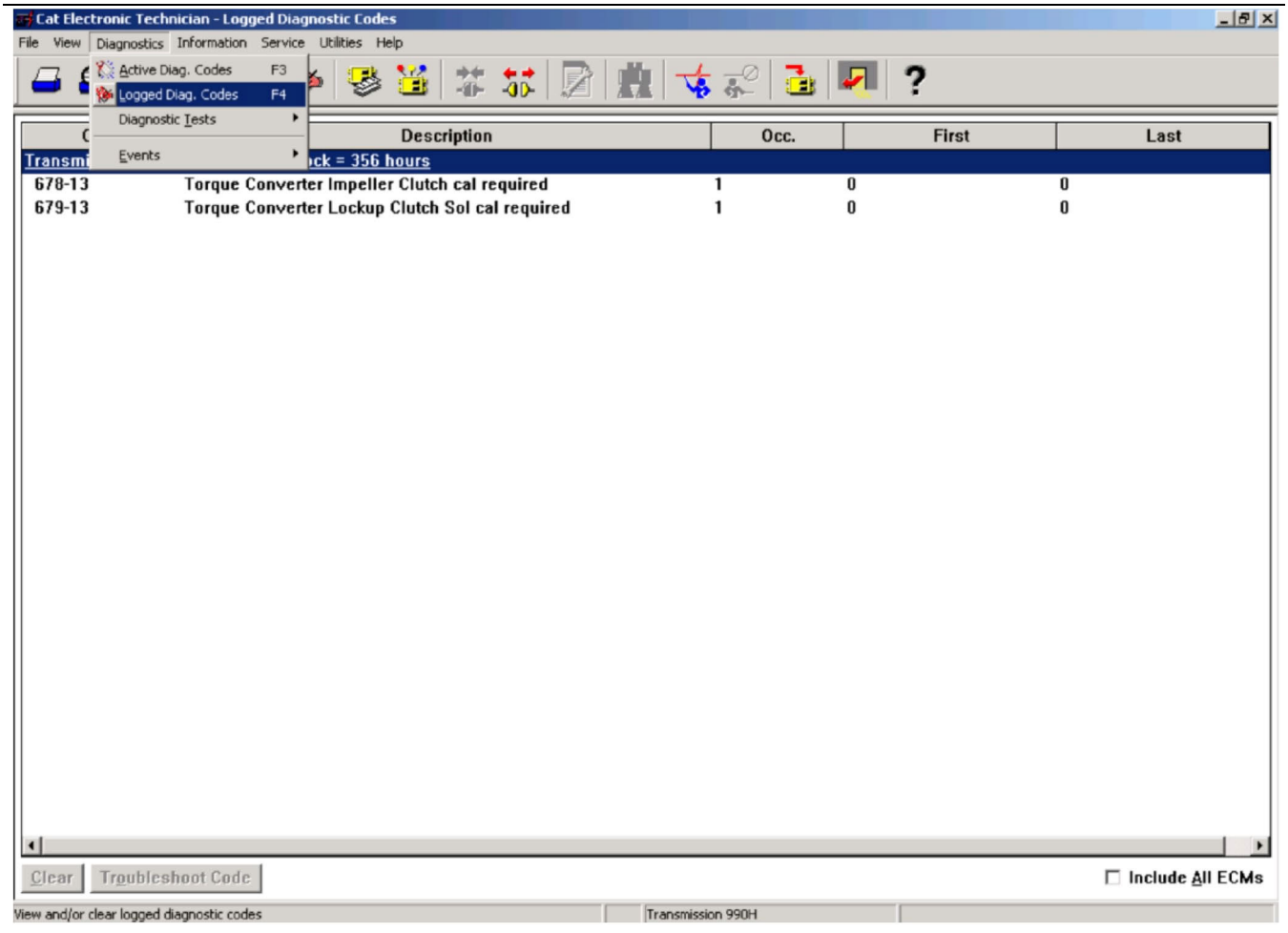


Illustration 11 g03596868

Typical Cat ® ET screen for logged diagnostic codes

Reference: See Troubleshooting, “Diagnostic Code List” for the list of diagnostic codes for the ECM.

See Troubleshooting, “Using Caterpillar Electronic Technician to Determine Diagnostic Codes”. Diagnostic information is accessed with the following drop-down menus:

Event Codes

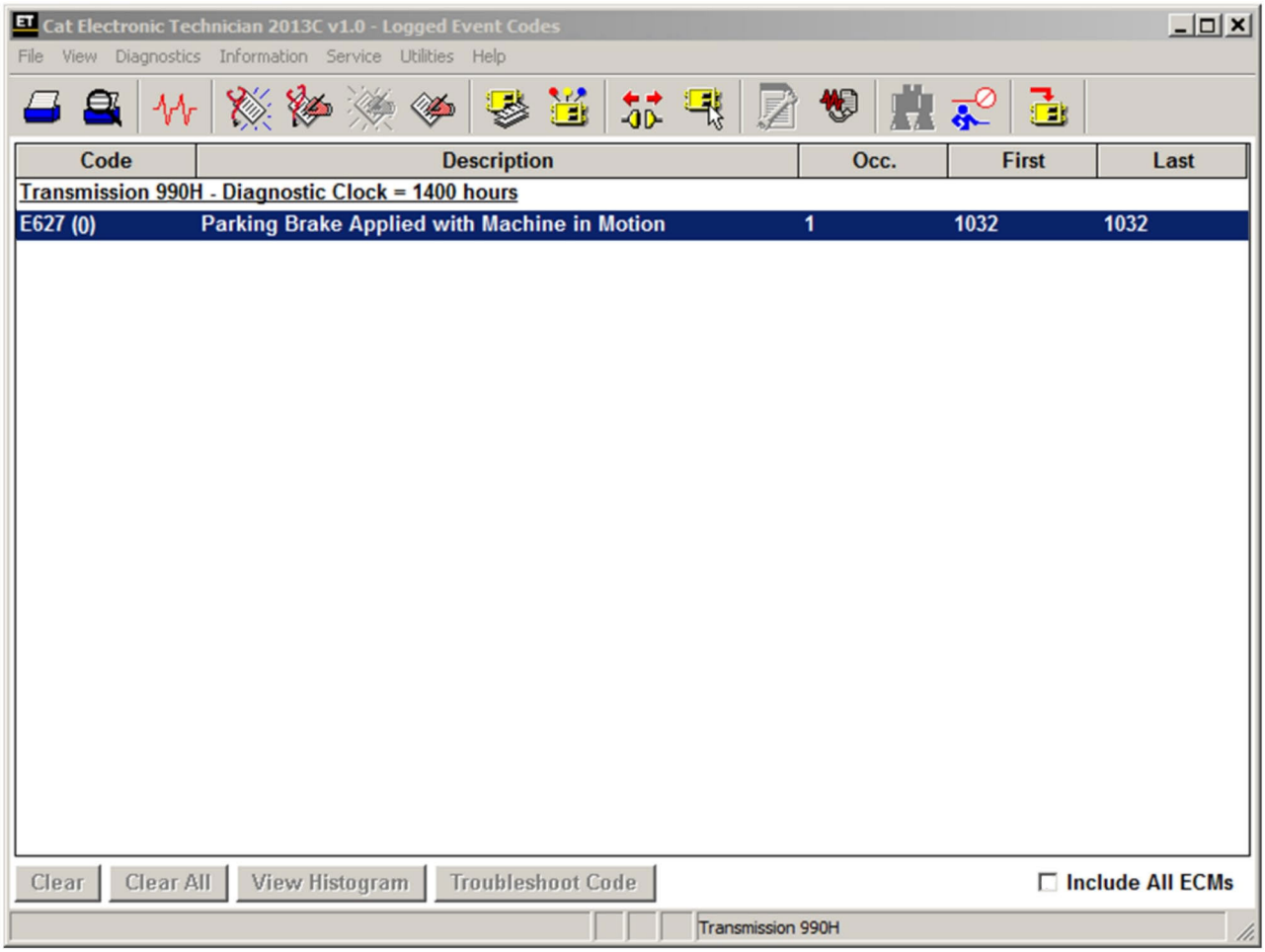


Illustration 12 g03597403

Typical Cat ® ET screen for a logged event code

An indicator for logged events is provided. The indicator allows the service technician to track event codes that are intermittent. The data for the logged event will include the following information:

- An event identifier (EID) - E followed by code number and warning level in parentheses. Example “E123 (2)”
- A text description of the problem
- The number of occurrences of the problem
- Time stamped information for the first occurrence of the problem
- Time stamped information for the last occurrence of the problem

Table 2

Event Codes For Transmission ECM (MID 81)		
Code (Level)	**Description**	**Activation / Possible Causes**
E49 (0)	Coasting in Neutral Warning	Event is activated when the machine is moving > 12 kph for 5 seconds in neutral. Event becomes logged after 10 seconds elapse and the machine is moving > 12 kph in neutral. Event is deactivated when the machine is moving < 12 kph for 1 second in neutral. Ensure that transmission is in gear while moving.
E155 (0)	High Torque Converter Oil Temperature	Event is activated when the torque converter oil (TCO) temperature is > 129° C (264° F). Event is deactivated when the TCO temperature lowers to 119° C (246° F) or less. Excessive torque converter slip will cause high TCO temps. Ensure that the correct transmission gear is being used for the load on the machine. Change machine operation to allow TCO to cool. If needed, park the machine and set engine at high idle until event clears. If event reoccurs and machine load is normal, investigate the following: · Oil level in the transfer gear case · Engine coolant level · Transmission oil cooler · Low TC oil flow - may be caused by the following: **-** TC inlet relief valve is bypassing excessive oil. **-** Pump flow or oil pressure is low. **Reference (in this manual):** Troubleshooting, “Torque Converter” Testing and Adjusting: “Torque Converter Stall - Test” “Torque Converter Impeller Clutch Pressure - Test” “Torque Converter Lockup Clutch Pressure - Test”
E627 (0)	Machine Driven with Park Brake On	Event is activated when the parking brake is applied when the machine is moving > 4 km/h (2.5 mph) for 1 second. Event becomes logged after 4 seconds. Event inactive if the park brake is turned off or the speed goes below 4 km/h (2.5 mph) for 1 second. Disengage parking brake if the intent is to move the machine. If the event persists, check the troubleshooting information for transmission output speed (TOS) sensors and parking brake system.

Status Groups Listed in Cat ® ET

The Status groups are lists of machine parameters.
The values of the parameters are shown in real time.

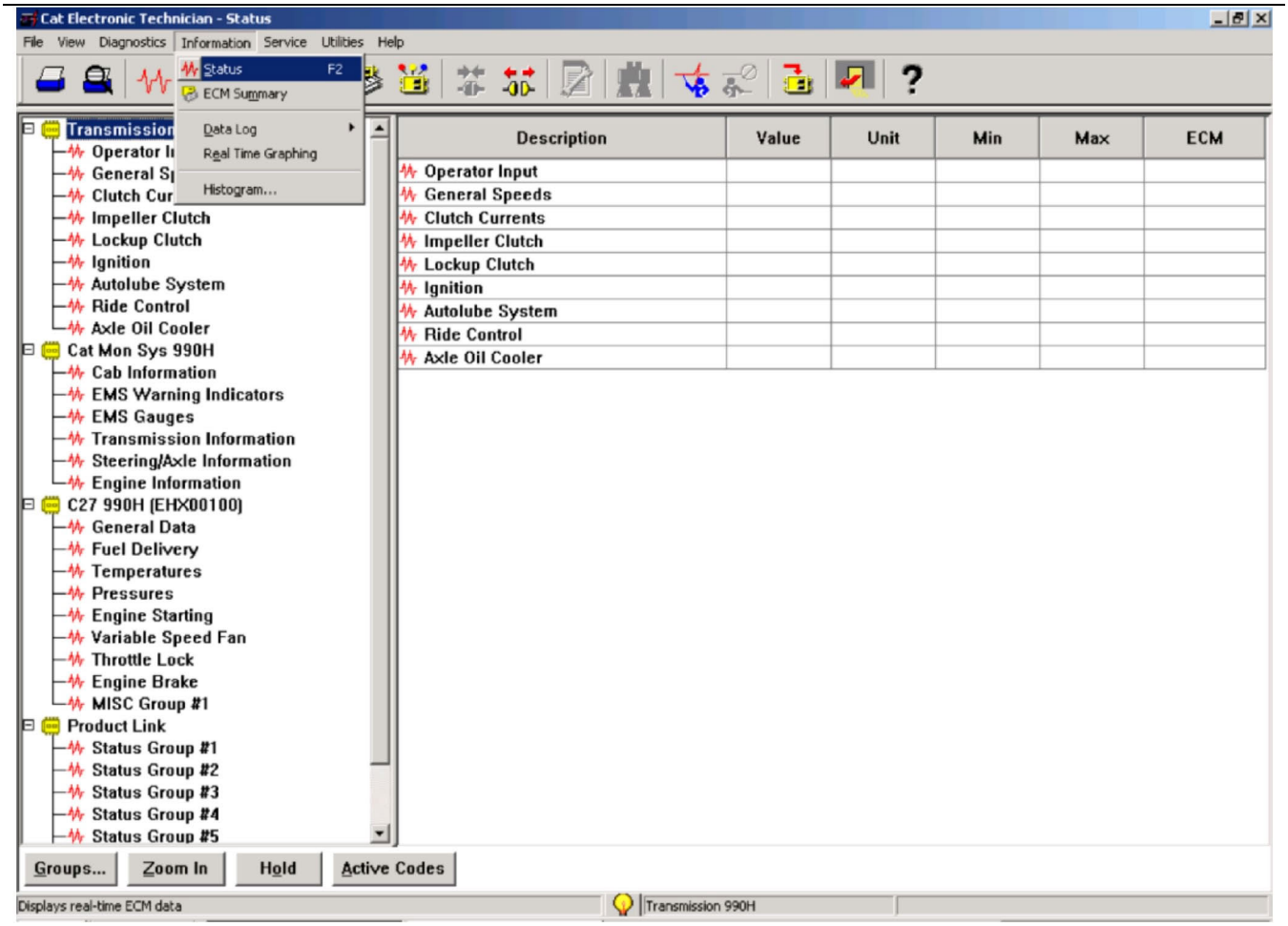


Illustration 13 g03596916

Typical Cat ® ET Status Screen

i01661548

Machine Preparation for Troubleshooting

SMCS Code: 3000

Refer to the following warnings and notice for all inspections and tests of the power train. If the source of the problem is not determined, perform the inspections and tests. Perform the inspections and tests in sequential order. For all tests, the power train oil must be at normal operating temperature.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide”, for tools and supplies suitable to collect and contain fluids in Caterpillar machines.

Dispose of all fluids according to local regulations and mandates.

1. Move the machine to a smooth, horizontal location that is away from operating machines and away from personnel.

Note: Permit only one operator on the machine. Keep all other personnel away from the machine or in the operator's sight.

2. Shift the transmission direction control to the NEUTRAL position. Move the lever for steering the transmission into the LOCKED position.

3. Lower the bucket or the blade to the ground.

4. Stop the engine.

5. Install the steering frame lock.

6. Place wheel blocks in front of the wheels and behind the wheels.

7. Move the control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system.

8. Depress the brake pedal repeatedly. This will relieve any pressure that may be present in the brake hydraulic system.

9. The pressure in the hydraulic system has been released. Lines and components can be removed.

Troubleshooting can be complex. A list of some of the possible problems and corrections are on the following pages.

This list of possible problems and possible corrections will only provide an indication of the location of a problem and the repairs that are required. Remember that a problem is not necessarily caused by one part, but by the relation of one part with other parts. This list can not provide all possible problems and corrections. Service personnel must find the problem and the source of the problem. Then, complete the necessary repairs.

Perform a visual inspection first. If the visual checks are completed but the problem has not been identified, perform operational checks. If the problem is not understood, perform instrument tests. This procedure will help to identify power train problems.

i02406937

Visual Inspection

SMCS Code: 3000

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth level surface.

Lower the bucket and or attachments to the ground.

Stop the engine and engage the parking brake.

Block the wheels and install the steering frame lock.

Turn the battery disconnect switch to the OFF position and remove the key.

Place a Special Instruction, SEHS7332, "Do Not Operate" tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide", for tools and supplies suitable to collect and contain fluids in Caterpillar machines.

Dispose of all fluids according to local regulations and mandates.

Note: If the machine will not move, check the fuse for the power train electronic control module (ECM). The fuse panel is located in the electronics compartment on the right side of the cab platform. Open the access door on the right side of the cab platform in order to access the fuse panel.

Perform visual checks first when you are troubleshooting a problem. Before you make these checks, stop the engine and engage the parking brake. Shift the transmission direction control to the NEUTRAL position. During these checks, use a magnet to separate ferrous particles (iron) from nonferrous particles (O-ring seals, aluminum, bronze, etc), if necessary.

1. Check the oil level in the differentials.

2. Check the transmission oil level. Look for air bubbles in the oil or water in the oil. Many problems in the transmission are caused by low oil level or by air in the oil. Add oil to the transmission, if necessary. Refer to the Operation and Maintenance Manual, "Lubricant Viscosities and Refill Capacities" for the recommended oil grade and the recommended oil viscosity. Refer to the manual for the machine that is being serviced.

   a. Air bubbles may be caused by a fitting that is loose or damaged. A loose fitting or damaged fitting allows air to enter the suction side of the system and oil is also allowed to leak. Also, if the transmission oil level is too high and the

gears are agitating the oil in the sump, air bubbles may result.

b. A leaking transmission oil cooler may cause coolant to enter the system. Water may enter the system if the filler cap or the dipstick is not properly installed.

3. Check all oil lines, all hoses, and all connections for damage and for leaks. Look for oil on the ground under the machine.

Note: If oil can leak out of a fitting or out of a connection, air can leak into the system. Air in the system is as harmful as having too little oil.

4. Remove the drain plug in the bottom of the output transfer gear case in order to drain the oil from the transmission. Remove the suction screen and clean the suction screen. Inspect the oil and the suction screen for foreign material. Remove the transmission oil filter and inspect the filter for foreign material. (Cut the filter open, if necessary.)

Note: There is an oil filter bypass valve on the inlet side of the transmission oil filter. Whenever the pressure difference between the inlet oil and the outlet oil is more than 345 ± 21 kPa (50 ± 3 psi), the bypass valve will open and oil will be allowed to bypass the oil filter element. Any oil that does not flow through the oil filter element flows directly into the hydraulic control circuit. This dirty oil can cause valves to become stuck and valve orifices could become restricted.

a. Rubber particles indicate a seal failure or a hose failure.

b. Shiny steel particles indicate a mechanical failure or gear wear of the transmission or of a pump.

c. A thick accumulation of fibrous material indicates worn clutch discs in the transmission.

d. Aluminum particles indicate torque converter wear, a torque converter failure, or a worn clutch piston.

e. Iron particles or steel particles indicate broken components in the transmission.

Note: If any of these particles are found during any visual check, all components of the transmission hydraulic system must be cleaned. Do not use any damaged parts. Any damaged parts must be removed and new parts must be installed.

5. The drive shafts and universal joints must rotate freely unless cold oil is causing a resistance. If the drive shafts do not turn freely, disconnect the drive shafts and check that the transmission will turn.

i02284233

Operational Checks (Power Train)

SMCS Code: 3000-035

Operate the machine in each direction and in all speeds. Note the noises that are not normal and find the sources of the noises. If the machine power train is not operating correctly refer to the following topics in the “Symptom Procedures” section for a list of possible problems and corrections.

- Troubleshooting, “Torque Converter”
- Troubleshooting, “Transmission”
- Troubleshooting, “Differential and Final Drive”

The following checks for troubleshooting are set in sequence to find problems and causes quickly.

These checks for troubleshooting should be done in order. Do not go to the next check until the problem in the previous check has been corrected or you are instructed to go to the next check. If the correct result for the check is found, go directly to the next check.

Take note of all warnings and notices in these checks. You must read all the warnings and the notices before you start a check. You must understand all the warnings and the notices before you start a check.

The checks that follow can be used to find many of the problems that may occur during the operation of the machine. The checks that follow can also give an indication of the part of the system that has the problem.

Symptom Procedures

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Torque Converter

SMCS Code: 3101-035

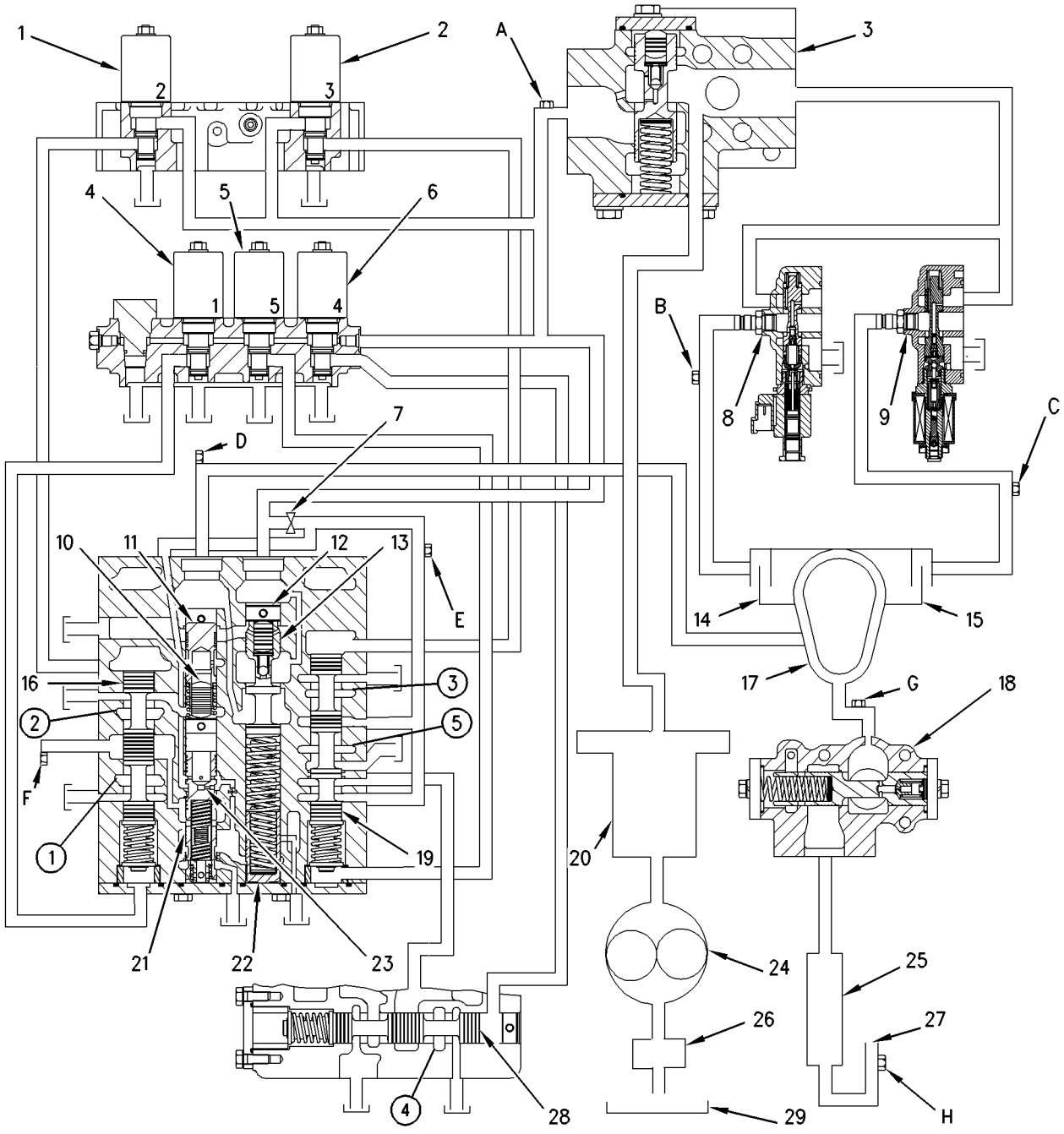


Illustration 14 g00850541

Transmission Hydraulic Controls in the NEUTRAL position and with the Engine Stopped.

(1) Number 2 clutch solenoid
(2) Number 3 clutch solenoid
(3) Priority valve
(4) Number 1 clutch solenoid
(5) Number 5 clutch solenoid
(6) Number 4 clutch solenoid
(7) Flow control orifice
(8) Lockup clutch solenoid valve
(9) Impeller clutch solenoid valve
(10) Slug
(11) Torque converter inlet ratio valve
(12) Slug
(13) Modulating relief valve
(14) Lockup clutch
(15) Impeller clutch
(16) Direction selection spool
(17) Torque converter
(18) Torque converter outlet relief valve
(19) Selector spool for first speed and for third speed
(20) Transmission oil filter
(21) Pressure differential valve
(22) Load piston
(23) Flow control orifice
(24) Transmission oil pump
(25) Oil cooler
(26) Magnetic screen
(27) Lubrication passage for transmission
(28) Selector spool for second speed
(29) Reservoir
(A) Pressure tap for the oil pump
(B) Pressure tap for lockup clutch
(C) Pressure tap for impeller clutch
(D) Torque converter inlet pressure tap P3
(E) Speed clutch pressure tap P1
(F) Direction clutch pressure tap P2
(G) Torque converter outlet pressure tap
(H) Transmission lubrication pressure tap

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide”, for tools and supplies suitable to collect and contain fluids in Caterpillar machines.

Dispose of all fluids according to local regulations and mandates.

Troubleshooting Problem List

- Torque converter pressure is high.
- Torque converter pressure is low.
- The torque converter overheats.
- The torque converter does not respond correctly for the torque converter pedal.
- The lockup clutch does not engage.
- The lockup clutch engages intermittently.
- The impeller clutch does not engage.

Troubleshooting

Note: In the following section, when components are referenced with a number, refer to Illustration 14 .

Check for any active service codes within the power train electronic control . Solve any active service codes within the power train electronic control . Use the built-in electrical diagnostics that are performed with the Caterpillar Monitoring System and with the electronic control module.

Note: This machine is equipped with a power train electronic control. The power train electronic control has a built-in diagnostic system that detects faults in the electronic system of the power train.

Table 3

Troubleshooting Information for the Calibration of the Impeller Clutch		
Error Message	**Probable Causes**	**Possible Corrective Actions**
Torque converter output speed is low.	Engine speed is too low.	Use the throttle lock to set the engine speed above the following minimum value: 1650 rpm
	Speed sensor problem	Check for fault codes on the torque converter output speed sensor. Check the sensor connector. Adjust or replace the sensor, if necessary.
	Impeller clutch pressure is too low.	Check valve function. Check the connector. Check ECM output. Check the converter for excessive leakage in the circuit for the impeller clutch.
	Damaged impeller clutch	Check transmission screens. Inspect the impeller clutch.
	Excessive drag in transmission	Check transmission screens. Inspect the impeller clutch.
Torque converter output speed is high.	Speed sensor problem	Check for fault codes on the torque converter output speed sensor. Check the sensor connector. Adjust or replace the sensor, if necessary.
	Engine speed is too high.	Adjust the engine high idle speed.
The speed change of the torque converter is in the low range.	Speed sensor problem	Check for fault codes on the torque converter output speed sensor Check the sensor connector. Adjust or replace the sensor, if necessary.
	Impeller clutch pressure is too low.	Check valve function. Check the solenoid connector. Check ECM output. Check the converter for excessive leakage in the circuit for the impeller clutch.
	Drag in the lockup clutch.	Check for residual pressure in the circuit for the lockup clutch. Check the screens in the transmission for material from the clutch. Inspect the lockup clutch for damaged discs or damaged plates. If the lockup clutch has new discs, operate the machine and engage the lockup clutch several times. Repeat the calibration.
	Excessive drag in the transmission	Check the screens in the transmission for material from the clutch. Inspect the transmission for warped direction clutches or damaged direction clutches.

(continued)

(Table 3, contd)

Pressure to hold is too high.	Impeller clutch pressure is out of tolerance.	Check valve function. Check the solenoid connector. Check the ECM output. Check the converter for excessive leakage in the circuit of the impeller clutch. Check for high torque converter inlet pressures and outlet pressures. Check the PTO system which is downstream of the converter for restrictions.
Pressure to hold is too low.	Impeller clutch pressure is out of tolerance.	Check valve function. Check the solenoid connector. Check ECM output.
Hold pressure inconsistent	Impeller clutch pressure is not responding properly.	Check valve function. Check the solenoid connector. Check ECM output. Check the converter for excessive leakage in the circuit of the impeller clutch. Check the transmission screens for debris.

Reference: For additional information on troubleshooting the power train electronic control module (ECM), refer to Service Manual, “Electronic Transmission Control System” for diagnostic procedures on the power train electronic control .

Reference: For additional information on troubleshooting the power train electronic control module (ECM), refer to Service Manual, “Caterpillar Monitoring System” for diagnostic procedures.

Probable Causes of Problems in the Torque Converter

The problem indicates that the torque converter pressure is high.

The probable causes of the problem include the following items:

1. There is a restriction inside the torque converter.

2. There is a restriction in an oil passage or in the oil cooler.

3. Torque converter inlet relief valve (3) is stuck in the closed position.

The problem indicates that the torque converter pressure is low.

The probable causes of the problem include the following items:

1. Torque converter inlet relief valve (3) is stuck in the open position.

2. Adjustment of torque converter outlet relief valve (5) is not correct.

3. The valve spool in torque converter outlet relief valve (5) does not move.

4. Pump flow or oil pressure is low. This may be caused by any of the following conditions:

a. Oil level is low.

b. There is a restriction in the oil flow circuit or a dirty oil strainer.

c. Oil pump failure.

d. Air leaks on the inlet side of the pump.

e. The transmission has an inside leak. Seals around the clutch piston could be worn.

f. Modulating relief valve (13) is stuck open.

The problem indicates that the torque converter overheats.

The probable causes of the problem include the following items:

1. The machine is being used for the wrong application. There is too much torque converter slip, which is caused by too much load.

2. Incorrect transmission gear is being used for the load that is on the machine. Shift to a lower gear.

3. The oil level in the transfer gear case is incorrectly high or low.

4. The coolant level in the engine radiator is low.

5. The oil cooler or oil lines are restricted.

6. Oil flow through the torque converter is too low. This may be caused by any of the following conditions:

a. The torque converter inlet relief valve (3) is bypassing too much oil flow.

b. Pump flow or oil pressure is low. Refer to the Problem: Torque converter pressure is low.

The problem indicated that the torque converter does not respond correctly to the torque converter pedal.

The probable causes of the problem include the following items:

1. The torque converter is in reduced rimpull mode (if equipped). This changes the response of the left service brake pedal.

2. The sensor for the left service brake pedal is calibrated incorrectly.

3. The sensor for the left service brake pedal is faulty or the sensor has failed.

4. The impeller clutch solenoid or the impeller clutch solenoid valve are faulty. The impeller clutch solenoid or the impeller clutch solenoid valve have failed.

5. There is a problem in the electrical circuit.

The problem indicates that the lockup clutch does not engage.

The probable causes of the problem include the following items:

1. The on/off switch for the lockup clutch is not in the ON position.

2. The on/off switch for the lockup clutch is faulty or the switch has failed.

3. The lockup clutch solenoid or the lockup clutch solenoid valve are faulty. The lockup clutch solenoid or the lockup clutch solenoid valve have failed.

4. There is a problem in the electrical circuit.

5. The lockup clutch has not been enabled.

The problem indicates that the lockup clutch engages intermittently.

The probable causes of the problem include the following items:

1. Erratic signals from the engine speed sensor or the torque converter speed sensor can cause the lockup clutch in the torque converter to cycle on and off when the lockup clutch is enabled.

The problem indicates that the impeller clutch does not engage.

The probable causes of the problem include the following items:

1. The impeller clutch solenoid or the impeller clutch solenoid valve are faulty. The impeller clutch solenoid or the impeller clutch solenoid valve have failed.

2. There is a problem in the electrical circuit.

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Transmission

SMCS Code: 3030-035

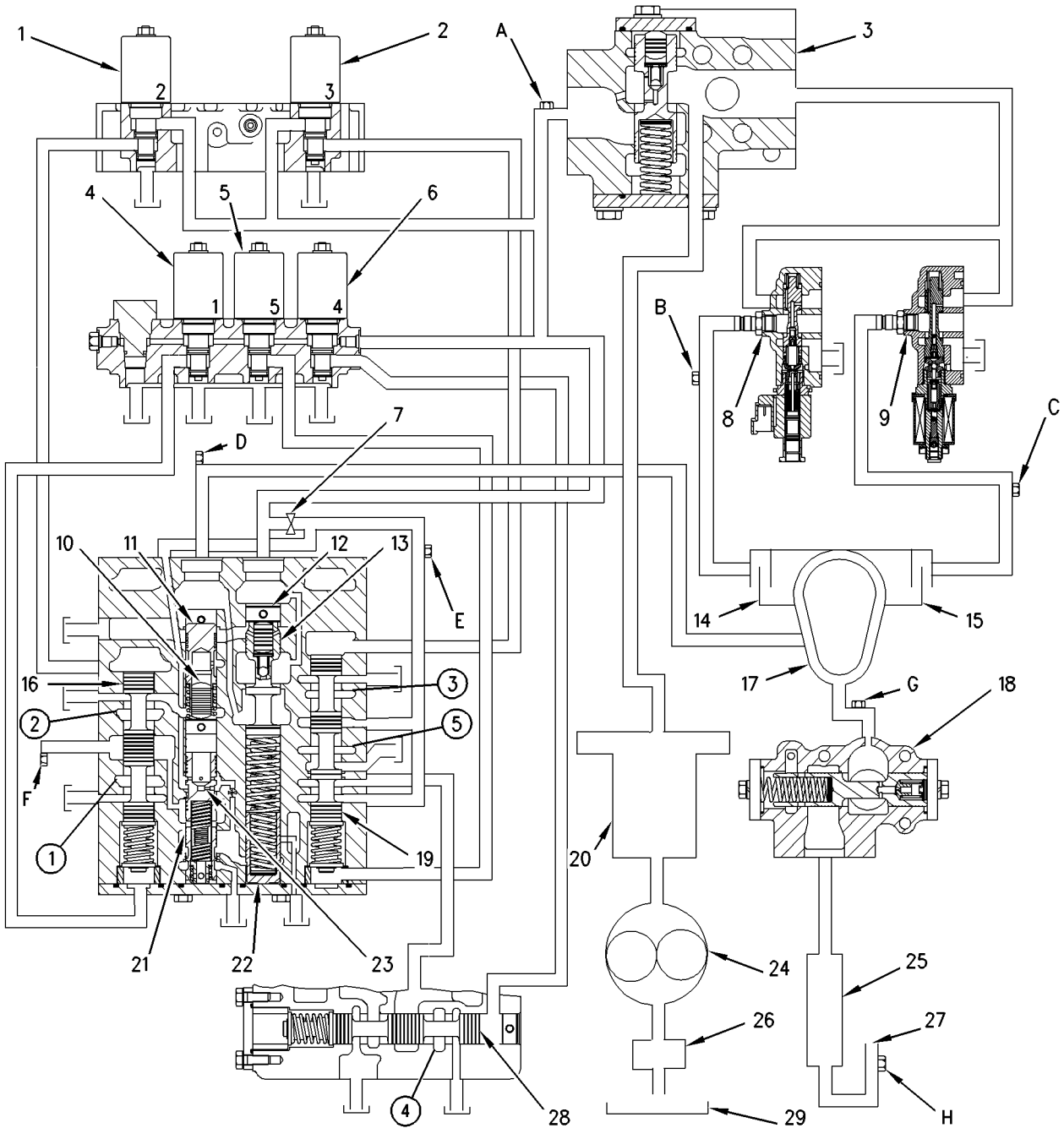


Illustration 15 g00850541

Transmission Hydraulic Controls in the NEUTRAL position and with the Engine Stopped.

(1) Number 2 clutch solenoid
(2) Number 3 clutch solenoid
(3) Priority valve
(4) Number 1 clutch solenoid
(5) Number 5 clutch solenoid
(6) Number 4 clutch solenoid
(7) Flow control orifice
(8) Lockup clutch solenoid valve
(9) Impeller clutch solenoid valve
(10) Slug
(11) Torque converter inlet ratio valve
(12) Slug
(13) Modulating relief valve
(14) Lockup clutch
(15) Impeller clutch
(16) Direction selection spool
(17) Torque converter
(18) Torque converter outlet relief valve

(19) Selector spool for first speed and for third speed
(20) Transmission oil filter
(21) Pressure differential valve
(22) Load piston
(23) Flow control orifice
(24) Transmission oil pump
(25) Oil cooler
(26) Magnetic screen
(27) Lubrication passage for transmission
(28) Selector spool for second speed
(29) Reservoir
(A) Pressure tap for the oil pump
(B) Pressure tap for lockup clutch
(C) Pressure tap for impeller clutch
(D) Torque converter inlet pressure tap P3
(E) Speed clutch pressure tap P1
(F) Direction clutch pressure tap P2
(G) Torque converter outlet pressure tap
(H) Transmission lubrication pressure tap

⚠ WARNING

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Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide”, for tools and supplies suitable to collect and contain fluids in Caterpillar machines.

Dispose of all fluids according to local regulations and mandates.

Troubleshooting Problem List

- The transmission does not operate in any speed or the transmission slips in all speeds.
- The transmission overheats.
- Pump noise that is not heard normally.
- Noise in the transmission that is not normal
- The transmission operates in FORWARD only.
- The transmission operates in REVERSE only.
- The transmission does not operate in FIRST SPEED FORWARD or in REVERSE.
- The transmission does not operate in SECOND SPEED FORWARD or in REVERSE.
- The transmission does not operate in THIRD SPEED FORWARD or in REVERSE.
- Clutch engagement is slow. (This causes slow shifting in all gears.)
- Clutch engagement is slow in all FORWARD gears, in all REVERSE gears, or in any one gear speed (FORWARD and REVERSE).
- The transmission engages but the machine does not move. The engine lugs.
- The engine is running and the parking brake is engaged. However, the action alarm does not sound when the transmission is put into the FORWARD direction or into the REVERSE direction.

- The backup alarm does not sound when the transmission is put in REVERSE.
- Stall speed is low.
- Stall speed is high when the machine is operated in both directions.
- Stall speed is high when the machine is operated in one direction or in one speed.

Troubleshooting

Note: In the following section, when components are referenced with a number, refer to Illustration 15 .

Check for any active diagnostic codes for the power train electronic control. Use the built-in electrical diagnostics that are performed with the Caterpillar Monitoring System and with the electronic control module.

Note: This machine is equipped with a power train electronic control module (ECM). The power train ECM has built-in system diagnostics that detect faults in the electronic system of the power train.

Reference: For additional information on troubleshooting the Caterpillar Monitoring System, refer to System Operation, “Caterpillar Monitoring System” for diagnostic procedures.

Reference: For additional information on troubleshooting the power train ECM, refer to System Operation, “Electronic Transmission Control System” for diagnostic procedures for the power train electronic control.

Probable Causes of Transmission Problems

The problem indicates that the transmission does not operate in any speed or that the transmission slips in all speeds.

The probable causes for the problem include the following items:

1. The fuse for the power train ECM is missing or broken.

2. There is a problem in the electrical circuit.

3. Oil pressure is low. This may be caused by any of the following conditions:

a. Oil level is low.

b. The oil strainer is dirty. The oil flow circuit has a restriction.

c. Oil pump failure.

d. Air leaks on the inlet side of the pump.

e. There is leakage inside the transmission. The seals around the clutch piston are worn.

f. Modulating relief valve (13) is stuck open.

4. There is a torque converter failure.

5. There is a mechanical failure in the transmission.

6. Clutch discs and clutch plates are excessively worn.

7. The torque converter impeller clutch is not engaged.

The problem indicates that the transmission overheats.

The probable causes for the problem include the following items:

1. Coolant level in the radiator is low.

2. The machine is being used for the wrong application. There is too much torque converter slip, which is caused by too much load.

3. Incorrect transmission gear is being used for the load that is on the machine. Shift to a lower gear.

4. The temperature gauge is faulty.

5. The oil level is incorrectly high or low.

6. The oil cooler or oil lines are restricted.

7. The clutch slips too much. This may be caused by any of the following conditions:

a. Low oil pressure. Refer to the Problem: The transmission does not operate in any speed or the transmission slips in all speeds.

b. A clutch is damaged.

8. Oil flow is low. This may be caused by pump wear or by leakage in the hydraulic system.

9. There is air in the oil. This may be caused by air leaks on the intake side of the pump.

10. The magnetic screen for the pump inlet is plugged.

11. Torque converter inlet ratio valve (11) is stuck open. This causes low oil flow through the torque converter.

12. The clutch or clutches are not fully released. (This is called clutch drag.) This may be caused by any of the following conditions:

a. Plates warped or discs warped.

b. The return spring is broken. The return spring is weak.

The problem is the pump noise that is not heard normally.

The probable causes for the problem include the following items:

1. A loud noise at short intervals indicates that foreign material is in the transmission hydraulic system.

2. A constant loud noise indicates pump failure.

3. There is air at the inlet side of the pump.

The problem indicates noise in the transmission that is not normal.

The probable causes for the problem include the following items:

1. Transmission components are worn or damaged.

a. Gears are damaged.

b. The teeth of the clutch plates and/or clutch discs are worn.

c. The clutch plates are slipping and there is noise from the clutch discs.

d. Other transmission components are worn or there are damaged transmission components.

The problem indicates that the transmission operates in FORWARD only.

The probable causes for the problem include the following items:

1. Number 1 REVERSE clutch solenoid (4) is inoperative.

2. There is a problem in the electrical circuit.

3. The REVERSE clutch is not engaged or the REVERSE clutch slips. This may be caused by any of the following conditions:

a. Low oil pressure due to leaking piston seals.

b. The clutch discs and clutch plates have too much wear.

c. Clutch components are broken.

4. Selector spool (16) is stuck.

The problem indicates that the transmission operates in REVERSE only.

The probable causes for the problem include the following items:

1. Number 2 FORWARD clutch solenoid (1) is inoperative.

2. There is a problem in the electrical circuit.

3. The FORWARD clutch is not engaged or the FORWARD clutch slips. This may be caused by any of the following conditions:

a. Low oil pressure due to leaking piston seals.

b. The clutch discs and clutch plates have too much wear.

c. Clutch components are broken.

4. Selector spool (16) is stuck.

The problem indicates that the transmission does not operate in FIRST SPEED FORWARD or in REVERSE.

The probable causes for the problem include the following items:

1. Number 5 FIRST SPEED clutch solenoid (5) is inoperative.

2. There is a problem in the electrical circuit.

3. The FIRST SPEED clutch is not engaged or the FIRST SPEED clutch slips. This may be caused by any of the following conditions:

a. Low oil pressure due to leaking piston seals.

b. The clutch discs and clutch plates have too much wear.

c. Clutch components are broken.

4. Selector spool (19) is stuck.

The problem indicates that the transmission does not operate in SECOND SPEED FORWARD or in REVERSE.

The probable causes for the problem include the following items:

1. Number 4 SECOND SPEED clutch solenoid (6) is inoperative.

2. There is a problem in the electrical circuit.

3. The SECOND SPEED clutch is not engaged or the SECOND SPEED clutch slips. This may be caused by any of the following conditions:

a. Low oil pressure due to leaking piston seals.

b. The clutch discs and clutch plates have too much wear.

c. Clutch components are broken.

4. Selector spool (28) is stuck.

5. The parameter lockout for the top gear prevents going into the requested gear.

The problem indicates that the transmission does not operate in THIRD SPEED FORWARD or in REVERSE.

The probable causes for the problem include the following items:

1. Number 3 THIRD SPEED clutch solenoid (2) is inoperative.

2. There is a problem in the electrical circuit.

3. The THIRD SPEED clutch is not engaged or the THIRD SPEED clutch slips. This may be caused by any of the following conditions:

a. Low oil pressure due to leaking piston seals.

b. The clutch discs and clutch plates have too much wear.

c. Clutch components are broken.

4. Selector spool (19) is stuck.

5. The parameter lockout for the top gear prevents going into the requested gear.

The problem indicates that the clutch engagement is slow. (This causes slow shifting in all gears.)

The probable causes for the problem include the following items:

1. Oil pressure is low. Refer to the Problem: The transmission does not operate in any speed or the transmission slips in all speeds.

2. The modulating relief valve is stuck.

3. The impeller clutch solenoid valve (9) has malfunctioned.

The problem indicates that the clutch engagement is slow in all FORWARD gears, in all REVERSE gears, or in any one gear speed (FORWARD and REVERSE).

The probable causes for the problem include the following items:

Clutch pressure is low because of leaking seals on the piston for the affected gear.

The problem indicates that the transmission engages. The machine does not move. The engine lugs.

The probable causes for the problem include the following items:

1. Service brakes are locked up.

2. The parking brake is not released. Also, the parking brake may be locked up.

3. There is a mechanical failure in a differential (front differential or rear differential).

4. There is a mechanical failure in a final drive.

5. Gears in the transmission do not turn because there is a mechanical failure in the transmission or too many clutches are engaged.

The problem indicates that the backup alarm does not sound when the transmission is put in REVERSE.

The probable causes for the problem include the following items:

1. The backup alarm fuse has failed.

2. The backup alarm has failed.

3. There is a problem in the electrical circuit.

The problem indicates that the stall speed is low.

The probable causes for the problem include the following items:

1. Engine performance is not correct.

2. The oil is cold.

The problem indicates that the stall speed is high when the machine is operated in both directions.

The probable causes for the problem include the following items:

1. Oil level is low.

2. There is air in the oil.

3. Direction clutches are slipping.

4. There is a failure in the torque converter.

5. The torque converter impeller clutch is slipping.

The problem indicates that the stall speed is high when the machine is operated in one direction or in one speed.

The probable causes for the problem include the following items:

1. There is a leak in the clutch circuit.

2. There is a failure in the direction clutch or in the speed clutch that has high stall speed.

i02407570

Differential and Final Drive

SMCS Code: 3258-035; 4051-035

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Troubleshooting Problem List

- There is constant noise in the differential.
- Noise occurs in the differential at different intervals.
- Noise only occurs during turns.
- Lubricant is leaking.
- The drive wheels do not turn but the universal joint turns.

Troubleshooting

Check for any active service codes from the power train electronic control. Solve any active service codes from the power train electronic control. Use the built-in electrical diagnostics that are performed with the Caterpillar Monitoring System and with the electronic control module.

Note: This machine is equipped with a power train electronic control module (ECM). The power train ECM has a built-in diagnostic system that detects faults in the electronic system of the power train.

Reference: For additional information on troubleshooting the power train ECM, refer to Service Manual, “Electronic Transmission Control System” for diagnostic procedures on the power train electronic control .

Reference: For additional information on troubleshooting the power train ECM, refer to Service Manual, “Caterpillar Monitoring System” for diagnostic procedures.

Probable Causes of Problems in the Differential and Final Drive

The problem indicates that there is constant noise in the differential.

The probable causes include the following items:

1. The level of lubricant is incorrectly high or low.

2. The wrong type of lubricant is being used.

3. Wheel bearings are damaged or improperly adjusted.

4. The ring gear and the pinion do not have correct tooth contact.

5. The ring gear and the pinion are damaged or worn.

6. There is too much pinion to gear backlash or too little pinion to gear backlash.

7. Pinion bearings are loose or worn.

8. Side bearings are loose or worn.

The problem indicates that noise occurs in the differential at different intervals.

The probable causes include the following items:

1. Ring gear does not run evenly because the bolts on the ring gear are not tight or the ring gear is warped.

2. Differential bearings are loose or broken.

The problem indicates that noise only occurs during turns.

The probable causes include the following items:

1. Differential pinion gears are too tight on the retainer pins or on the pinion shaft.

2. Side gears are too tight in the differential case.

3. Differential pinion gears or side gears are faulty.

4. Thrust washers are damaged or worn.

5. There is too much backlash between the side gears and the pinion gears.

The problem indicates that the lubricant is leaking.

The probable causes include the following items:

1. Loss of lubricant through the axle shafts can be caused by any of the following conditions:

a. Lubricant is above the proper level.

b. The wrong type of lubricant is being used.

c. There is a restriction in the axle housing breather.

d. An oil seal for the axle shaft is worn or an oil seal was incorrectly installed.

2. Loss of lubricant at the pinion shaft can be caused by the following conditions:

a. Lubricant is above the proper level.

b. The wrong type of lubricant is being used.

c. There is a restriction in the axle housing breather.

d. An oil seal on the pinion shaft is worn or installed incorrectly.

e. A universal joint flange is loose on the pinion shaft.

The problem indicates that the drive wheels do not turn but the universal joint turns.

The probable causes include the following items:

1. An axle shaft is broken.

2. Ring gear teeth are damaged.

3. The side gear or the differential pinion is broken.

4. The differential pinion shaft or the retainer pin is broken.

Diagnostic Code Procedures

i02398073

Diagnostic Code List

SMCS Code: 7569

The following table lists the diagnostic codes for the Power Train ECM (MID 081). When a diagnostic code becomes active, refer to the Troubleshooting section of this manual for a specific troubleshooting procedure.

Component Identifier (CID)

Table 4

Component Identifier (CID) Machine ECM (MID 081)	
For troubleshooting, see the procedure with the same diagnostic code.	
CID / FMI	Description
CID 0041 8 Volt DC Supply	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0070 Parking Brake Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0138 Reduced Rimpull Selection Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0168 Electrical System Voltage	
FMI 00	Data Valid but Above Normal Operating Range
FMI 01	Data Valid but Below Normal Operating Range
CID 0190 Engine Speed Sensor	
FMI 02	Data Erratic, Intermittent or Incorrect
CID 0191 Transmission Output Speed Sensor	
FMI 01	Data Valid but Below Normal Operating Range
CID 0363 Machine Ride Control Actuator	

(continued)

(Table 4, contd)

Component Identifier (CID) Machine ECM (MID 081)	
For troubleshooting, see the procedure with the same diagnostic code.	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 0367 Ride Control Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0378 Machine Autolube Solenoid	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 0379 Machine Autolube Pressure Sensor	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0444 Starter Motor Relay	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 0562 Caterpillar Monitoring System	
FMI 09	Abnormal Update Rate
FMI 12	Bad Device or Component
CID 0590 Engine Control Module	
FMI 09	Abnormal Update Rate
CID 0603 Torque Converter Impeller Clutch Pressure Sensor	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0623 Directional Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0626 Steering/Transmission Lock Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0627 Parking Brake Pressure Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal

(continued)

(Table 4, contd)

Component Identifier (CID) Machine ECM (MID 081)	
For troubleshooting, see the procedure with the same diagnostic code.	
CID 0628 Quickshift Switch	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 0650 Harness Code	
FMI 02	Data Erratic, Intermittent or Incorrect
FMI 09	Abnormal Update Rate
FMI 12	Bad Device or Component
CID 0670 Left Pedal Position Sensor	
FMI 00	Data Valid but Above Normal Operating Range
FMI 01	Data Valid but Below Normal Operating Range
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
FMI 13	Out of Calibration
CID 0672 Torque Converter Output Speed Sensor	
FMI 01	Data Valid but Below Normal Operating Range
CID 0678 Torque Converter Impeller Clutch Solenoid	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
FMI 13	Out of Calibration
CID 0679 Torque Converter Lockup Clutch Solenoid	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
FMI 13	Out of Calibration
CID 0826 Torque Converter Oil Temperature Sensor	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 1022 Autolube Grease Level Sensor	
FMI 03	Voltage Above Normal
FMI 04	Voltage Below Normal
CID 1400 Axle Oil Cooler Fan Bypass Solenoid	

(continued)

(Table 4, contd)

Component Identifier (CID) Machine ECM (MID 081)	
For troubleshooting, see the procedure with the same diagnostic code.	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 1401 Transmission Solenoid 1	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 1402 Transmission Solenoid 2	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 1403 Transmission Solenoid 3	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 1404 Transmission Solenoid 4	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal
CID 1405 Transmission Solenoid 5	
FMI 03	Voltage Above Normal
FMI 05	Current Below Normal
FMI 06	Current Above Normal

Note: Table 4 refers to the diagnostic codes for the power train ECM only. When the Caterpillar Monitoring System is in service mode, the diagnostic codes for the power train ECM are shown on the display area of the Caterpillar Monitoring System. The information of the diagnostic code for the power train ECM is transferred via the Cat Data Link to the Caterpillar Monitoring System. This diagnostic information is shown when the Caterpillar Monitoring System is in the service mode. The module identifier (MID) tells the service person the ECM that is sending the diagnostic code. The MID for the power train ECM is 081. The information in table 4 refers to only the diagnostic codes with a MID of 081. The MID of other electronic control modules or components on a particular machine are listed on the electrical system schematic. Troubleshooting information for the diagnostic codes with a MID that is not 081 can be found in the service manual for that system.

Reference: For more information on the Caterpillar Monitoring System, refer to Testing and Adjusting, “Using Caterpillar Monitoring System to Determine Diagnostic Codes”.

Module Identifier (MID)

Diagnostics from other electronic control modules are shown on the monitoring system. Other electronic control modules transfer this diagnostic information on the Cat Data Link to the monitoring system.

The module identifier (MID) identifies the electronic control module that detected the fault. Each electronic control module on the machine has a unique MID. Use the following chart in order to match the MID for each diagnostic code to a specific electronic control module. The chart for the Module Identifier (MID) is located on the Electrical System Schematic for your machine. See the chart if the MID is not shown on the display of your machine. After the operator determines the electronic control module that has detected the fault, see the service manual module for that particular ECM for more troubleshooting information. The service manual for each ECM is part of the machine's Service Manual.

If the MID is for the Power Train ECM, use this service manual module. The MID for the Power Train ECM is 081. If the MID is different use the appropriate service manual module.

Table 5

Description of the Module Identifier	
MID	**Description**
030	Caterpillar Monitoring System
036	Engine ECM
074	Payload Control System
081	Power Train ECM
082	Implement ECM

Failure Mode Identifier

The codes for the Failure Mode Identifier are defined by the SAE standards. The following list contains a Cat version of definitions. Illustration 16 that follows will help you understand the use of FMI with sensors.

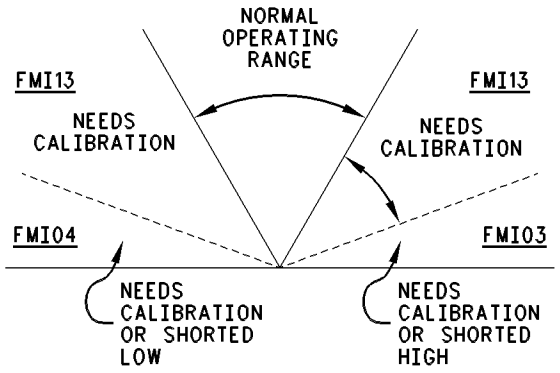


Illustration 16 g00493694

Table 6

Failure Mode Identifier and Message Center Displays	
FMI	**“Failure Description”**
00	“Data valid but above normal operating range”
01	“Data valid but below normal operating range”
02	“Data erratic, intermittent or incorrect”
03	“Data above normal or shorted high”
04	“Voltage below normal or shorted low”
05	“Current below normal or open circuit”
06	“Current above normal or grounded circuit”
07	“Mechanical system not responding”
08	“Abnormal frequency, pulse width, or period”
09	“Abnormal update”
10	“Abnormal Rate of Change”
11	“Failure mode not identifiable”
12	“Bad device or component”
13	“Out of calibration”
14	N/A
15	N/A
16	“Parameter not available”
17	“Module not responding”
18	“Sensor supply fault”
19	“Condition not met”
20	N/A

Detailed FMI Explanation

FMI 00 "Data Valid But Above Normal Operating Range" – Every electronic control system sets a high limit for the expected operating range of the signal. The high limit includes over range signals. This could be a high temperature. A sensor that is still operating but sending a signal above the expected limit will cause a FMI 00 to be stored.

Some of the possible causes of a FMI 00 are listed below.

- The signal is above normal.
- The signal is shorted to the +battery circuit.
- The sensor needs to be calibrated.

This is an example of a sensor that needs calibration. A PWM signal that is at a duty cycle of 80 percent is a valid signal. If the PWM signal has a duty cycle of 81 percent the sensor is still working, but the sensor signal is above the expected signal limits.

FMI 01 "Data Valid But Below Normal Operating Range" – Every electronic control system sets a low limit for the expected operating range of the signal. The limit includes signals that are under the lower limit. The low signal could be the oil pressure signal. The sensor is still working but sending a signal below the expected limit will cause a FMI 01 to be stored.

Some of the possible causes of a FMI 01 are listed below.

- The signal is below the normal range.
- The timing is retarded.

This is an example of a PWM sensor. This sensor is not expected to generate a PWM signal below a duty cycle of 5 percent with zero air pressure. If the sensor generates a signal with a duty cycle of 4 percent when the engine is shutdown. The sensor is still working but sending a signal below the expected limit will cause a FMI 01 to be stored.

FMI 02 "Data Erratic, Intermittent or Incorrect" – The signal from a component is present. The electronic control module that reads the diagnostic information can not read the signal properly. The signal appears to be gone, unstable or invalid. The data can be correct or incorrect intermittently. Also, this condition relates to communication between electronic control modules. This is an example of communication between electronic control modules. When the monitoring system is looking for the engine speed from the engine ECM over the Cat Data Link.

- There is a failed connection.
- The signal is intermittent or erratic.
- The software has been changed.
- The signal is noisy.
- The signal is out of range.

FMI 03 "Voltage Above Normal or Shorted High" – The component or system voltage is higher than the limit. FMI 03 most often relates to a signal circuit.

Some of the components that could cause a FMI 03 are listed below.

- The sensor or the switch has failed.
- The harness is damaged.
- The electronic control module has failed.

Some of the possible causes of a FMI 03 are listed below.

- A sensor that has failed and the voltage output is high.
- Any wiring harness that has a sensor signal wire shorted to a high voltage. A high voltage is any voltage that is greater than the sensor supply voltage.
- A wiring harness that has an open circuit in the sensor signal wire will cause the electronic control module to pull up. When this occurs the input circuit is pulled up to the supply voltage.
- A faulty control will also cause a FMI 03. This is very unlikely.

FMI 04 "Voltage Below Normal or Shorted Low" – The component or system voltage is lower than the limit. FMI 04 most often relates to a signal circuit.

Some of the components that could cause a FMI 04 are listed below.

- The sensor or the switch has failed.
- The harness is damaged.
- The electronic control has failed.

Some of the possible causes of a FMI 04 are listed below.

- A sensor that has failed and the voltage output is low.
- Any wiring harness that has a sensor signal wire shorted to ground.
- A failed ECM will also cause a FMI 04. This is very unlikely.

FMI 05 "Current Below Normal or Open Circuit" – The current through the component or the system is lower than the limit. FMI 05 is most often related to a driver circuit.

Some of the possible causes of a FMI 05 are listed below.

- There is an open circuit or a poor harness connection.
- There is an open relay.
- There is a switch in the open position.

FMI 06 "Current Above Normal or Grounded Circuit" – The current through the component or the system is higher than the limit. FMI 06 is most often related to a driver circuit. This fault is very similar to FMI 04.

Some of the possible causes of a FMI 06 are listed below.

- There is a short to ground in the harness connection.
- There is a shorted relay.
- A failed ECM will also cause a FMI 06. This is very unlikely.

FMI 07 "Mechanical System Not Responding Properly" – The control detects a signal that is sent to a mechanical system and the response is not correct.

Some of the possible causes of a FMI 07 are listed below.

- The component responds improperly.
- The component is stuck in a position.
- The component has failed.
- The engine is shut down.
- The machine is being used improperly.

FMI 08 "Abnormal Frequency, Pulse Width or Period" – This occurs when the signal is not in the expected range. FMI 08 can also relate to a faulty sensor.

Some of the possible causes of a FMI 08 are listed below.

- The harness connections are intermittent or poor.
- The engine misfired.
- The signal is noisy due to nearby interference.
- There are loose mechanical devices.

FMI 09 "Abnormal Update" – This relates to communications on the data link. FMI 09 occurs when an electronic control module is not able to get information from another control.

Some of the possible causes of a FMI 09 are listed below.

- The control module is not communicating on the data link correctly.
- The rate of data transmission is abnormal.
- The data link has failed.
- There is a mismatch of software.

FMI 10 "Abnormal Rate of Change" – This relates to a signal that changes too fast. The rate of change is outside of the expected limit.

FMI 11 "Failure Mode Not Identifiable" – The electronic control module identifies more than one FMI as being responsible for a single failure.

Some of the possible causes of a FMI 11 are listed below.

- There is a mechanical failure.
- There is damage to multiple circuits.

FMI 12 "Bad Device or Component" – The electronic control sends a signal and the electronic control expects a response. The control receives no response or the response is incorrect.

Some of the possible causes of a FMI 12 are listed below.

- There is a failure of the electronic control.
- There is a failure on the data link.
- There are one or more controls with mismatched software.

FMI 13 "Out of Calibration" – The electrical signal is not within limits for a specific mechanical condition.

Some of the possible causes of a FMI 13 are listed below.

- Calibration is required.
- The data is out of range.

FMI 14, 15, and 20 – These codes are not active.

FMI 16 "Parameter Not Available" – The electronic control module does not support the requested parameter.

FMI 17 "Module Not Responding" – The electronic control module does not respond to the request for data.

FMI 18 "Sensor Supply Failure" – The sensor power supply in the electronic control module has failed.

FMI 19 “Condition Not Met” – The conditions that are defined by the software were not met.

i01662238

Using Caterpillar Monitoring System to Determine Diagnostic Codes

SMCS Code: 7490; 7569

Procedure

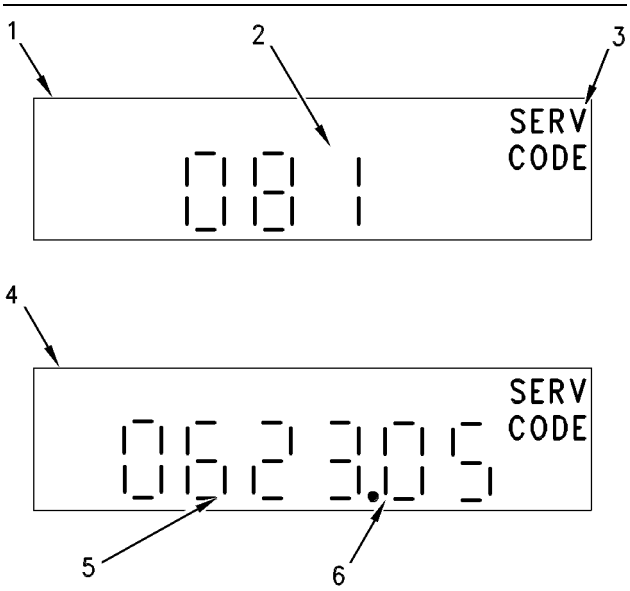


Illustration 17 g00462496

Display Area Of Caterpillar Monitoring System

The display area contains MID 081 , CID 0623, and FMI 05.

(1) First display. (2) Module identifier (MID). (3) Service code indicator. (4) Second display. (5) Component identifier (CID). (6) Failure mode identifier (FMI).

Use the following procedure to troubleshoot the service code information. Connect the 4C-8195 Control Service Tool to the service connector for the monitor at the fuse panel.

1. Place the Caterpillar Monitoring System in service mode (mode 3). In order to place the Caterpillar Monitoring System in service mode, press and hold the mode switch of the control service tool. Release the mode switch while the mode number “-3-” is shown on the display.

Note: The diagnostic scrolling mode may be entered in order to see the service codes, but the service codes can be more easily diagnosed by using the service mode. The service mode allows the service codes to be placed on hold for further investigation. The service mode also allows the service code to be cleared when the problem has been fixed.

2. A service code is shown. The service code is on hold at this time. The display toggles between showing MID (2) and CID (5) and FMI (6). Screen (1) displays “—” when the service codes are not displayed and while you are in the service mode.

3. In order to view all the service codes, scroll through the service codes. In order to scroll through the service codes, press and hold the scroll switch of the control service tool. The display momentarily shows MID (2), CID (5) and FMI (6) for each service code. The word “End” is shown after the last service code in the list.

4. Place the desired service code on hold. In order to place the service code on hold, release the scroll switch when the desired service code is shown.

5. Use the information from the MID in order to determine the ECM that is generating the service code. If the MID is not 081, see Electrical System Schematic, “Module Identifier (MID) Table” of the machine that is being serviced. Use the table to determine the ECM that has detected the fault. Then see the service manual module for that electronic control. If the MID is 081, use this Service Manual Module to troubleshoot the fault that generated the service code.

6. Observe service code indicator (3). In service mode, the service code indicator functions as a fault present indicator.

- If fault present indicator (3) shows “SERV CODE” , then the fault that caused the service code that is shown is currently present.
- If fault present indicator (3) is OFF, then the fault that caused the service code that is shown is not present at this time.

7. Refer to the test procedure in Testing and Adjusting in order to troubleshoot the service code with the same CID and the same FMI.

8. After a service code is corrected, clear the service code. In order to clear the service code, momentarily press the clear switch of the service tool while the fault is on hold. After clearing, the display advances to the next available service code.

9. Repeat Steps 2 through 8 for the remaining service codes. Return to the normal mode when you are finished. In order to return to the normal mode, press and hold the mode switch of the control service tool. Release the mode switch when mode “-0-” is shown on the display.

i02459945

Using Caterpillar Electronic Technician to Determine Diagnostic Codes

SMCS Code: 0785-UE; 7569

Connect the electronic technician (ET) to the machine. Turn the keyswitch to the RUN position. Start the ET. The ET will initiate communications with the Electronic Control Modules (ECM) on the machine. After communication has been established, the ET will list the ECM on the machine. Choose the desired ECM. After the diagnostic codes have been determined with the Cat ET, see the test procedure for the corresponding diagnostic code.

Reference: Troubleshooting, “Service Tools”

Active Diagnostic Codes

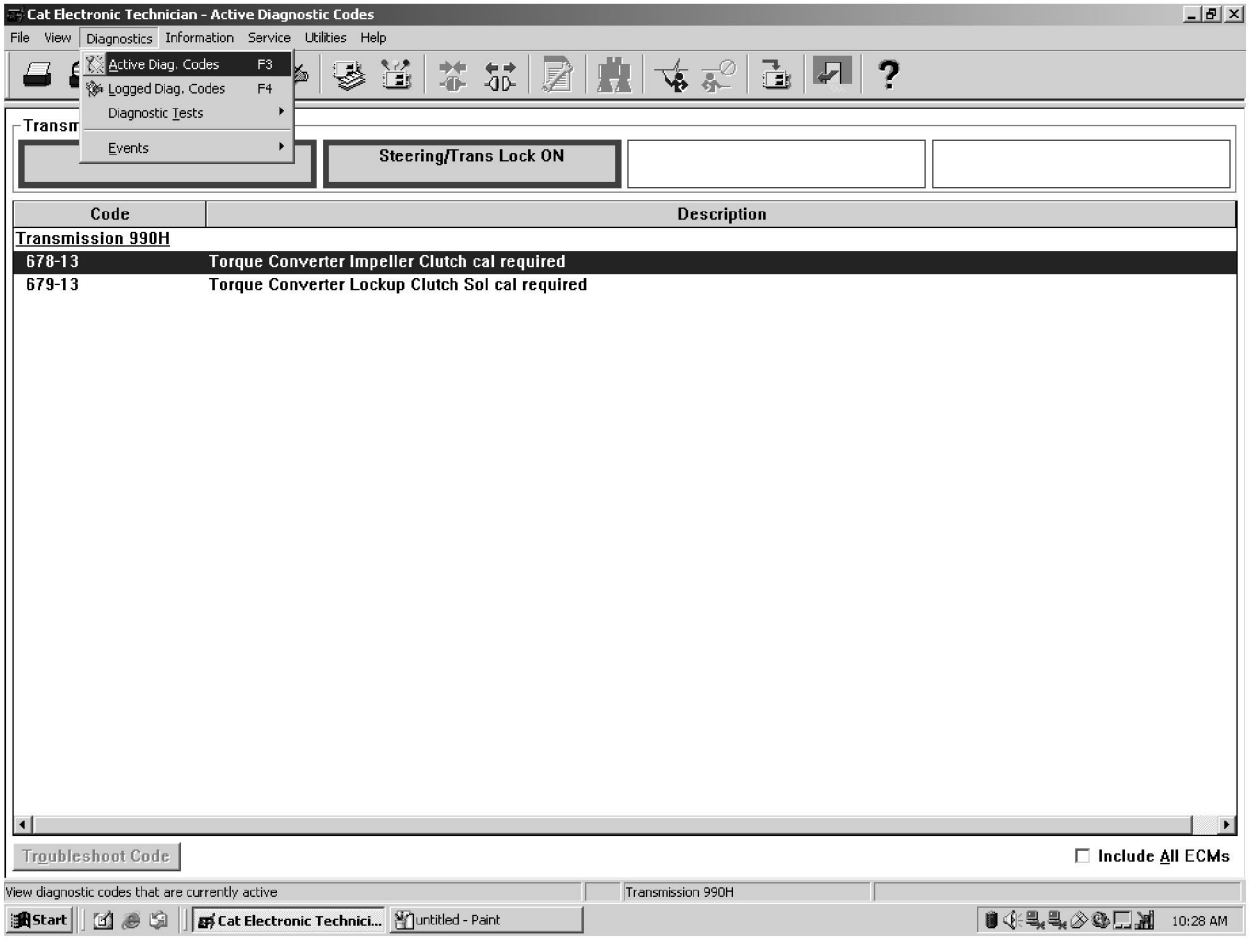


Illustration 18 g01227673

Typical ET screen for active diagnostic codes

The following procedures may cause new diagnostic codes to be logged. Therefore, before any procedures are performed make a list of all the active diagnostic codes in order to determine the system problems. Clear the diagnostic codes that were caused by the procedure, when each procedure is complete.

Note: Before performing a procedure, always check all the circuit breakers. Repair the cause of any circuit breaker that is tripped.

A screen is provided in ET for active diagnostic codes. The screen will display the diagnostic codes that are active. Active diagnostic information shall include a component identifier (CID), a failure mode identifier (FMI) and a text description of the problem.

Logged Diagnostic Codes

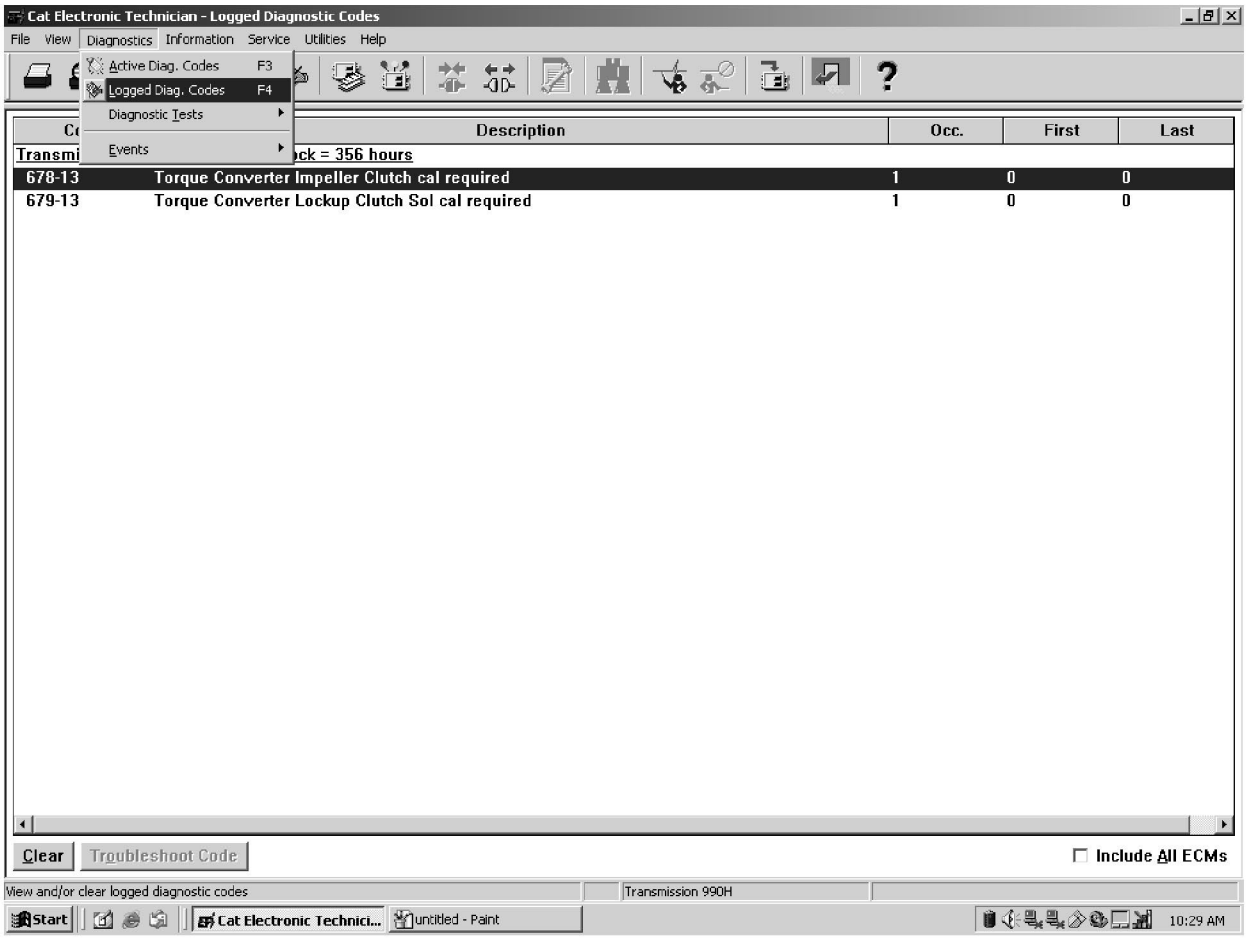


Illustration 19 g01227674

Typical ET screen for logged diagnostic codes

A screen is provided in ET for logged diagnostic codes. The screen will display diagnostic codes that are logged. The ET will log diagnostic codes that are intermittent. The logged diagnostic data shall include a component identifier (CID), a failure mode identifier (FMI), and a text description of the problem. Also, the logged diagnostic data shall include the number of occurrences of the problem and two time stamps. The time stamp displays the first occurrence of the problem and the time stamp displays the most recent occurrence of the problem.

Diagnostics are logged in non-volatile memory. On powerup, the ECM will clear any diagnostic codes that have not been detected or active within the last 150 hours of machine operation.

i06855950

Using Caterpillar Electronic Technician to Determine Diagnostic Codes

SMCS Code: 0785-UE; 7569

Connect Cat ® Electronic Technician (Cat ® ET) to the machine. Turn the key start switch to the RUN position. Start Cat ET. Cat ET will initiate communications with the Electronic Control Modules on the machine. After communication has been established, Cat ET will list the Electronic Control Modules. Choose the desired Electronic Control Module. After the diagnostic codes have been determined with Cat ET, refer to the test procedure for the corresponding diagnostic code.

Reference: Troubleshooting, “Service Tools”

Active Diagnostic Codes

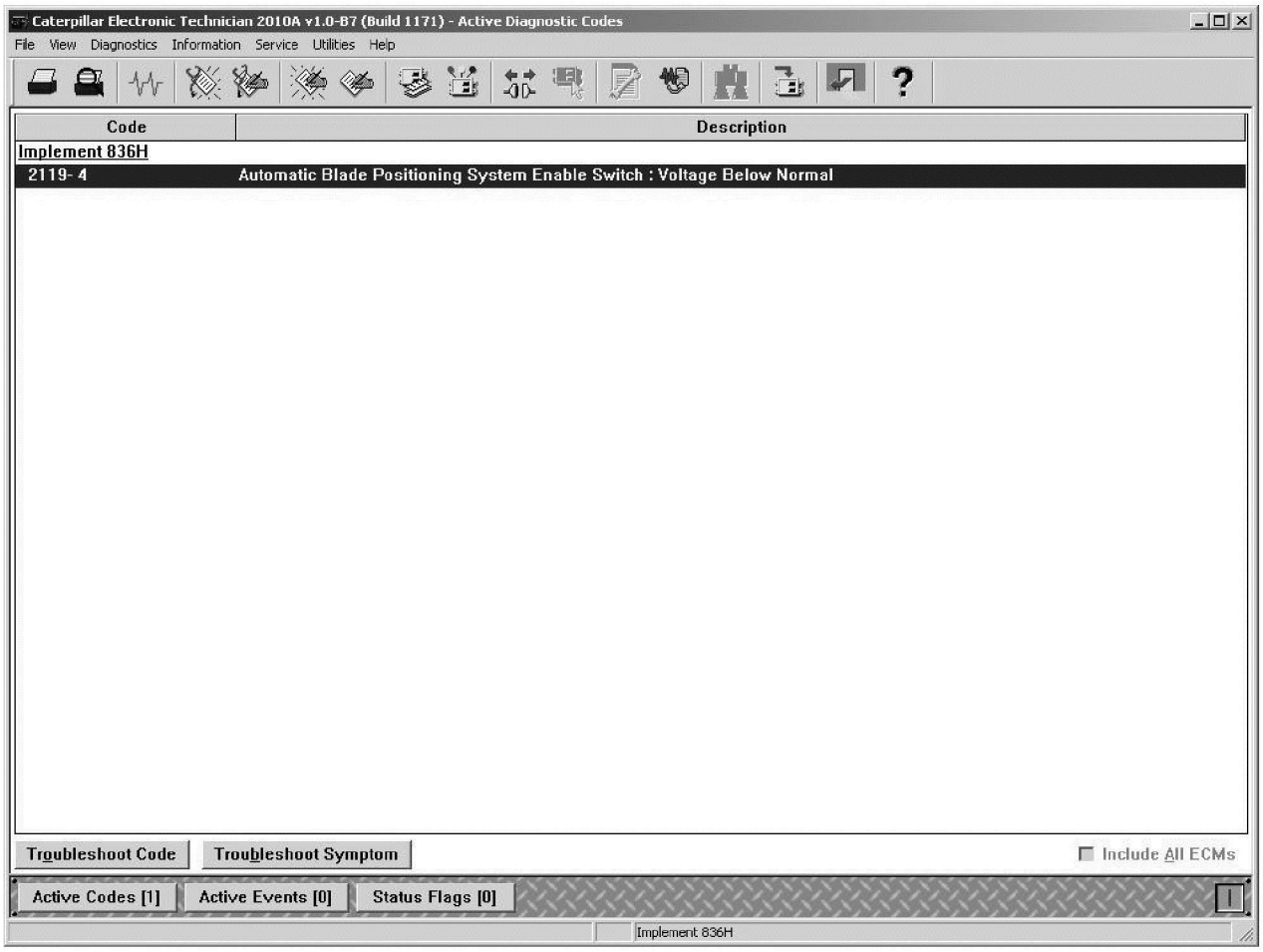


Illustration 20 g02052559

Typical Cat ET screen for active diagnostic codes

The following procedures may cause new diagnostic codes to be logged. Therefore, before any procedures are performed, make a list of all the active diagnostic codes to determine the system problems. Clear the diagnostic codes that were caused by the procedure, when each procedure is complete.

Note: Before performing a procedure, always check all the circuit breakers. Repair the cause of any circuit breaker that is tripped.

A screen is provided in Cat ET for active diagnostic codes. The screen will display the diagnostic codes that are active. Active diagnostic information shall include a component identifier (CID), a failure mode identifier (FMI), and a text description of the problem.

Logged Diagnostic Codes

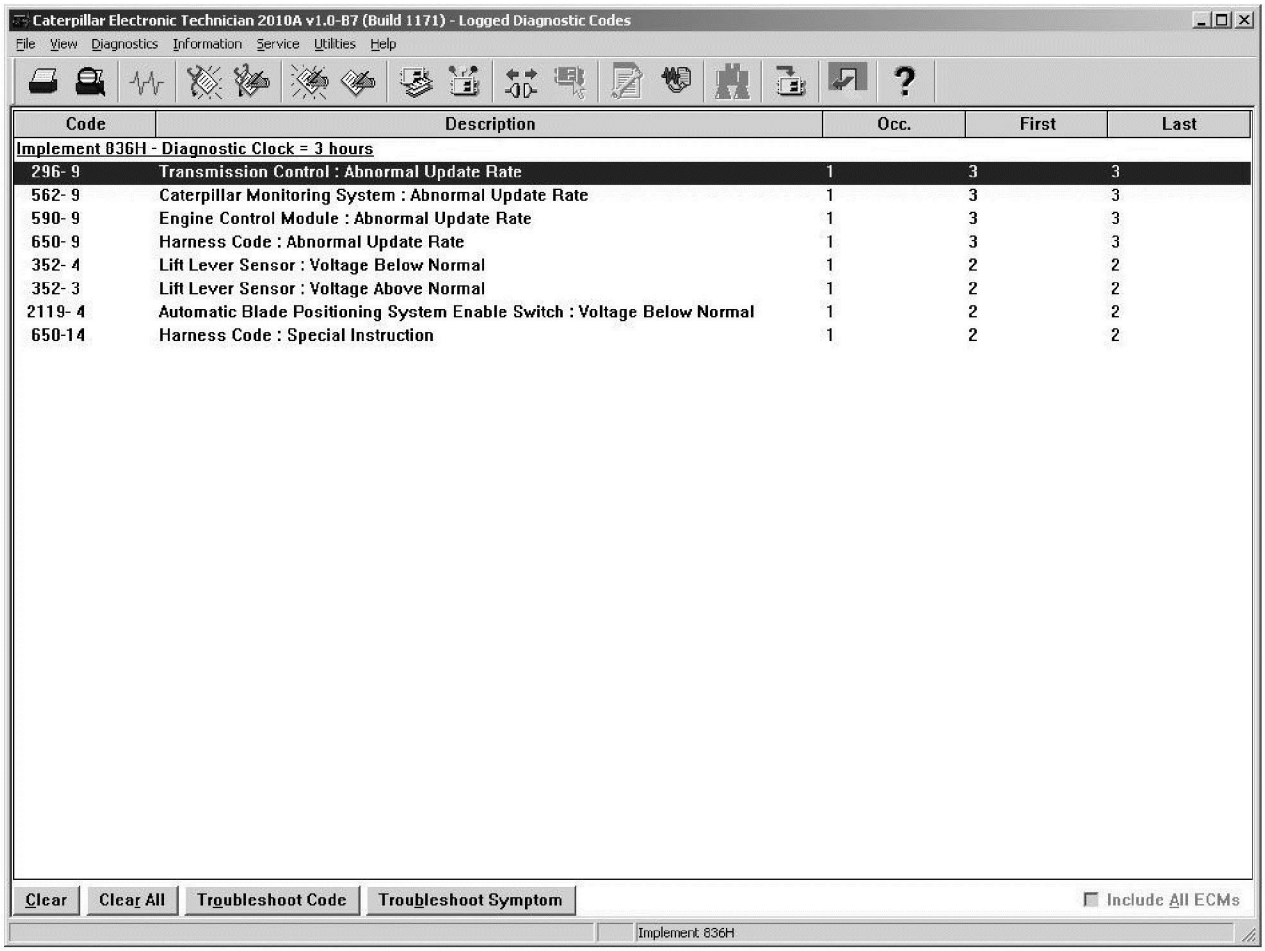


Illustration 21 g02052574

Typical Cat ET screen for logged diagnostic codes

A screen is provided in Cat ET for logged diagnostic codes. The screen will display diagnostic codes that are logged. Cat ET will log diagnostic codes that are intermittent. The logged diagnostic data shall include a component identifier (CID), a failure mode identifier (FMI), and a text description of the problem. Also, the logged diagnostic data shall include the number of occurrences of the problem and two time stamps. The time stamp displays the first occurrence of the problem and the time stamp displays the most recent occurrence of the problem.

Diagnostics are logged in non-volatile memory. On powerup, the ECM will clear any diagnostic codes that have not been detected or active within the last 150 hours of machine operation.

i02437204

MID 081 - CID 0041 - FMI 03

SMCS Code: 1439-038

Conditions Which Generate This Code:

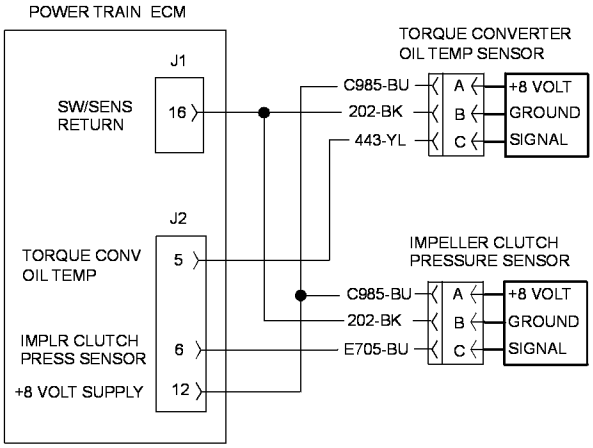


Illustration 22 g01217611

Schematic of the +8 Volt Sensor Supply

This diagnostic code is recorded when the Power Train electronic control module (ECM) reads the voltage of the sensor supply circuit as higher than normal.

Possible causes of this diagnostic code are listed:

- The output of sensor supply to battery has shorted.
- The impeller clutch pressure sensor is faulty or the torque converter oil temperature sensor is faulty.

System Response:

The machine response is listed:

- The lockup clutch is disabled.
- Hesitation during direction shifts.
- Calibrations will not function.

Test Step 1. CHECK FOR THE CORRECT VOLTAGE AT THE ECM.

A. Turn the disconnect switch and the key start switch to the ON position.

B. Check the voltage at the ECM connector from contact J2-12 (sensor supply) to contact J1-16 (ground). Use the 7X-1710 Cable probes to measure the voltage. Do NOT disconnect the machine harness from the ECM.

Expected Result:

The voltage is 8.0 ± 0.5 DCV or the voltage is 10.0 ± 0.5 DCV.

Results:

- OK – The voltage is 8.0 or ± 0.5 DCV or the voltage is 10.0 ± 0.5 DCV. The sensor supply voltage is correct. Verify that the diagnostic code is present. If the diagnostic code is still present, the ECM has failed. Replace the ECM.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code is active. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NOT OK – Voltage is greater than 8.0 or 10.0 ± 0.5 DCV. The sensor supply voltage is NOT correct. Proceed to test step 2.

Test Step 2. CHECK THE HARNESS FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The disconnect switch and the key start switch remain in the ON position.

B. Disconnect the machine harness from the ECM.

C. At the machine harness connector for the ECM, measure the voltage from connector contact J2-12 (sensor supply) to contact J1-16 (ground).

Expected Result:

The voltage is 0.0 ± 0.5 DCV.

Results:

- OK – The voltage is 0.0 ± 0.5 DCV. The voltage is correct. The ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code is active. If the cause of the diagnostic code is not

found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NOT OK – Voltage is NOT 0.0 ± 0.5 DCV. The harness has failed.

  Repair: The machine harness is shorted to the +battery circuit. Repair the machine harness or replace the machine harness.

  STOP.

i02437206

MID 081 - CID 0041 - FMI 04

SMCS Code: 1439-038

Conditions Which Generate This Code:

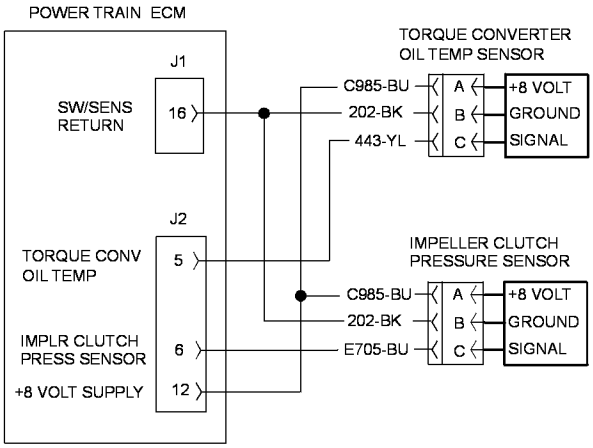


Illustration 23 g01217611

Schematic of the +8 Volt Sensor Supply

The diagnostic code is recorded when the Power Train electronic control module (ECM) indicates that the voltage of the sensor supply circuit is too low.

Possible causes of this diagnostic code are listed:

- The output of sensor supply has an open circuit.
- The torque converter speed sensor is faulty or the transmission oil temperature is faulty.

System Response:

The machine response is listed:

- The lockup clutch is disabled.
- Hesitation during direction shifts.
- Calibrations will not function.

Test Step 1. CHECK THE VOLTAGE AT THE ECM.

A. Turn the disconnect switch and the key start switch to the ON position.

B. Check the voltage at the ECM connector from contact J2-12 (sensor supply) to contact J1-16 (ground). Use the 7X-1710 Cable probes to measure the voltage. Do NOT disconnect the machine harness from the ECM.

Expected Result:

The voltage is 8.0 ± 0.5 DCV or the voltage is 10.0 ± 0.5 DCV.

Results:

- OK – The voltage is 8.0 or ± 0.5 DCV or the voltage is 10.0 ± 0.5 DCV. The sensor supply voltage is correct. Verify that the diagnostic code is present. If the diagnostic code is still present the ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code is active. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NOT OK – Voltage is NOT 8.0 ± 0.5 DCV or the voltage is 10.0 ± 0.5 DCV. The voltage is less than 8.0 ± 0.5 DCV or the voltage is 10.0 ± 0.5 DCV. The sensor supply voltage is NOT correct.Proceed to test step 2.

Test Step 2. CHECK FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the ECM.

C. At the harness connector for the ECM, measure the resistance between frame ground and contact J2-12 and J1-16 of the sensor supply circuit.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. The ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code is active. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NOT OK – The resistance is less than 5000 ohms. The machine harness or a sensor has failed. Proceed to test step 3.

Test Step 3. DISCONNECT THE SENSORS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. One at a time, disconnect any sensor that uses the sensor supply voltage from the machine harness.

C. After disconnecting the sensor (s), check the resistance from frame ground to contact J2-12 and J2-9 (sensor supply) of the machine harness connector for the ECM.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. The sensor that was just disconnected has failed.

  Repair: Replace the sensor.

  STOP.

- NOT OK – The resistance is less than 5000 ohms. If the resistance is less than 5000 ohms after all the sensors have been disconnected from the machine harness. The machine harness is shorted to ground.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

i02439090

MID 081 - CID 0070 - FMI 03

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

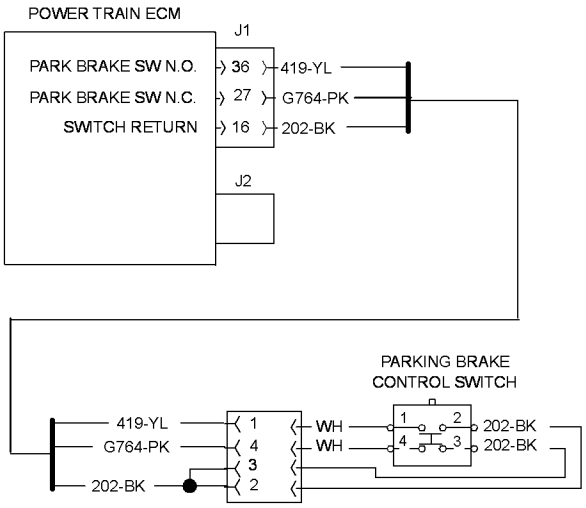


Illustration 24 g01218762

Schematic of the Parking Brake Switch

This diagnostic code is associated with the Parking Brake Switch. The switch is connected to two inputs of the ECM. One contact is open and the other contact is grounded during proper operation.

This FMI 03 means that the ECM has determined that the normally open contact and the normally closed contact are open.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0070 FMI 03 is active before performing this procedure.**

System Response:

The parking brake remains engaged when a failure exists for this diagnostic code.

Test Step 1. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE HARNESS.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. Measure the resistance between contact J1-16 (wire 202-BK(Black)) of the machine harness for the ECM and contact 2 (wire 202-BK(Black)) at the switch.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The circuit is correct.Proceed to Test Step 2.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SWITCH CIRCUITS FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The machine harness connector(s) remains disconnected from the ECM.

B. The disconnect switch and the key start switch remain in the OFF position.

C. Disconnect contact 2 (wire 419-YL(Yellow)) and contact 4 (wire G764-PK(Pink)) from the connector of the switch.

D. At the machine harness connector for the ECM, measure the resistance from contact 2 (wire 419-YL(Yellow)) and contact J1-27 (wire G764-PK(Pink)) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct.Proceed to Test Step 3.
- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

  Repair: The short is between wire 419-YL(Yellow) and the circuit with the lowest resistance measurement or the short is between wire G764-PK(Pink) and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

A. The machine harness remains disconnected from the ECM and the switch.

B. At the harness connector for the switch, connect a jumper wire between contact 2 (wire 419-YL(Yellow)) and contact 4 (wire G764-PK(Pink)).

C. At the harness connector for the ECM, measure the resistance from contact J1-36 (wire 419-YL(Yellow)) to contact J1-27 (wire G764-PK(Pink)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH.

A. Remove the jumper that was installed in the previous Test Step.

B. The machine harness remains disconnected from the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 1 (wire 419-YL(Yellow)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire 419-YL(Yellow)). Note the resistance.

F. Disconnect the lead from contact 1 (wire 419-YL(Yellow)) and connect the lead to contact Contact 4 (wire G764-PK(Pink)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G764-PK(Pink)).

Expected Result:

The resistance from contact 2 to contact 4 is less than 5 ohms, and the resistance from contact 2 to contact 1 is greater than 5000 ohms.

Results:

- YES – The resistance from contact 2 to contact 4 is less than 5 ohms, and the resistance from contact 2 to contact 1 is greater than 5000 ohms. The switch is operating correctly.Proceed to Test Step 5.

- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 1 (wire 419-YL(Yellow)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire 419-YL(Yellow)). Note the resistance.

F. Disconnect the lead from contact 1 (wire 419-YL(Yellow)) and connect the lead to contact 4 (wire G764-PK(Pink)).

G. Measure the resistance between contact 2 (wire 202419-BK(Black)YL(Yellow)) and contact 4 (wire G764-PK(Pink)). Note the resistance.

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire 419-YL(Yellow)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 4 (wire G764-PK(Pink)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- YES – The resistance from contact 2 to contact 1 is less than 5 ohms, and the resistance from contact 2 and contact 4 is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 6.

- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all the harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0070 FMI 03.

Expected Result:

The CID 0070 FMI 03 is active.

Results:

- YES – The CID 0070 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0070 FMI 03 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02439126

MID 081 - CID 0070 - FMI 04

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

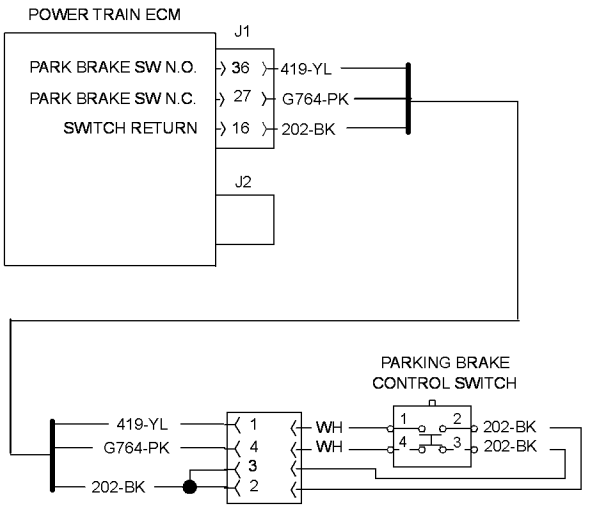


Illustration 25 g01218762

Schematic of the Parking Brake Switch

This diagnostic code is associated with the Parking Brake Switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation.

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.**Ensure that the diagnostic code of CID 0070 FMI 04 is active before performing this procedure.**

System Response:

The parking brake remains engaged when a failure exists for this diagnostic code.

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch and the disconnect switch to the ON position.

Expected Result:

The CID 0070 FMI 04 has been replaced by CID 0070 FMI 03.

Results:

- OK – The CID 0070 FMI 04 has been replaced by CID 0070 FMI 03. The machine harness and the ECM are correct.Proceed to Test Step 3.
- NOT OK – The CID 0070 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-36 (wire 419-YL(Yellow)) and J1-27 (wire G764-PK(Pink)) of the machine harness to all the contacts that are used in machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-36 (wire 419-YL(Yellow)) and the circuit with the lowest

resistance or the short is between J1-27 (wire G764-PK(Pink)) and the circuit with the lowest resistance.

Repair: Repair the wiring harness or replace the wiring harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact2 (wire 202-BK(Black)) of the harness connector for the switch.

C. Connect the other lead from a multimeter to contact 1 (wire 419-YL(Yellow)) of the harness connector for the switch.

D. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire 419-YL(Yellow)) . Note the resistance.

E. Disconnect the lead from contact 1 (wire 419-YL(Yellow)) and connect the lead to contact 4 (wire G764-PK(Pink)) .

F. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G764-PK(Pink)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G764-PK(Pink)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 2 (wire 419-YL(Yellow)) is greater than 5000 ohms.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G764-PK(Pink)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire 419-YL(Yellow)) is greater than 5000 ohms. Proceed to Test Step 4.

- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 1 (wire 419-YL(Yellow)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire 419-YL(Yellow)). Note the resistance.

F. Disconnect the lead from contact 1 (wire 419-YL(Yellow)) and connect the lead to contact 4 (wire G764-PK(Pink)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G764-PK(Pink)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire 419-YL(Yellow)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact Contact 4 (wire G764-PK(Pink)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire 419-YL(Yellow)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 4 (wire G764-PK(Pink)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 5.

- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0070 FMI 04 is present.

Expected Result:

The CID 0070 FMI 04 is active.

Results:

- YES – The CID 0070 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0070 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02439166

MID 081 - CID 0138 - FMI 03

SMCS Code: 7332-038

Conditions Which Generate This Code:

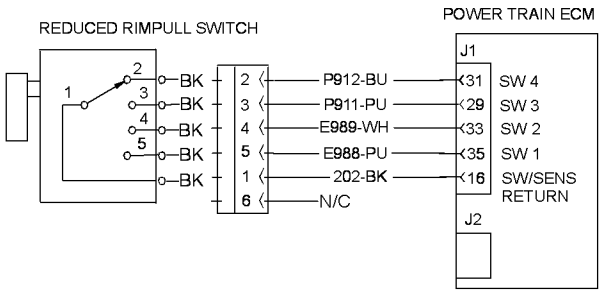


Illustration 26 g01218806

Schematic for Reduced Rimpull Selector Switch

Table 7

Status of Reduced Rimpull Switch				
Switch Position	**Switch 1 J1-35**	**Switch 2 J1-33**	**Switch 3 J1-29**	**Switch 4 J1-31**
1	Closed	Open	Open	Open
2	Open	Closed	Open	Open
3	Open	Open	Closed	Open
4	Open	Open	Open	Closed

The reduced rimpull switch has four inputs to the ECM. During normal operation, three of the inputs are open and the other input is grounded. The diagnostic code is detected when all of the inputs are open or shorted to the +battery. Before you perform this procedure use Table 7 to determine the connector and the contacts that correspond to the problem circuit. The diagnostic code is set in five seconds and the diagnostic code is cleared in one second.

Possible causes of this diagnostic code are listed:

- There is a problem in the harness.
- The switch failed.

System Response:

The machine response is listed:

- Reduced rimpull is disabled.

Test Step 1. CHECK FOR AN OPEN CIRCUIT.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Disconnect the machine harness connectors J1 and J2 from the ECM.

C. At the machine harness connector for the ECM, check the continuity to ground of the switch contacts with the reduced rimpull selector switch that is activated and with the reduced rimpull selector switch that is not activated. Refer to Table 7 for the correct status of the reduced rimpull selector switch.

Expected Result:

The continuity check does NOT agree with Table 7 .

Results:

- YES – The continuity check does NOT agree with the information in the table. The harness or the reduced rimpull switch is faulty.Proceed to Test Step 2.

- NO – The continuity check agrees with the information in the table.Proceed to Test Step 3.

Test Step 2. CHECK THE SWITCH.

A. Disconnect the machine harness from the reduced rimpull switch.

B. Check the continuity to ground of the switch contacts with the reduced rimpull switch that is activated and with the reduced rimpull switch that is not activated. Refer to Table 7 for the correct status of the reduced rimpull switch.

Expected Result:

The continuity check does NOT agree with Table 7 .

Results:

- YES – The continuity check does NOT agree with the information in the table. The reduced rimpull switch is malfunctioning.

  Repair: Repair the switch or replace the switch.

  STOP.

- NO – The continuity check agrees with the information in the table.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR A SHORT TO +VOLTAGE

A. At the machine harness connector J1 for the ECM, check the continuity from each of the wires for the switch contact to these + voltage contacts: J1-1 (wire 164-WH(White)), J1-6 (wire 164-WH(White)), J1-40 (wire 307-OR(Orange)), J2-9 (wire 709-OR(Orange)) and J2-12 (wire C985-BU(Blue)).

Expected Result:

Continuity exists between one of the sources of the + voltage and the switch circuit.

Results:

- YES – Continuity exists between one of the sources of + voltage. The machine harness is faulty.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

- NO – Continuity does not exist between one of the sources of + voltage and the switch circuit. The machine harness is correct. It is unlikely that the ECM is faulty. Exit this procedure and perform CID 0138 FMI 03 again.

  Repair: Replace the Power Train ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace” for more information on replacing the ECM.

  STOP.

i02439174

MID 081 - CID 0138 - FMI 04

SMCS Code: 7332-038

Conditions Which Generate This Code:

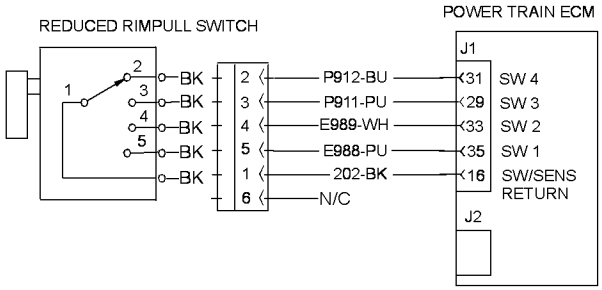


Illustration 27 g01218806

Schematic for the Reduced Rimpull Selector Switch

Table 8

Status of Reduced Rimpull Switch				
Switch Position	**Switch 1 J1-35**	**Switch 2 J1-33**	**Switch 3 J1-29**	**Switch 4 J1-31**
1	Closed	Open	Open	Open
2	Open	Closed	Open	Open
3	Open	Open	Closed	Open
4	Open	Open	Open	Closed

The reduced rimpull switch has four inputs to the ECM. During normal operation, three of the inputs are open and the other input is grounded. The diagnostic code is detected when all of the inputs are open or shorted to the +battery. Before you perform this procedure use Table 8 to determine the connector and the contacts that correspond to the faulty circuit. The diagnostic code is set in five seconds and the diagnostic code is cleared in one second.

Possible causes of this diagnostic code are listed:

- There is a problem in the harness.
- The switch failed.

System Response:

The machine response is listed:

- Reduced rimpull is disabled.

Test Step 1. CHECK THE SWITCH CIRCUIT.

A. Ensure that the diagnostic code is active.

B. Disconnect the connector of the reduced rimpull switch from the machine harness.

Expected Result:

The active diagnostic code changes from “04” to “03” .

Results:

- YES – The rimpull switch or the switch harness has failed.

  Repair: Repair the switch or replace the switch and the switch harness.
  Repeat the Test Step in order to verify failure of the reduced rimpull switch.

- NO – The diagnostic code indicator remains on. The reduced rimpull switch is not the cause of this diagnostic code.Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS CIRCUIT.

This test checks the continuity of the entire harness circuit that is faulty. The reduced rimpull switch which was previously checked in Test Step 1 is included in this Test Step.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Connect the reduced rimpull switch of Step 1 to the machine harness.

C. Disconnect the machine harness connectors J1 and J2 from the ECM.

D. At the machine harness connector for the ECM, check the continuity to ground of the switch contacts with the reduced rimpull switch that is activated and with the reduced rimpull switch that is not activated. Refer to Table 8 for the correct switch status.

Expected Result:

The continuity check does NOT agree with Table 8 .

Results:

- YES – The continuity check does NOT agree with the information in the table. The harness circuit is faulty. There is a short to ground in the machine harness between the ECM and the reduced rimpull switch.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

- NO – The continuity check agrees with the information in the table. The harness circuit is correct. It is unlikely that the ECM is faulty. Exit this procedure and perform CID 0138 FMI 04 again.

  Repair: If the cause is not found, replace the ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace” for more information on replacing the ECM.

  STOP.

i02457448

MID 081 - CID 0168 - FMI 00

SMCS Code: 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the power train ECM identifies a system voltage that is above 35.0 DCV.

The possible causes of this diagnostic code are listed:

- The voltage regulator is not operating properly.
- Jump starting with a welder.

System Response:

The machine response is listed:

- Starting is disabled.
- The functions of the transmission are disabled until the voltage is above 32.0 DCV and the direction switch is placed in neutral.

Note: Ensure that CID 0168 FMI 00 is active and that the diagnostic code indicator is active.

Test Step 1. CHECK THE CHARGING SYSTEM.

A. Turn the key start switch to the ON position.

B. Ensure that CID 0168 FMI 00 is active. See Testing and Adjusting, “Using Caterpillar Electronic Technician to Determine Diagnostic Codes”.

C. Ensure that the diagnostic code indicator is active.

Expected Result:

The diagnostic code indicator is active.

Results:

- YES – The diagnostic code indicator is active. Proceed to test step 3.
- NO – The diagnostic code indicator is not active. Proceed to test step 2.

Test Step 2. CHECK THE CHARGING SYSTEM.

A. Start the engine.

B. Ensure that CID 0168 FMI 0 is active.

C. Observe the status of the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is active.

Results:

- YES – The diagnostic code indicator is active. The charging system is charging at an excessive voltage.

  Repair: Check the charging system.

  STOP.

- NO – The diagnostic code indicator is not active.

  Repair: There is no problem at this time. Watch for a recurrence of this diagnostic code.

  STOP.

Test Step 3. CHECK THE BATTERY VOLTAGE.

A. The engine is stopped.

B. At the battery, measure the voltage.

Expected Result:

The voltage is less than 35.0 DCV.

Results:

- OK – The voltage is less than 35.0 DCV. The ECM must be incorrectly recording this problem.

  Repair: It is unlikely that the ECM has failed. Perform the previous Steps again. If the cause of the problem is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NOT OK – The voltage is greater than 35.0 DCV. The charging system is charging at an excessive voltage.

  Repair: Check the charging system.

  STOP.

i01665379

MID 081 - CID 0168 - FMI 01

SMCS Code: 1406-038

Conditions Which Generate This Code:

The diagnostic circuit of the power train ECM identifies a system voltage that is below 18.0 DCV.

The possible causes of this diagnostic code are listed:

- The system voltage remains low for an extended time after the engine is started.
- There is an open circuit between the battery and the ECM.
- There is an open circuit between the ECM and system ground.
- One set of batteries is disconnected with the key in the ON position. Also, the engine must not be running.

System Response:

The machine response is listed:

- The functions of the transmission are disabled until the voltage is above 18.0 DCV and the direction switch is placed in neutral.

Note: Ensure that CID 0168 FMI 01 is active and that the diagnostic code indicator is active.

Test Step 1. CHECK THE BATTERY VOLTAGE.

A. Start the engine.

B. Run the engine at high idle for several minutes.

C. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be greater than 18.0 DCV.

Results:

- OK – The voltage is greater than 18.0 DCV. The battery voltage is correct. Proceed to test step 2.
- NOT OK – The voltage is less than 18.0 DCV. The charging system is not operating correctly.

  Repair: Check the charging system. Refer to Testing and Adjusting, “Starting And Charging System” in the Service Manual for the machine that is being serviced.

  STOP. Repaired OK

Test Step 2. CHECK THE SYSTEM VOLTAGE AT THE ECM.

A. Run the engine at high idle.

B. Locate the connector for the power train ECM .

C. Use 7X-1710 Multimeter Probe Group.

D. Measure the system voltage between J1-1 (wire 164-WH(White)) and J1-2 (wire A273-BK(Black)), and measure the voltage between J1-6 (wire 164-WH(White)) and J1-5 (wire A273-BK(Black)).

Expected Result:

The voltage should be less than 18.0 DCV.

Results:

- OK – Voltage is less than 18.0 DCV. The harness has failed.

  Repair: Repair the harness or replace the harness.

  STOP.

- NOT OK – Voltage is greater than 18.0 DCV. The system voltage is correct.

  Repair: Ensure that CID 0168 FMI 01 is active. Disconnect the harness connector from the ECM and inspect contacts J1-1, J1-6, J1-2, and J1-5 for corrosion or debris. Reconnect the harness connector to the ECM. If the diagnostic code is active, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) − Replace”.

  STOP.

i02449889

MID 081 - CID 0190 - FMI 02

SMCS Code: 1907-038

Conditions Which Generate This Code:

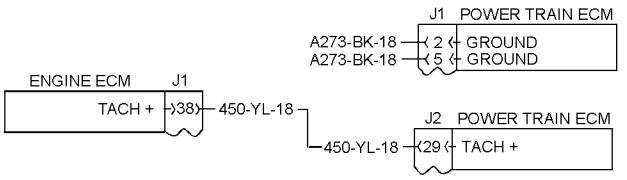


Illustration 28 g01226508

Schematic of the Engine Speed Signal

The CID 0190 FMI 02 diagnostic code is recorded when the power train electronic control module (ECM) reads an abnormal signal from the engine ECM. The power train ECM will be unable to calculate the ratio of the torque converter.

The power train ECM compares the signals from the engine speed sensor and the torque converter output speed sensor. A CID 0190 FMI 02 diagnostic code is recorded when the engine speed signal is below the dropout signal level, and the torque converter output speed sensor senses the engine speed as above low idle.

Note: The engine must be running in order for the power train ECM to show this diagnostic code.

Test Step 1. CHECK FOR OTHER DIAGNOSTIC CODE

A. Check for an active diagnostic code of a MID 081 CID 0190 from the Engine ECM.

Expected Result:

The diagnostic code of MID 081 CID 0190 from the Engine ECM is active.

Results:

- OK – The diagnostic code of MID 081 CID 0190 from the Engine ECM is active.

  Repair: Stop this procedure and perform the procedure for the diagnostic code of MID 081 CID 0190.

  STOP.

- NOT OK – The diagnostic code of MID 081 CID 0190 from the Engine ECM is not present.Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN IN THE MACHINE HARNESS

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect machine harness connectors J1 and J2 from the power train ECM.

C. Disconnect machine harness connectors J1 and J2 from the engine ECM.

D. At the machine harness connectors, measure the resistance from J2-29 of the power train ECM to J1-38 of the engine ECM.

Expected Result:

The resistance is less than 5.0 Ohms.

Results:

- OK – The resistance is less than 5.0 Ohms.The signal circuit in the machine harness is correct. Proceed to Step Test Step 3.
- NOT OK – The resistance is not less than 5.0 Ohms.

  Repair: The signal circuit (wire 450-YL(Yellow)) is open in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT

A. At the machine harness connector for the power train ECM, measure the resistance between J2-29 (wire 450-YL(Yellow)) and all contacts that are used in the machine harness connectors.

B. At the machine harness connector for the engine ECM, measure the resistance between J1-38 (wire 450-YL(Yellow)) and all contacts that are used in the machine harness connectors.

Expected Result:

Each resistance is greater than 5000 Ohms.

Results:

- OK – Each resistance is greater than 5000 Ohms. The machine harness is correct. Proceed to Step Test Step 4.
- NOT OK – Each resistance is not greater than 5000 Ohms.

  Repair: There is a short in the machine harness. The short is between J2-29 (wire 450-YL(Yellow)) and the contact with the low resistance. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL PRESENT

A. Clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Start the engine and run the engine at low idle.

E. Check the status of the CID 0190 FMI 02.

Expected Result:

The CID 0190 FMI 02 is not active.

Results:

- OK – The CID 0190 FMI 02 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected.

  Repair: Resume normal operation.

  STOP.
- NOT OK – The CID 0190 FMI 02 is active. The diagnostic code has not been corrected.Proceed to Step Test Step 5.

Test Step 5. CHECK THE FREQUENCY OF THE SIGNAL

A. Insert the 7X-1710 Multimeter Probe into contact J2-29 (wire 450-YL(Yellow)) at the back of the machine harness.

B. Insert the 7X-1710 Multimeter Probe into contact J1-2 (wire A273-BK(Black)) at the back of the machine harness.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Start the engine and run the engine at low idle.

E. Measure the frequency of the signal.

Note: The frequency is equal to 20 Hertz for 1 RPM.

F. Compare the frequency of the signal to the RPM of the engine.

Expected Result:

The frequency should be 20 times greater than the RPM of the engine.

Results:

- OK – The frequency is 20 times greater than the RPM of the engine.

  Repair: It is unlikely that the power train ECM has failed. Exit this procedure. Perform the procedures again. If the cause of the failure is not found, replace the power train ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NOT OK – The frequency is not correct or erratic.

  Repair: It is unlikely that the engine ECM has failed. Exit this procedure. Perform the procedures again. If the cause of the failure is not found, replace the engine ECM. See the Testing and Adjusting, “Electronic Control Module - Replace”.

  STOP.

i02449890

MID 081 - CID 0191 - FMI 01

SMCS Code: 3175-038

Conditions Which Generate This Code:

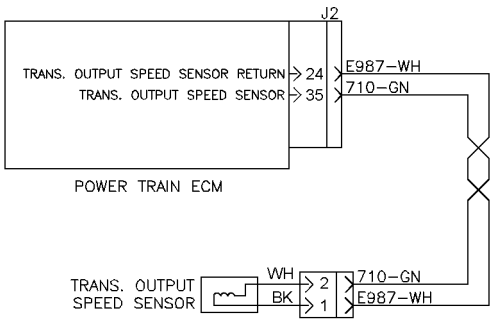


Illustration 29 g01063636

Schematic of the speed sensor (transmission output)

This diagnostic code is associated with the speed sensor (transmission output). The FMI 01 means that the ECM has determined that the signal from the transmission output speed sensor is below normal operating range. The transmission output speed sensor is a frequency sensor.

The frequency of the signal increases as the transmission output speed increases.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The signal circuit of the sensor is shorted to the ground.
- The sensor needs to be adjusted.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0191 FMI 01 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR

A. Perform a visual inspection of the sensor, the wiring for the sensor, and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor, or the hardware that is associated with the sensor.

Results:

- YES – There is no apparent damage to the sensor, the wiring for the sensor, or the hardware that is associated with the sensor.Proceed to Test Step 2.
- NO – There is apparent damage to the sensor, the wiring for the sensor, or the hardware that is associated with the sensor.

  Repair: Replace the damaged part. Proceed to Test Step 8.

Test Step 2. CHECK FOR A SHORTED SENSOR

A. Turn the disconnect switch to the OFF position.

B. Disconnect the harness from the speed sensor.

C. At the sensor, measure the resistance between each connector contact and the case of the sensor.

Expected Result:

The resistance of either measurement is greater than 5 ohms.

Results:

- YES – Resistance of either measurement is greater than 5 ohms.Proceed to Test Step 3.
- NO – Resistance of either measurement is less than 5 ohms. The sensor has failed.

  Repair: Replace the sensor. Install the speed sensor. Adjust the speed sensor.

  STOP.

Test Step 3. CHECK THE RESISTANCE AT THE SENSOR

A. The disconnect switch remains in the OFF position and the speed sensor remains disconnected from the harness.

B. At the sensor, measure the resistance between the two contacts of the connector.

Expected Result:

The resistance should be approximately 1075 ohms.

Results:

- YES – Resistance is approximately 1075 ohms. Proceed to Test Step 4.
- NO – Resistance is not approximately 1075 ohms. The sensor has failed.

  Repair: Replace the sensor. Install the speed sensor. Adjust the speed sensor.

  STOP.

Test Step 4. CHECK FOR A SHORTED HARNESS

A. The disconnect switch remains in the OFF position and the speed sensor remains disconnected from the harness.

B. Disconnect the harness from the Power Train ECM.

C. At the harness connector for the Power Train ECM, measure the resistance between contact “J2-35” (wire 710-GN(Green)) and all other connector contacts.

Expected Result:

The resistance is greater than 5 ohms.

Results:

- YES – Resistance is greater than 5 ohms.Proceed to Test Step 5.
- NO – Resistance is less than 5 ohms.

  Repair: Wire 710-GN(Green) is shorted between the speed sensor and the Power Train ECM. Repair the harness or replace the harness.

  STOP.

Test Step 5. CHECK THE GROUND CIRCUIT

A. The disconnect switch remains in the OFF position and the speed sensor remains disconnected from the harness.

B. At the harness connector for the speed sensor, measure the resistance between contact “J2-24” (wire E987-WH(White)) and frame ground.

Expected Result:

The resistance is greater than 5 ohms.

Results:

- YES – Resistance is 5 ohms or more.Proceed to Test Step 6.
- NO – Resistance is less than 5 ohms. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT

A. The disconnect switch remains in the OFF position and the speed sensor remains disconnected from the harness.

B. At the harness connector for the speed sensor, place a jumper from contact 1 (wire 710-GN(Green)) to contact 2 (wire E987-WH(White)).

C. At the harness connector for the ECM, measure the resistance between contact “J2-35” (wire 710-GN(Green)) and contact 2 (wire E987-WH(White)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- YES – The resistance is less than 5 ohms. Proceed to Test Step 7.
- NO – The resistance is greater than 5 ohms.

  Repair: There is an open in either (wire 710-GN(Green)) or (wire E987-WH(White)). Repair the harness or replace the harness.

  STOP.

Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0191 FMI 01.

Expected Result:

The CID 0191 FMI 01 is not active at the minimum range of the sensor.

Results:

- YES – The CID 0191 FMI 01 is not active at the minimum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.
- NO – The CID 0191 FMI 01 is active at the minimum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace” for the machine that is being serviced.

  STOP.

Test Step 8. CHECK THE ADJUSTMENT OF THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the adjustment procedure for the speed sensor.

C. Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

Note: Operate the machine and take the sensor through the operating range of the sensor.

D. Check the status of the diagnostic code.

Expected Result:

The CID 0191 FMI 01 is not active.

Results:

- YES – The diagnostic is not active. The adjustment has corrected the failure. Resume normal operation.

  STOP.
- NO – CID 0191 FMI 01 is still active.

  Repair: Exit this procedure. Perform this procedure again.

  STOP.

i02449891

MID 081 - CID 0363 - FMI 03

SMCS Code: 5479-038-R6

Conditions Which Generate This Code:

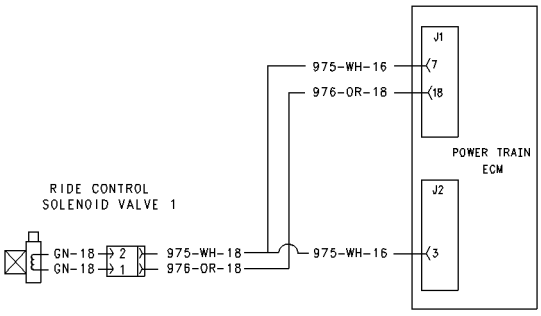


Illustration 30 g00954555

Schematic of the Solenoid Valve (Ride Control)

This diagnostic code is associated with the Solenoid Valve (Ride Control). The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0363 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the ride control function will always remain active.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J1-18 (wire 976-OR(Orange)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-18 (976-OR(Orange)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 0363 FMI 03 is active.

Expected Result:

The CID 0363 FMI 03 is active.

Results:

- YES – The CID 0363 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0363 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449893

MID 081 - CID 0363 - FMI 05

SMCS Code: 5479-038-R6

Conditions Which Generate This Code:

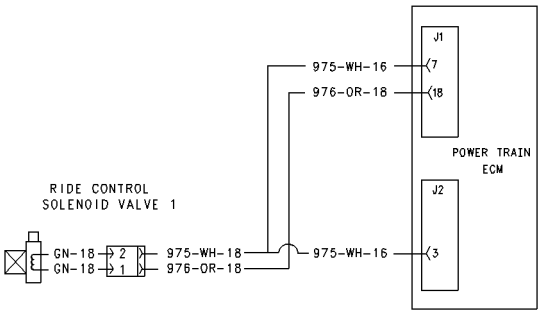


Illustration 31 g00954555

Schematic of the Solenoid Valve (Ride Control)

This diagnostic code is associated with the Solenoid Valve (Ride Control). The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0363 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the ride control function is inoperable.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 976-OR(Orange)) to contact 2 (wire 975-WH(White)).

D. Observe the status of the CID 0363 FMI 05.

Expected Result:

The CID 0363 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J1-18 (wire 976-OR(Orange)) to contact J1-7 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in (wire 976-OR(Orange)) or in (wire 975-WH(White)) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0363 FMI 05.

Expected Result:

The CID 0363 FMI 05 is active.

Results:

- YES – The CID 0363 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0363 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449894

MID 081 - CID 0363 - FMI 06

SMCS Code: 5479-038-R6

Conditions Which Generate This Code:

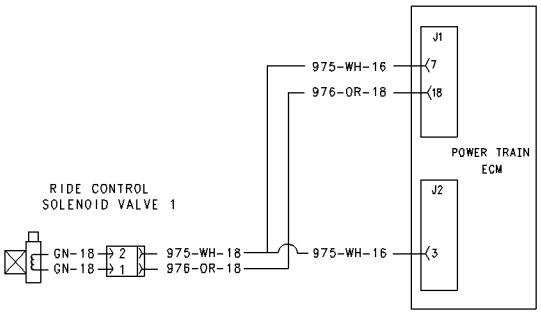


Illustration 32 g00954555

Schematic of the Solenoid Valve (Ride Control)

This diagnostic code is associated with the Solenoid Valve (Ride Control). The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0363 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the ride control function is inoperable.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 0363 FMI 06 changes to CID 0363 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 0363 FMI 06 changes to CID 0363 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 0363 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-18 (wire 976-OR(Orange)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-18 (wire 976-OR(Orange)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0363 FMI 06.

Expected Result:

The CID 0363 FMI 06 is active.

Results:

- YES – The CID 0363 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0363 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449895

MID 081 - CID 0367 - FMI 03

SMCS Code: 7332-038-R6

Conditions Which Generate This Code:

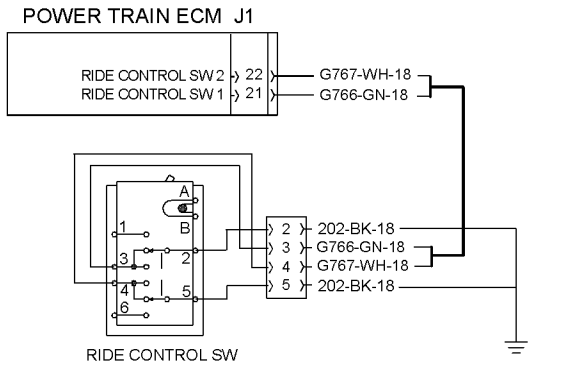


Illustration 33 g01223040

Schematic of the Rocker Switch (Ride Control)

This diagnostic code is associated with the Rocker Switch (Ride Control). The switch is connected to two inputs of the ECM. Both contacts are closed when the switch is in the OFF position. Wire G766-GN(Green) is open and wire G767-WH(White) is closed, when the ride control switch is in the ON position. Wire G767-WH(White) is open and wire G766-GN(Green) is closed, when the ride control switch is in the AUTO position. Refer to table 9 .

Table 9

Status of the Ride Control Switch			
Mode	**Switch Position**	**G766-GN (Green) Circuit J1-21 Input 1**	**G767-WH (White) Circuit J1-22 Input 2**
ON	Down	Open	Closed
OFF	Center	Closed	Closed
AUTO	Up	Closed	Open

This FMI 03 means that the ECM has determined that both contacts are open.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0367 FMI 03 is active before performing this procedure.**

Test Step 1. INSPECT THE HARNESS CONNECTIONS.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Inspect all harness connections that are associated with the Rocker Switch (Ride Control). Make sure that the connectors are clean and tight.

C. Check the connectors for proper mating.

D. Check the wires at the connectors.

E. Check each wire for nicks or signs of abrasion in the insulation.

F. Check for moisture at the connectors.

G. Check the connectors for dirty contacts or corroded contacts.

H. Check each pin and each socket of the machine harness connectors.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and free of corrosion.Proceed to test step 2.
- NOT OK – The machine harness connectors are in need of repair.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SWITCH CIRCUITS IN THE HARNESS

A. The disconnect switch and the key start switch remain in the OFF position.

B. Disconnect the machine harness connectors from the ECM and the switch.

C. At the harness connector for the switch, connect a jumper wire between contact 3 (wire G766-GN(Green)) and contact 4 (wire G767-WH(White)).

D. At the harness connector for the ECM, measure the resistance from contact J1-22 (wire G767-WH(White)) to contact J1-21 (wire G766-GN(Green)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH

A. The disconnect switch and the key start switch remain in the OFF position.

B. The machine harness connectors remain disconnected from the ECM and the switch.

C. Remove the jumper that was installed in the previous Test Step.

D. Measure the resistance between contact 2 (wire 202-BK(Black)) of the machine harness for the switch to frame ground. Note the resistance.

E. Measure the resistance between contact 5 (wire 202-BK(Black)) of the machine harness for the switch to frame ground. Note the resistance.

Expected Result:

The resistance for each measurement is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. Each circuit is correct.Proceed to Test Step 4.

- NOT OK – A resistance measurement is 5000 ohms or greater. The circuitwith the 5000 ohms or greater measurement is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The disconnect switch and the key start switch remain in the OFF position.

B. The machine harness connectors remain disconnected from the ECM and the switch.

C. Check the continuity to ground of the open contacts and the grounded contacts for each position of the switch. Activate and deactivate each position of the switch.

Expected Result:

The continuity checks do not agree with the ground and open combinations.

Results:

- YES – The continuity checks do not agree with the ground and open combinations. The transmission auto/manual switch is faulty.

  Repair: Repair the switch or replace the switch.

  STOP.

- NO – The continuity checks agree with the ground and open combinations.Proceed to Test Step 5.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all the harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0367 FMI 03.

Expected Result:

The CID 0367 FMI 03 is active.

Results:

- YES – The CID 0367 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0367 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449896

MID 081 - CID 0367 - FMI 04

SMCS Code: 7332-038-R6

Conditions Which Generate This Code:

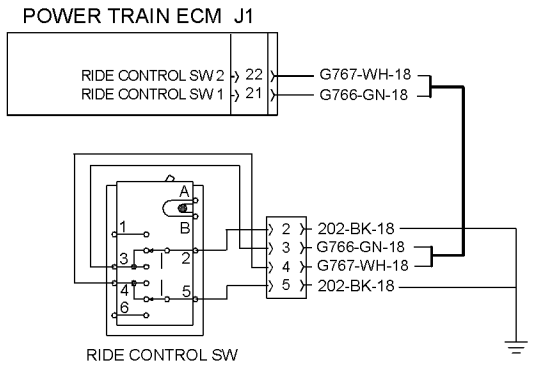


Illustration 34 g01223040

Schematic of the Ride Control Switch

This diagnostic code is associated with the Ride Control Switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation. Refer to table 10 .

Table 10

Status of the Ride Control Switch			
Mode	**Switch Position**	**G766-GN (Green) Circuit J1-21 Input 1**	**G767-GN (Green) Circuit J1-22 Input 2**
AUTO	**Up**	**Closed**	**Open**
OFF	Center	Closed	Closed
ON	Down	Open	Closed

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.**Ensure that the diagnostic code of CID 0367 FMI 04 is active before performing this procedure.**

System Response:

When this diagnostic code occurs, the ride control function is disabled.

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch and the disconnect switch to the ON position.

Expected Result:

The CID 0367 FMI 04 has been replaced by CID 0367 FMI 03.

Results:

- OK – The CID 0367 FMI 04 has been replaced by CID 0367 FMI 03. The machine harness and the ECM are correct.Proceed to Test Step 3.
- NOT OK – The CID 0367 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-22 (wire G767-WH(White)) and J1-21 (wire G766-GN(Green)) of the machine harness to all the contacts that are used in machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-22 (wire G767-WH(White)) and the circuit with the lowest

resistance or the short is between J1-21 (wire G766-GN(Green)) and the circuit with the lowest resistance.

Repair: Repair the wiring harness or replace the wiring harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

C. Connect the other lead from a multimeter to contact 4 (wire G767-WH(White)) of the harness connector for the switch.

D. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G767-WH(White)) . Note the resistance.

E. Disconnect the lead from contact 4 (wire G767-WH(White)) and connect the lead to contact 3 (wire G766-GN(Green)).

F. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 3 (wire G766-GN(Green)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 3 (wire G766-GN(Green)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G767-WH(White)) is greater than 5000 ohms.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 3 (wire G766-GN(Green)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G767-WH(White)) is greater than 5000 ohms.Proceed to Test Step 4.
- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 4 (wire G767-WH(White)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G767-WH(White)). Note the resistance.

F. Disconnect the lead from contact 4 (wire G767-WH(White)) and connect the lead to contact 3 (wire G766-GN(Green)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 3 (wire G766-GN(Green)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G767-WH(White)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 3 (wire G766-GN(Green)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G767-WH(White)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 3 (wire G766-GN(Green)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly. Proceed to Test Step 5.
- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0367 FMI 04 is present.

Expected Result:

The CID 0367 FMI 04 is active.

Results:

- YES – The CID 0367 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0367 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449897

MID 081 - CID 0378 - FMI 03

SMCS Code: 5479-038

Conditions Which Generate This Code:

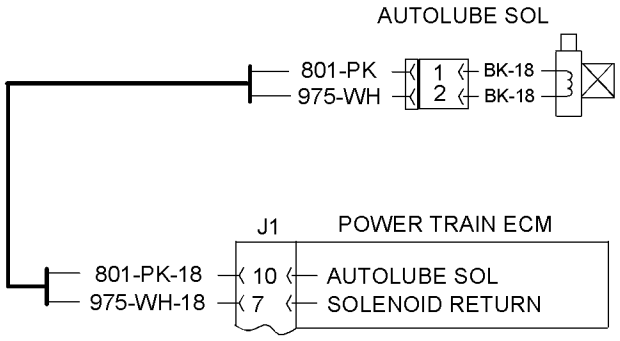


Illustration 35 g01223079

Schematic of the Autolube Solenoid

This diagnostic code is associated with the autolube solenoid. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0378 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SOLENOID CIRCUIT FOR A SHORT TO THE + BATTERY.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the solenoid.

C. Disconnect the machine harness connectors J1 and J2 from the ECM.

D. At machine harness connector J1 and J2, measure the resistance from the signal contact J1-10 (wire 801-PK(Pink)) to all possible sources of +battery.

Expected Result:

The resistance should be greater than 5000 ohms for each measurement.

Results:

- OK – The resistance is greater than 5000 ohms. The machine harness is correct.Proceed to test step 2.
- NOT OK – The resistance is NOT correct. There is a short in the machine harness. The short is between signal contact J1-10 (wire 801-PK(Pink)) and the circuit with the low resistance measurement.

  Repair: Repair the harness or replace the harness.

STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Clear all inactive diagnostic codes.

E. Operate the machine.

F. Observe the status of CID 0378 FMI 03 for the solenoid.

Expected Result:

The CID 0378 FMI 03 for the solenoid is NOT present.

Results:

- OK – The diagnostic code is NOT present. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

- NOT OK – The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this CID 0378 FMI 03 again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02449899

MID 081 - CID 0378 - FMI 05

SMCS Code: 5479-038

Conditions Which Generate This Code:

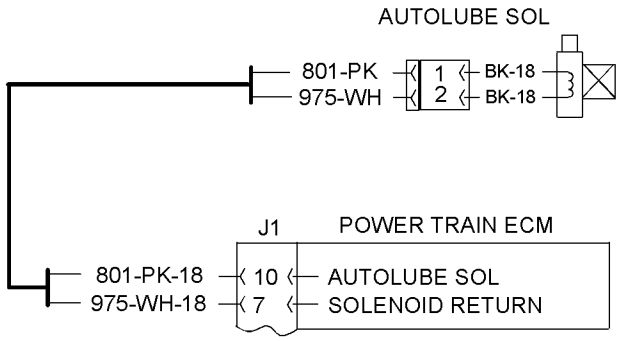


Illustration 36 g01223079

Schematic of the Autolube Solenoid

This diagnostic code is associated with the autolube solenoid. The FMI 05 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0378 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 801-PK(Pink)) to contact 2 (wire 975-WH(White)).

D. Observe the status of the CID 0378 FMI 05.

Expected Result:

The CID 0378 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J1-10 (wire 801-PK(Pink)) to contact J1-7 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in (wire 801-PK(Pink)) or in (wire 975-WH(White)) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0378 FMI 05.

Expected Result:

The CID 0378 FMI 05 is active.

Results:

- YES – The CID 0378 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0378 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449900

MID 081 - CID 0378 - FMI 06

SMCS Code: 5479-038

Conditions Which Generate This Code:

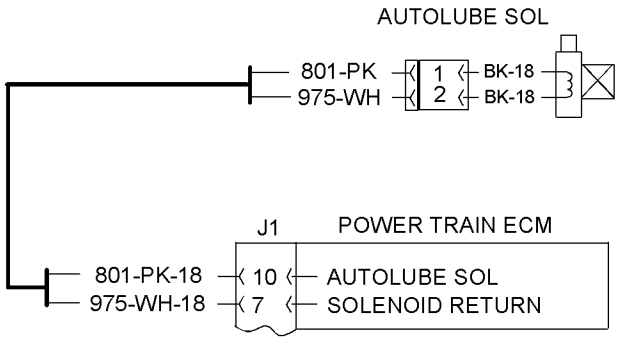


Illustration 37 g01223079

Schematic of the Autolube Solenoid

This diagnostic code is associated with the autolube solenoid. The FMI 06 means that the ECM has determined that there is a short to ground in the circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0378 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 0378 FMI 06 changes to CID 0378 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 0378 FMI 06 changes to CID 0378 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 0378 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-10 (wire 801-PK(Pink)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-10 (wire 801-PK(Pink)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0378 FMI 06.

Expected Result:

The CID 0378 FMI 06 is active.

Results:

- YES – The CID 0378 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0378 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02449901

MID 081 - CID 0379 - FMI 03

SMCS Code: 1439-038-LBX

Conditions Which Generate This Code:

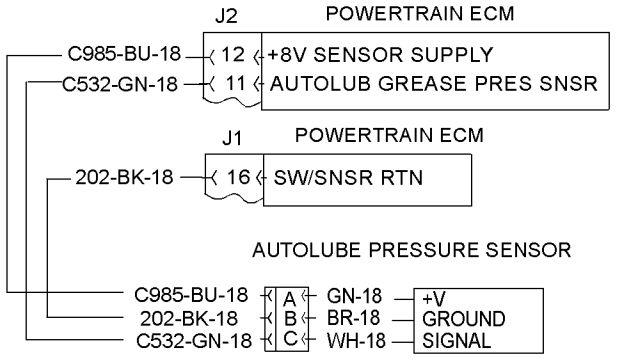


Illustration 38 g01225069

Schematic of the Machine Autolube Pressure Sensor

This diagnostic code is associated with the machine autolube pressure sensor. The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0379 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along contact A (wire C985-BU(Blue)) for the voltage supply.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A (wire C985-BU(Blue)) to contact B (wire 202-BK(Black)).

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 8 DCV. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE SENSOR.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. At the back of the harness connector for the sensor, remove the 7X-1710 Multimeter Probe from contact 1 and insert the probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert the 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-11 (wire C532-GN(Green)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-11 (wire C532-GN(Green)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The circuit is correct.Proceed to Test Step 5.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0379 FMI 03.

Expected Result:

The CID 0379 FMI 03 is not active.

Results:

- OK – The CID 0379 FMI 03 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.

- NOT OK – The CID 0379 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02449902

MID 081 - CID 0379 - FMI 04

SMCS Code: 1439-038-LBX

Conditions Which Generate This Code:

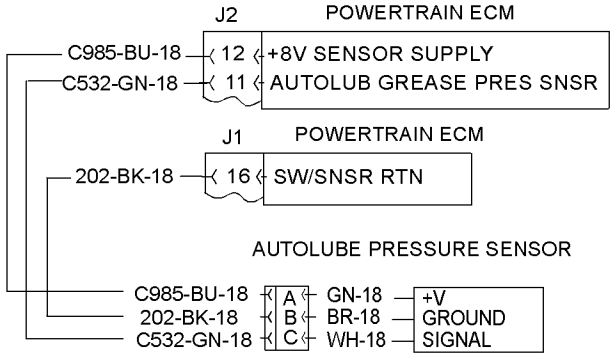


Illustration 39 g01225069

Schematic of the Machine Autolube Pressure Sensor

This diagnostic code is associated with the machine autolube pressure sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0379 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR.

A. Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

Results:

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.Proceed to Test Step 3.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  Repair: Replace the damaged part. Proceed to Test Step 2.

Test Step 2. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the calibration of the position sensor.

C. Check the status of the diagnostic code.

Expected Result:

The CID 0379 FMI 04 is not active.

Results:

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation.

  STOP.

- NOT OK – CID 0379 FMI 04 is still active. Exit the calibration procedure.Proceed to Test Step 3.

Test Step 3. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along contact A (wire C985-BU(Blue)) for the voltage supply.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A (wire C985-BU(Blue)) to contact B (wire 202-BK(Black)).

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 4.

- NOT OK – The voltage is NOT 8 DCV. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The 7X-1710 Multimeter Probe remains along contact B (wire 202-BK(Black)).

C. At the back of the harness connector for the sensor, insert the other 7X-1710 Multimeter Probe along contact C (wire C532-GN(Green)).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0379 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.

- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 5. CHECK THE SIGNAL AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J1-6 (wire C532-GN(Green)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0379 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-11 (wire C532-GN(Green)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0379 FMI 04.

Expected Result:

The CID 0379 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The CID 0379 FMI 04 is not active at the maximum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.
- NOT OK – The CID 0379 FMI 04 is active at the maximum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02457460

MID 081 - CID 0444 - FMI 03

SMCS Code: 1426-038

Conditions Which Generate This Code:

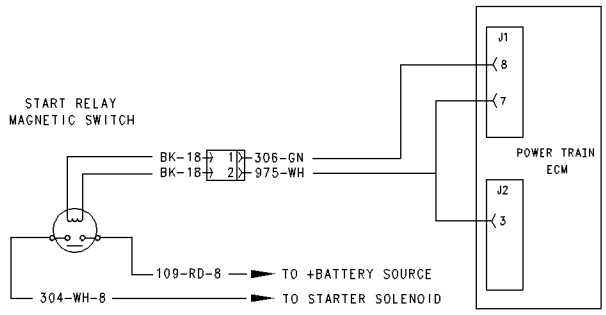


Illustration 40 g00592497

Schematic of the Starter Solenoid

This diagnostic code is associated with the Starter Solenoid. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0444 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

The shifting for the transmission is disabled.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J1-8 (wire 306-GN(Green)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-8 (306-GN(Green)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 0444 FMI 03 is active.

Expected Result:

The CID 0444 FMI 03 is active.

Results:

- YES – The CID 0444 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0444 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02457462

MID 081 - CID 0444 - FMI 05

SMCS Code: 1426-038

Conditions Which Generate This Code:

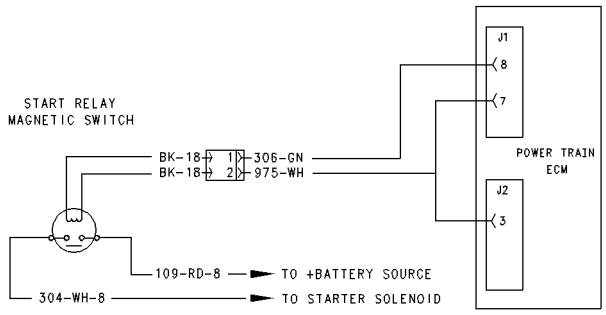


Illustration 41 g00592497

Schematic of the Starter Solenoid

This diagnostic code is associated with the Starter Solenoid. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0444 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

The engine will not start.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 306-GN(Green)) to contact 2 (wire 975-WH(White)).

D. Observe the status of the CID 0444 FMI 05.

Expected Result:

The CID 0444 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J1-8 (wire 306-GN(Green)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

Repair: The open is in wire 306-GN(Green) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0444 FMI 05.

Expected Result:

The CID 0444 FMI 05 is active.

Results:

- YES – The CID 0444 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0444 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01796490

MID 081 - CID 0444 - FMI 06

SMCS Code: 1426-038

Conditions Which Generate This Code:

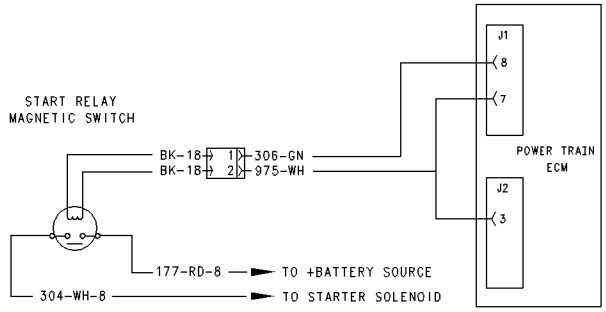


Illustration 42 g00436098

Schematic of the Start Relay

This diagnostic code is associated with the Start Relay. The FMI 06 means that the ECM has determined that the current of the relay is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the relay is shorted to ground.
- The relay has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0444 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code is active, the ECM will turn off the current to the failed relay.

Test Step 1. CHECK THE RELAY

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the relay with the active diagnostic code from the machine harness.

Expected Result:

CID 0444 FMI 06 changes to CID 0444 FMI 05 when the relay is disconnected.

Results:

- YES – CID 0444 FMI 06 changes to CID 0444 FMI 05 when the relay is disconnected. The circuit is correct.

  Repair: The relay has failed. Repeat this test "CHECK THE RELAY" in order to verify the failure of the relay. Replace the relay.

  STOP.

- NO – CID 0444 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT TO GROUND

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The relay remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-8 (wire 306-GN(Green)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-8 (wire 306-GN(Green)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0444 FMI 06.

Expected Result:

The CID 0444 FMI 06 is active.

Results:

- YES – The CID 0444 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Troubleshooting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The CID 0444 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02451340

MID 081 - CID 0562 - FMI 09

SMCS Code: 7490-038

Conditions Which Generate This Code:

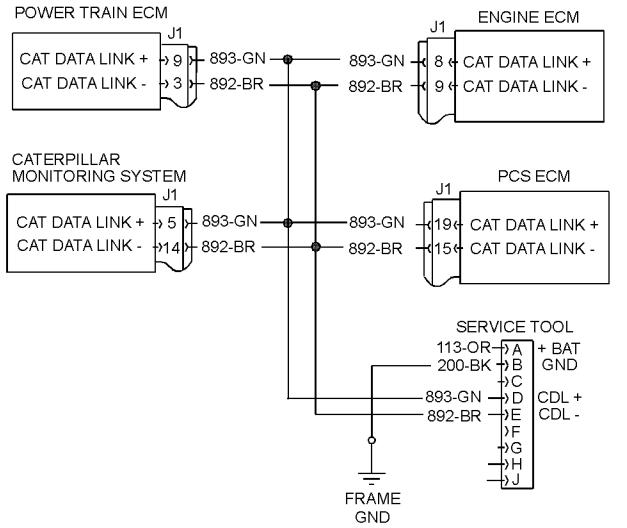


Illustration 43 g01223827

Schematic of the Cat Data Link

This diagnostic code is recorded when the Power Train ECM cannot communicate with the Caterpillar Monitoring System via the Cat Data Link. The update rate from the ECM is not correct.

The Cat Data Link is an input and an output of all modules. The Cat Data Link is designed to enable communications for all electronic control modules and service tools. The Cat Data Link is not a visible component. The data link consists of internal control circuits and the connecting harness wiring.

Test Step 1. CHECK THE COMPATIBILITY OF THE SOFTWARE.

A. Verify that the software is compatible. For the correct software part numbers, refer to the Electronics Groups in the parts manual for the machine that is being serviced.

Expected Result:

The software is compatible.

Results:

- OK – The software is compatible.Proceed to test step 2.
- NOT OK – The software is NOT compatible.

  Repair: Install the correct software. Ensure that the correct part number was used if any electronic control modules have been replaced. Continue if the conditions are not resolved.

  STOP.

Test Step 2. CHECK THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect connector J1 from the ECM.

C. Turn the disconnect switch and the key start switch to the ON position.

D. At connector J1, measure the voltage from +battery terminals to the negative battery terminals.

Expected Result:

The voltage should measure 18 to 35 DCV.

Results:

- OK – The voltage is correct. The ECM is receiving the voltage.Proceed to test step 3.
- NOT OK – The voltage does NOT measure 18 to 35 DCV.

  Repair: The ECM is NOT receiving the correct voltage. Ensure that proper ground is available. If the ground is correct, repair the power circuit. Also, check the circuit breakers.

  If conditions are not resolved proceed to test step 3.

Test Step 3. CHECK THE DATA LINK CIRCUIT FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Inspect the machine harness connectors that are related to the circuits of the Cat Data Link. Ensure that the connector contacts are clean and tight.

C. Disconnect the machine harness from all modules.

D. At the machine harness connector for the ECM, measure the resistance from contact J1-3 (wire 892-BR(Brown)) and contact J1-9 (wire 893-GN(Green)) to all possible sources of ground.

Expected Result:

The resistance should be greater than 5000 ohms for each measurement.

Results:

- OK – The resistance measurement is correct. The machine harness is correct.Proceed to test step 4.
- NOT OK – The resistance measurement is not correct.

  Repair: There is a short in the machine harness. The short is between J1-3 (wire 892-BR(Brown)) and the circuit with the low resistance measurement or the short is between J1-9 (wire 893-GN(Green)) and the circuit with the low resistance measurement. Repair the harness or replace the harness. If conditions are not resolved, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”. If the problem remains present, exit this procedure and perform this procedure again.

  STOP.

Test Step 4. CHECK THE CAT DATA LINK FOR A SHORT TO POSITIVE VOLTAGE.

A. The key start switch and the disconnect switch remain in the OFF position.

B. All modules remain disconnected from the machine harness.

C. At the machine harness connector for the power train ECM, measure the resistance from contact J1-3 and contact J1-9 to all possible sources of positive voltage.

Expected Result:

The resistance measurement should be greater than 5000 ohms for each measurement.

Results:

- OK – The resistance is correct. The machine harness is correct.Proceed to test step 5 .
- NOT OK – The resistance is not correct.

  Repair: There is a short in the machine harness. The short is between connector contact J1-3 and the circuit with the low resistance measurement or the short is between connector contact J1-9 and the circuit with the low resistance measurement. Repair the harness or replace the harness. If conditions are not resolved replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

Test Step 5. CHECK THE CAT DATA LINK FOR AN OPEN CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. At the power train ECM, measure the resistance from contact J1-3 (wire 892-BR(Brown)) to the corresponding contact J1-14 (wire 892-BR(Brown)) of the Caterpillar Monitoring System.

C. At the power train ECM, measure the resistance from connector contact J1-9 (wire 893-GN(Green)) to the corresponding connector contact J1-5 (wire 893-GN(Green)) of the Caterpillar Monitoring System.

Expected Result:

There should be less than 5 ohms resistance for each measurement.

Results:

- OK – The Cat Data Link circuit in the machine harness is correct.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this diagnostic code procedure again. If the cause of the problem is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NOT OK – There is an open in the harness.

  Repair: The open is in wire (892-BR(Brown)) or wire (893-GN(Green)) of the Cat Data Link. Repair the harness or replace the harness.

  STOP.

i02451343

MID 081 - CID 0562 - FMI 12

SMCS Code: 7490-038

Conditions Which Generate This Code:

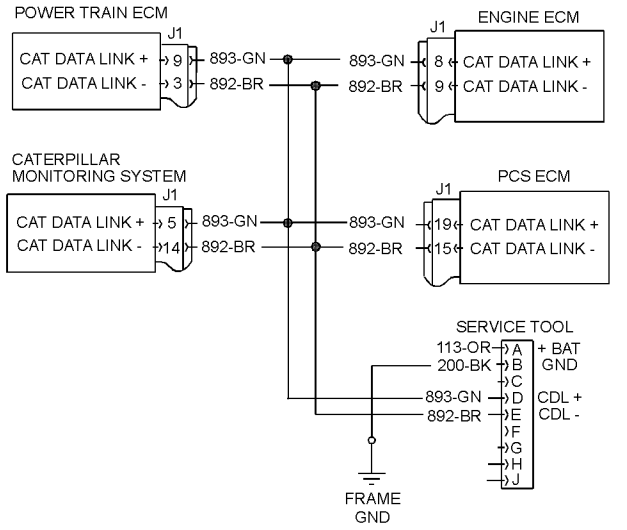


Illustration 44 g01223827

Schematic of the Cat Data Link

This diagnostic code is recorded when the Power Train ECM can not communicate properly with the Caterpillar Monitoring System ECM. The Caterpillar Monitoring System ECM and the power train ECM communicate via the Cat Data Link.

The possible causes for this diagnostic code are listed:

- The Caterpillar Monitoring System ECM or the Power Train ECM have incorrect software or hardware installed.

VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS

A. Verify that the following information is correct:

- The part number of the flash software for the Caterpillar Monitoring System ECM
- The part number of the flash software for the Power Train ECM
- The part number of the Caterpillar Monitoring System ECM
- The part number of the Power Train ECM

Note: Consult your Caterpillar Dealer for the correct part numbers of the flash software.

Expected Result:

All of the part numbers are correct.

Results:

- OK – All of the part numbers are correct. The CID 0562 FMI 12 is active. The problem has not been corrected. The ECM may have corrupted software.

  Repair: Reflash the ECM with the correct software. See the Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program” section for additional information.

  STOP.

- NOT OK – All of the part numbers are not correct.

  Repair: The installed Caterpillar Monitoring System ECM or the power train ECM have the wrong part number or the incorrect flash software is installed. Replace the incorrect Caterpillar Monitoring System ECM or the power train ECM with a module that has the correct part number. Flash the correct software. See the Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program” section for additional information.

  STOP.

i02456854

MID 081 - CID 0590 - FMI 09

SMCS Code: 1901-038

Conditions Which Generate This Code:

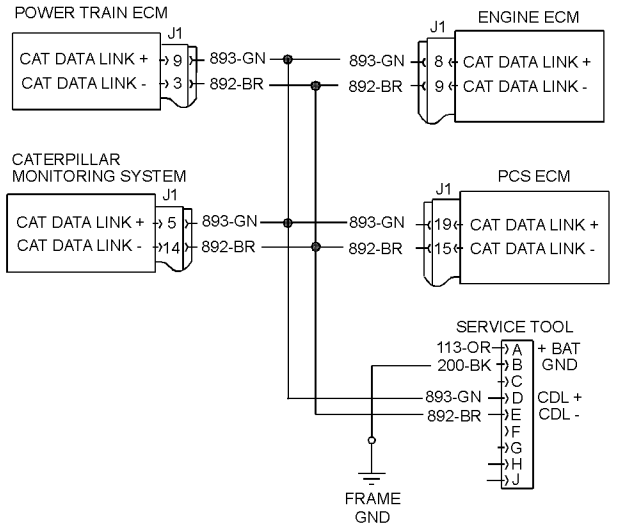


Illustration 45 g01223827

Schematic of the Cat Data Link

This diagnostic code is recorded when the Caterpillar Monitoring System (CMS) does not receive expected information from the Power Train ECM for a period of more than five seconds.

System Response:

This failure results in events that are logged against an ECM that can not be explained directly. The CMS cannot communicate with this ECM or the ECM appears to communicate intermittently.

Test Step 1. VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS.

A. Verify that the following information is correct:

- The part number of the flash software for the CMS
- The part number of the flash software for the Power Train ECM
- The part number of the CMS
- The part number of the Power Train ECM

Note: Consult your Caterpillar Dealer for the correct part numbers of the flash software.

Expected Result:

All of the part numbers are correct.

Results:

- OK – All of the part numbers are correct.Proceed to Test Step 2.
- NOT OK – All of the part numbers are not correct.

  Repair: The installed CMS or the Power Train ECM have the wrong part number or the incorrect flash software is installed. Replace the incorrect CMS or the Power Train ECM with a module that has the correct part number. Flash the correct software. See the Testing and Adjusting, “Electronic Control Module (ECM)-Flash Programming” section for additional information.

  STOP.

Test Step 2. INSPECT THE HARNESS CONNECTIONS.

A. Turn the disconnect switch to the OFF position.

B. Inspect all harness connections that are related to the Cat Data Link. Make sure that the connectors are clean and tight.

C. Check the connectors for proper mating. Ensure that all the seals are present and in place.

D. Check the harness for signs of damage or abrasion.

E. Check the wires at the connector. Ensure that the wires are secured tightly into the connector. **Take care not to pull the wire out of the connector.**

F. Check the exposed wires at the connectors for nicks or signs of abrasion.

G. Check for moisture inside the connector.

H. Check the connectors for dirty contacts or corroded contacts.

I. Check each pin and each socket of the machine harness connectors. Ensure that the contacts are properly installed. The contacts should mate correctly when the two pieces of the connector are placed together.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and free of corrosion.Proceed to Test Step 3.

- NOT OK – The machine harness connectors are in need of repair.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR SHORTS TO GROUND

A. The disconnect switch remains in the OFF position.

B. Disconnect the machine harness connectors from all electronic control modules that use the Cat Data Link.

C. At the machine harness for the CMS, measure the resistance between frame ground and connector contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit .

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct.Proceed to Test Step 4.

- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  Repair: There is a short between frame ground and contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK FOR SHORT TO THE +BATTERY CIRCUIT

A. The disconnect switch remains in the OFF position.

B. All related electronic control modules remain disconnected from the machine harness.

C. At the machine harness connector for the CMS, perform the checks that are listed here:

- Measure the resistance between the connector contact J1-1 (wire 113-OR(Orange)) and connector contact J1-9 (wire 893-GN(Green)).
- Measure the resistance between connector contact J1-1 (wire 113-OR(Orange)) and connector contact J1-3 (wire 892-BR(Brown)).

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The harness circuit resistance is correct. Proceed to Test Step 5.

- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  Repair: There is a short between the +battery circuit and contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK FOR OPEN HARNESS

A. The disconnect switch remains in the OFF position.

B. All related electronic control modules remain disconnected from the machine harness.

C. Check the resistance of the Cat Data Link circuit in the machine harness:

- Measure the resistance between connector contact J1-9 (wire 893-GN(Green)) of the CMS and connector contact J1-9 (wire 893-GN(Green)) of the Power Train ECM.
- Measure the resistance between connector contact J1-3 (wire 892-BR(Brown)) of the CMS and connector contact J1-3 (wire 892-BR(Brown)) of the Power Train ECM.

Expected Result:

The resistance measures less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The Cat Data Link circuit in the machine harness is correct. Proceed to Test Step 6.

- NOT OK – The resistance is greater than 5 ohms. The machine harness has failed.

Repair: The Cat Data Link circuit is open in the machine harness. Repair the machine harness or replace the machine harness.

STOP.

Test Step 6. CHECK FOR ADDITIONAL DIAGNOSTIC CODES FOR THE OTHER ELECTRONIC CONTROL MODULES.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. One at a time, reconnect the electronic control modules that use the Cat Data Link.

C. Turn the disconnect switch and the key start switch to the ON position.

D. After each of the electronic control modules has been reconnected, check for diagnostic codes that are logged against that electronic control module.

Expected Result:

Diagnostic codes are not present for the other electronic control modules.

Results:

- OK – Diagnostic codes are not present for the other electronic control modules. The Power Train ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the failure is not found, replace the ECM.

  STOP.

- NOT OK – Diagnostic codes are present for the other electronic control modules. The CMS has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform this procedure again. If the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module - Replace” section.

  STOP.

i02451344

MID 081 - CID 0603 - FMI 03

SMCS Code: 1439-038-VC

Conditions Which Generate This Code:

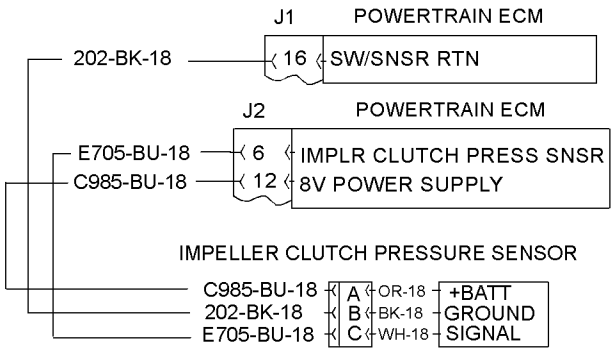


Illustration 46 g01223861

Schematic of the Torque Converter Impeller Clutch Pressure Sensor

This diagnostic code is associated with the Impeller Clutch Pressure Sensor. The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0603 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along contact A (wire C985-BU(Blue)) for the voltage supply.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A (wire C985-BU(Blue)) to contact B (wire 202-BK(Black)).

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 8 DCV. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE SENSOR.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. At the back of the harness connector for the sensor, remove the 7X-1710 Multimeter Probe from contact A and insert the probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert the 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-6 (wire E705-BU(Blue)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-6 (wire E705-BU(Blue)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The circuit is correct.Proceed to Test Step 5.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0603 FMI 03.

Expected Result:

The CID 0603 FMI 03 is not active.

Results:

- OK – The CID 0603 FMI 03 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.

- NOT OK – The CID 0603 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02451346

MID 081 - CID 0603 - FMI 04

SMCS Code: 1439-038-VC

Conditions Which Generate This Code:

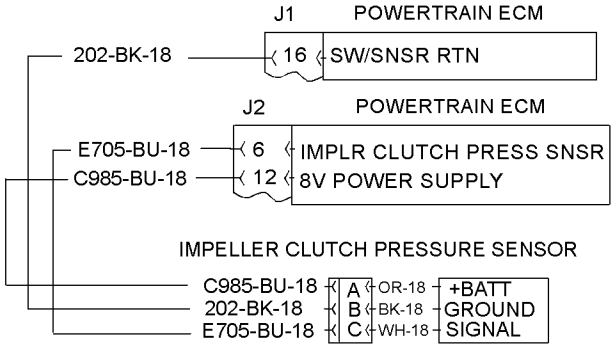


Illustration 47 g01223861

Schematic of the Torque Converter Impeller Clutch Pressure Sensor

This diagnostic code is associated with the Impeller Clutch Pressure Sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0603 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR.

A. Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

Results:

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.Proceed to Test Step 3.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  Repair: Replace the damaged part.
  Proceed to Test Step 2.

Test Step 2. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the calibration of the position sensor.

C. Check the status of the diagnostic code.

Expected Result:

The CID 0603 FMI 04 is not active.

Results:

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation.

  STOP.
- NOT OK – CID 0603 FMI 04 is still active. Exit the calibration procedure.Proceed to Test Step 3.

Test Step 3. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along contact A (wire C985-BU(Blue)) for the voltage supply.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A (wire C985-BU(Blue)) to contact B (wire 202-BK(Black)).

Expected Result:

The voltage is 8 volt.

Results:

- OK – The voltage is 8 volt. Proceed to Test Step 4.
- NOT OK – The voltage is NOT 8 volts. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The 7X-1710 Multimeter Probe remains along contact B (wire 202-BK(Black)).

C. At the back of the harness connector for the sensor, insert the other 7X-1710 Multimeter Probe along contact C (wire E705-BU(Blue)).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0603 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 5. CHECK THE SIGNAL AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-6 (wire E705-BU(Blue)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0603 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-6 (wire E705-BU(Blue)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0603 FMI 04.

Expected Result:

The CID 0603 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The CID 0603 FMI 04 is not active at the maximum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.

- NOT OK – The CID 0603 FMI 04 is active at the maximum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i01664572

MID 081 - CID 0623 - FMI 03

SMCS Code: 3171-038

Conditions Which Generate This Code:

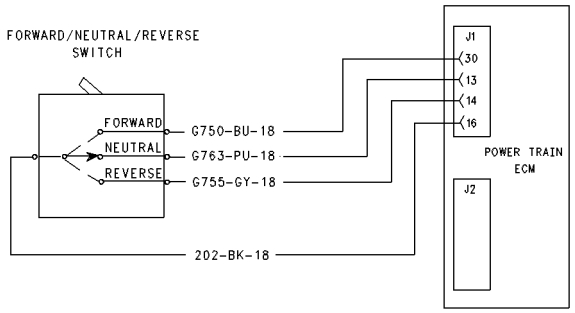


Illustration 48 g00438565

Schematic of the Directional Switch

The transmission direction switch has three inputs to the power train electronic control module (ECM). During normal operation, two of the inputs are open and the other input is grounded. This diagnostic code is detected when all of the inputs are open or shorted to the +battery. Before you perform this procedure use table 11 in order to determine the connector and the contacts that correspond to the faulty circuit. The fault is set in 30 seconds and the fault is cleared in one second.

Table 11

Status of Direction Switch			
Switch Position	**G755-GY (Grey) Circuit R Switch J1-14**	**G763-PU(Purple) Circuit N Switch J1-13**	**G750-BU (Blue) Circuit F Switch J1-30**
R	Closed	Open	Open
N	Open	Closed	Open
F	Open	Open	Closed

Note: Ensure that the desired fault is active.

Note: The following procedure can create other faults that may be detected by the power train ECM. Ignore these created faults and clear the created faults when the diagnostic code is corrected.

Possible causes of the diagnostic code are listed:

- There is a harness fault.
- There is a failed switch.

System Response:

The machine response is listed:

- The transmission will lock in neutral until a valid neutral switch position is sensed.

Test Step 1. CHECK FOR AN OPEN CIRCUIT.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Disconnect the machine harness connector J1 from the power train ECM.

C. At the machine harness connector for the power train ECM, check the continuity to ground of the switch contacts for the transmission direction switch that is activated and for the switch that is not activated. Refer to table 11 for the correct status of the transmission direction switch.

Expected Result:

The continuity check does NOT agree with table 11 .

Results:

- YES – The continuity check does NOT agree with the previous table. The harness or the transmission direction switch is faulty.Proceed to Test Step 2.
- NO – The continuity check agrees with the previous table. Proceed to Test Step 3.

Test Step 2. CHECK THE TRANSMISSION DIRECTION SWITCH.

A. Disconnect the machine harness from the transmission direction switch.

B. Check the continuity to ground of the switch contacts for the transmission direction switch that is activated and switch that is not activated. Refer to table 11 for the correct status of the transmission direction switch.

Expected Result:

The continuity check does NOT agree with table 11 .

Results:

- YES – The continuity check does NOT agree with the previous table. The transmission direction switch is faulty.

  Repair: Repair the switch or replace the switch.

STOP.

- NO – The continuity check agrees with the previous table.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR A SHORT TO THE +BATTERY.

A. At the machine harness connector J1 for the power train ECM, check the continuity between the wire for the switch contact and the following contacts: J1-1, J1-6, J1-40 and J2-12.

Expected Result:

Continuity exists between one of the sources of the battery voltage and the switch circuit.

Results:

- YES – Continuity exists between one of the sources of battery voltage. The machine harness is faulty.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

- NO – Continuity does not exist between one of the sources of battery voltage and the switch circuit. The machine harness is correct. It is unlikely that the power train ECM is faulty.

  Repair: If the cause is not found, replace the power train ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace” for more information on replacing the power train ECM.

  STOP.

i01665151

MID 081 - CID 0623 - FMI 04

SMCS Code: 3171-038

Conditions Which Generate This Code:

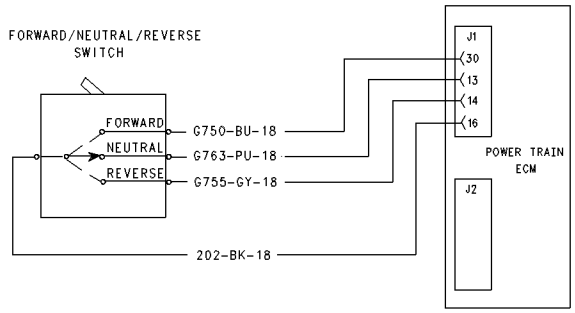


Illustration 49 g00438565

Schematic of the Directional Switch

This diagnostic code is associated with the Directional Switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation.

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Table 12

Status of Direction Switch			
Switch Position	**G755-GY (Grey) Circuit R Switch J1-14**	**G763-PU(Purple) Circuit N Switch J1-13**	**G763-PU(Purple) Circuit N Switch J1-13**
R	Closed	Open	Open
N	Open	Closed	Open
F	Open	Open	Closed

Possible causes of the diagnostic code are listed:

- There is a harness fault.
- There is a failed switch.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.**Ensure that the diagnostic code of CID 0623 FMI 04 is active before performing this procedure.**

System Response:

The transmission will lock in neutral until a valid switch position is sensed.

Test Step 1. CHECK FOR AN OPEN CIRCUIT.

A. Ensure that the fault is active.

B. Disconnect the connector of the transmission direction switch from the machine harness.

Expected Result:

The active fault changes from “04” to “03” .

Results:

- YES – The transmission direction switch or the switch harness is failed. Repeat Test Step 1 in order to verify the failure of the transmission direction switch.

  Repair: Repair the switch or replace the switch or the switch harness.

  STOP.

- NO – The fault present indicator remains ON. The transmission direction switch is not the cause of this fault.Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS CIRCUIT.

This test checks the continuity of the entire harness circuit that is faulty. The transmission direction switch which was previously checked in Test Step 1 is included in this test.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Connect the transmission direction switch to the machine harness.

C. Disconnect the machine harness connector J1 from the power train ECM.

D. At the machine harness connector for the power train ECM, check the continuity to ground of the switch contacts for the transmission direction switch that is activated and switch that is not activated. Refer to table 12 for the correct switch status.

Expected Result:

The continuity check does NOT agree with table 12 .

Results:

- YES – The continuity check does NOT agree with the previous table. The harness circuit is faulty. There is a short to ground in the machine harness between the power train ECM and the transmission direction switch.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

- NO – The continuity check agrees with the previous table. The harness circuit is correct. It is unlikely that the power train ECM is faulty. Exit this procedure and perform the diagnostic code again.

  Repair: If the cause is not found, replace the power train ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace” for more information on replacing the power train ECM.

  STOP.

i01664681

MID 081 - CID 0626 - FMI 03

SMCS Code: 1435-038-LX

Conditions Which Generate This Code:

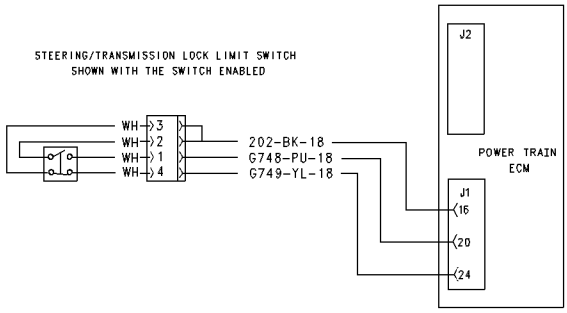


Illustration 50 g00593653

Schematic of the Steering / Transmission Switch

This diagnostic code is associated with the Steering / transmission Switch. The switch is connected to two inputs of the ECM. One contact is open and the other contact is grounded during proper operation. Refer to table 13 .

Table 13

Status of Steering and Transmission Lock Switch		
Steering and Transmission Lock Switch	**(N/O) J1-20**	**(N/C) J1-24**
Locked	Closed	Open
Unlocked	Open	Closed

This FMI 03 means that the ECM has determined that the normally open contact and the normally closed contact are open.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0626 FMI 03 is active before performing this procedure.**

System Response:

When this diagnostic code occurs, there is no change in the system operation.

Test Step 1. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE HARNESS.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. Measure the resistance between contact J1-16 (wire 202-BK(Black)) of the machine harness for the ECM and contact 2 (wire 202-BK(Black)) at the switch.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The circuit is correct.Proceed to Test Step 2.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SWITCH CIRCUITS FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The machine harness connector(s) remains disconnected from the ECM.

B. The disconnect switch and the key start switch remain in the OFF position.

C. Disconnect contact 1 (wire G748-PU(Purple)) and contact 4 (wire G749-YL(Yellow)) from the connector of the switch.

D. At the machine harness connector for the ECM, measure the resistance from contact 1 (wire G748 J1-20-PU(Purple)) and contact Contact 4 (wire G749-YL(Yellow)) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct.Proceed to Test Step 3.
- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

  Repair: The short is between wire G748-PU(Purple) and the circuit with the lowest resistance measurement or the short is between wire G749-YL(Yellow) and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

A. The machine harness remains disconnected from the ECM and the switch.

B. At the harness connector for the switch, connect a jumper wire between contact 1 (wire G748-PU(Purple)) and contact 4 (wire G749-YL(Yellow)).

C. At the harness connector for the ECM, measure the resistance from contact J1-20 (wire G748-PU(Purple)) to contact J1-24 (wire G749-YL(Yellow)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH.

A. Remove the jumper that was installed in the previous Test Step.

B. The machine harness remains disconnected from the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 1 (wire G748-PU(Purple)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G748-PU(Purple)). Note the resistance.

F. Disconnect the lead from contact 1 (wire G748-PU(Purple)) and connect the lead to contact 4 (wire G749-YL(Yellow)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact Contact 4 (wire G749-YL(Yellow)).

Expected Result:

The resistance from contact 2 to contact 4 is less than 5 ohms, and the resistance from contact 2 to contact 1 is greater than 5000 ohms.

Results:

- YES – The resistance from contact 2 to contact 2 is less than 5 ohms, and the resistance from contact 2 to contact 1 is greater than 5000 ohms. The switch is operating correctly.Proceed to Test Step 5.

- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 1 (wire G748-PU(Purple)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G748-PU(Purple)). Note the resistance.

F. Disconnect the lead from contact 1 (wire G748-PU(Purple)) and connect the lead to contact 4 (wire G749-YL(Yellow)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G749-YL(Yellow)). Note the resistance.

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G748-PU(Purple)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 4 (wire G749-YL(Yellow)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- YES – The resistance from contact 2 to contact 1 is less than 5 ohms, and the resistance from contact 2 and contact 4 is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 6.

- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all the harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0626 FMI 03.

Expected Result:

The CID 0626 FMI 03 is active.

Results:

- YES – The CID 0626 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0626 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01665205

MID 081 - CID 0626 - FMI 04

SMCS Code: 1435-038-LX

Conditions Which Generate This Code:

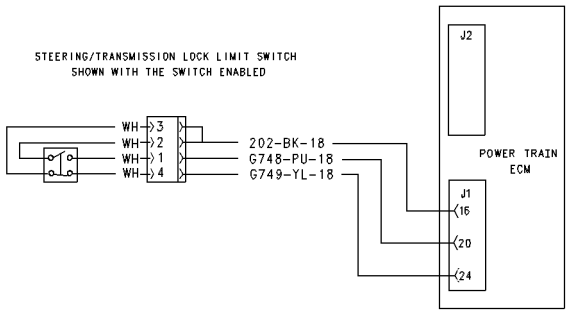


Illustration 51 g00593653

Schematic of the Steering / Transmission Lock Switch

This diagnostic code is associated with the Steering / Transmission Lock Switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation.

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.**Ensure that the diagnostic code of CID 0626 FMI 04 is active before performing this procedure.**

System Response:

When this diagnostic code occurs, there is no change in the system operation.

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch and the disconnect switch to the ON position.

Expected Result:

The CID 0626 FMI 04 has been replaced by CID 0626 FMI 03.

Results:

- OK – The CID 0626 FMI 04 has been replaced by CID 0626 FMI 03. The machine harness and the ECM are correct.Proceed to Test Step 3.

- NOT OK – The CID 0626 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-20 (wire G748-PU(Purple)) and J1-24 (wire G749-YL(Yellow)) of the machine harness to all the contacts that are used in machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-20 (wire G748-PU(Purple)) and the circuit with the lowest resistance or the short is between J1-24 (wire G749-YL(Yellow)) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact2 (wire 202-BK(Black)) of the harness connector for the switch.

C. Connect the other lead from a multimeter to contact 1 (wire G748-PU(Purple)) of the harness connector for the switch.

D. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G748-PU(Purple)) . Note the resistance.

E. Disconnect the lead from contact 1 (wire G748-PU(Purple)) and connect the lead to contact 4 (wire G749-YL(Yellow)) .

F. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G749-YL(Yellow)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G749-YL(Yellow)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G748-PU(Purple)) is greater than 5000 ohms.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 4 (wire G749-YL(Yellow)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G748-PU(Purple)) is greater than 5000 ohms.Proceed to Test Step 4.

- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 1 (wire G748-PU(Purple)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G748-PU(Purple)). Note the resistance.

F. Disconnect the lead from contact 1 (wire G748-PU(Purple)) and connect the lead to contact 4 (wire G749-YL(Yellow)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 4 (wire G749-YL(Yellow)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G748-PU(Purple)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 4 (wire G749-YL(Yellow)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G748-PU(Purple)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 4 (wire G749-YL(Yellow)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly. Proceed to Test Step 5.

- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0626 FMI 04 is present.

Expected Result:

The CID 0626 FMI 04 is active.

Results:

- YES – The CID 0626 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0626 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02451347

MID 081 - CID 0627 - FMI 03

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

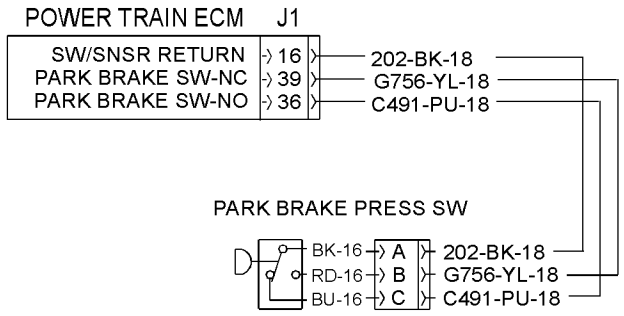


Illustration 52 g01223967

Schematic of the Parking Brake Pressure Switch

This diagnostic code is associated with the parking brake pressure switch. The switch is connected to two inputs of the ECM. One contact is open and the other contact is grounded during proper operation.

This FMI 03 means that the ECM has determined that the normally open contact and the normally closed contact are open.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0627 FMI 03 is active before performing this procedure.**

Test Step 1. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact A of the harness connector on the switch.

C. Connect the other lead from a multimeter to contact B of the harness connector on the switch.

D. Measure the resistance between contact A and contact B . Note the resistance.

E. Disconnect the lead from contact B and connect the lead to contact C.

F. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is greater than 5 ohms, and the resistance from contact A to contact C is less than 5 ohms.

Results:

- YES – The resistance from contact A to contact B is greater than 5 ohms, and the resistance from contact A to contact C is less than 5 ohms. Proceed to Test Step 2.
- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 2. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Activate the switch by starting the engine and disengaging the park brake.

C. Connect one lead from a multimeter to contact A of the harness connector on the switch.

D. Connect the other lead from a multimeter to contact B of the harness connector on the switch.

E. Measure the resistance between contact A and contact B. Note the resistance.

F. Disconnect the lead from contact B and connect the lead to contact C.

G. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A to contact C is greater than 5 ohms.

Results:

- YES – The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A and contact C is greater than 5 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 3.
- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE HARNESS

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector from the pressure switch.

C. Measure the resistance between frame ground of the machine and contact A (wire 202-BK(Black)) of the machine harness connector for the pressure switch.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-36 (wire C491-PU(Purple)) and J1-39 (wire G756-YL(Yellow)) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5 ohms.

Results:

- YES – Each resistance measurement is greater than 5 ohms.Proceed to Test Step 5.
- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-36 (wire C491-PU(Purple)) and the circuit with the lowest resistance or the short is between J1-39 (wire G756-YL(Yellow)) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 5. CHECK THE SWITCH CIRCUITS IN THE HARNESS

A. The machine harness remains disconnected from the ECM and the switch.

B. At the harness connector for the switch, connect a jumper wire between contact C (wire C491-PU(Purple)) and contact B (wire G756-YL(Yellow)).

C. At the harness connector for the ECM, measure the resistance from contact J1-36 (wire 419-YL(Yellow)) to contact J1-39 (wire G756-YL(Yellow)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.Proceed to Test Step 6.
- NOT OK – The resistance is greater than 5 ohms. The circuit is open.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0627 FMI 03 is present.

Expected Result:

The CID 0627 FMI 03 is active.

Results:

- YES – The CID 0627 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. SeeTesting and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0627 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02451348

MID 081 - CID 0627 - FMI 04

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

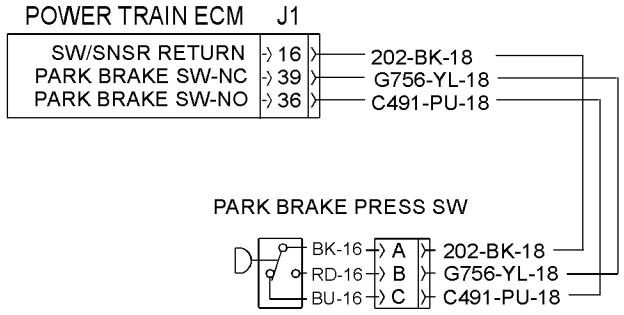


Illustration 53 g01223967

Schematic of the Park Brake Pressure Switch

This diagnostic code is associated with the parking brake pressure switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation.

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0627 FMI 04 is active before performing this procedure.**

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch and the disconnect switch to the ON position.

Expected Result:

The CID 0627 FMI 04 has been replaced by CID 0627 FMI 03.

Results:

- OK – The CID 0627 FMI 04 has been replaced by CID 0627 FMI 03. The machine harness and the ECM are correct.Proceed to Test Step 3.
- NOT OK – The CID 0627 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-36 (wire C491-PU(Purple)) and J1-39 (wire G756-YL(Yellow)) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms.Proceed to Test Step 3.
- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-36 (wire C491-PU(Purple)) and the circuit with the lowest resistance or the short is between J1-39 (wire G756-YL(Yellow)) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact A of the harness connector on the switch.

C. Connect the other lead from a multimeter to contact B of the harness connector on the switch.

D. Measure the resistance between contact A and contact B . Note the resistance.

E. Disconnect the lead from contact B and connect the lead to contact C.

F. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact C is less than 5 ohms, and the resistance from contact (A) to contact B is greater than 5000 ohms.

Results:

- YES – The resistance from contact A to contact C is less than 5 ohms, and the resistance from contact A to contact B is greater than 5000 ohms. Proceed to Test Step 4.
- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Activate the switch.

C. Connect one lead from a multimeter to contact A (wire 202-BK(Black)) of the harness connector on the switch.

D. Connect the other lead from a multimeter to contact C (wire C491-PU(Purple)) of the harness connector on the switch.

E. Measure the resistance between contact A and contact B. Note the resistance.

F. Disconnect the lead from contact B and connect the lead to contact C.

G. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A to contact C is greater than 5000 ohms.

Results:

- YES – The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A and contact C is greater than 5 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 5.
- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0627 FMI 04 is present.

Expected Result:

The CID 0627 FMI 04 is active.

Results:

- YES – The CID 0627 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0627 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02451349

MID 081 - CID 0628 - FMI 03

SMCS Code: 7332-038-Q9

Conditions Which Generate This Code:

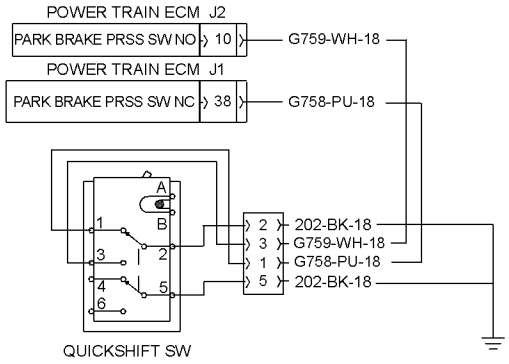


Illustration 54 g01224013

Schematic of the Quickshift Switch

This diagnostic code is associated with the quickshift switch. The switch is connected to two inputs of the ECM.

The possible causes of this diagnostic code are listed below:

- The harness connector is dirty or loose.
- The machine harness has failed.
- The switch has failed.
- The ECM has failed. This is unlikely.

Table 14

Status of the Quickshift Switch		
Quickshift Switch	**Terminal 1 (N/C) Wire G758-PU(Purple) J1-38**	**Terminal 3 (N/O) G759-WH(White) J2-10**
OFF	Closed	Open
ON	Open	Closed

This FMI 03 means that the ECM has determined that both contacts are open.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0628 FMI 03 is active before performing this procedure.**

Test Step 1. INSPECT THE HARNESS CONNECTIONS.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Inspect all harness connections that are associated with the Quickshift Switch. Make sure that the connectors are clean and tight.

C. Check the connectors for proper mating.

D. Check the wires at the connectors.

E. Check each wire for nicks or signs of abrasion in the insulation.

F. Check for moisture at the connectors.

G. Check the connectors for dirty contacts or corroded contacts.

H. Check each pin and each socket of the machine harness connectors.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and free of corrosion.Proceed to test step 2.
- NOT OK – The machine harness connectors are in need of repair.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SWITCH CIRCUITS IN THE HARNESS

A. The disconnect switch and the key start switch remain in the OFF position.

B. Disconnect the machine harness connectors from the ECM and the switch.

C. At the harness connector for the switch, connect a jumper wire between contact 1 (wire G758-PU(Purple)) and contact 3 (wire G759-WH(White)).

D. At the harness connector for the ECM, measure the resistance from contact J2-10 (wire G759-WH(White)) to contact J1-38 (wire G758-PU(Purple)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH

A. The disconnect switch and the key start switch remain in the OFF position.

B. The machine harness connectors remain disconnected from the ECM and the switch.

C. Remove the jumper that was installed in the previous Test Step.

D. Measure the resistance between contact 2 (wire 202-BK(Black)) of the machine harness for the switch to frame ground. Note the resistance.

E. Measure the resistance between contact 5 (wire 202-BK(Black)) of the machine harness for the switch to frame ground. Note the resistance.

Expected Result:

The resistance for each measurement is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. Each circuit is correct.Proceed to Test Step 4.
- NOT OK – A resistance measurement is 5000 ohms or greater. The circuitwith the 5000 ohms or greater measurement is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The disconnect switch and the key start switch remain in the OFF position.

B. The machine harness connectors remain disconnected from the ECM and the switch.

C. Check the continuity to ground of the open contacts and the grounded contacts for each position of the switch. Activate and deactivate each position of the switch.

Expected Result:

The continuity checks do not agree with the ground and open combinations.

Results:

- YES – The continuity checks do not agree with the ground and open combinations. The transmission auto/manual switch is faulty.

  Repair: Repair the switch or replace the switch.

  STOP.

- NO – The continuity checks agree with the ground and open combinations.Proceed to Test Step 5.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all the harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0628 FMI 03.

Expected Result:

The CID 0628 FMI 03 is active.

Results:

- YES – The CID 0628 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0628 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02451350

MID 081 - CID 0628 - FMI 04

SMCS Code: 7332-038-Q9

Conditions Which Generate This Code:

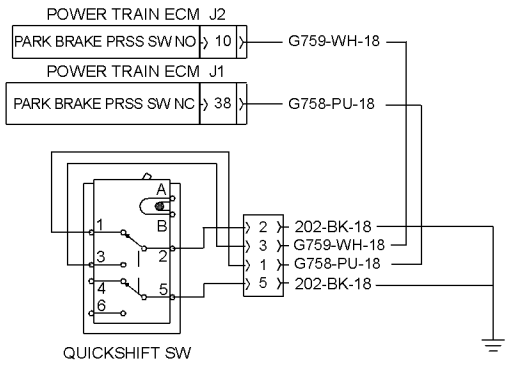


Illustration 55 g01224013

Schematic of the Quickshift Switch

This diagnostic code is associated with the quickshift switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation. Refer to table 15 .

Table 15

Status of the Quickshift Switch		
Quickshift Switch	**Terminal 1 (N/C) Wire G758-PU(Purple) J1-38**	**Terminal 3 (N/O) G759-WH(White) J2-10**
OFF	Closed	Open
ON	Open	Closed

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.**Ensure that the diagnostic code of CID 0628 FMI 04 is active before performing this procedure.**

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch and the disconnect switch to the ON position.

Expected Result:

The CID 0628 FMI 04 has been replaced by CID 0628 FMI 03.

Results:

- OK – The CID 0628 FMI 04 has been replaced by CID 0367 FMI 03. The machine harness and the ECM are correct.Proceed to Test Step 3.
- NOT OK – The CID 0628 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J2-10 (wire G759-WH(White)) and J1-38 (wire G758-PU(Purple)) of the machine harness to all the contacts that are used in machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J2-10 (wire G759-WH(White)) and the circuit with the lowest resistance or the short is between J1-38 (wire G758-PU(Purple)) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

C. Connect the other lead from a multimeter to contact 1 (wire G758-PU(Purple)) of the harness connector for the switch.

D. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 3 (wire G759-WH(White)). Note the resistance.

E. Disconnect the lead from contact 3 (wire G759-WH(White)) and connect the lead to contact 1 (wire G758-PU(Purple)).

F. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G758-PU(Purple)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G758-PU(Purple)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 3 (wire G759-WH(White)) is greater than 5000 ohms.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 1 (wire G758-PU(Purple)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) to contact 3 (wire G759-WH(White)) is greater than 5000 ohms.Proceed to Test Step 4.
- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 202-BK(Black)) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 3 (wire G759-WH(White)) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G759-WH(White)). Note the resistance.

F. Disconnect the lead from contact 3 (wire G759-WH(White)) and connect the lead to contact 1 (wire G738-PU(Purple)).

G. Measure the resistance between contact 2 (wire 202-BK(Black)) and contact 1 (wire G758-PU(Purple)).

Expected Result:

The resistance from contact 2 (wire 202-BK(Black)) to contact 3 (wire G759-WH(White)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 1 (wire G758-PU(Purple)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- YES – The resistance from contact 2 (wire 202-BK(Black)) to contact 3 (wire G759-WH(White)) is less than 5 ohms, and the resistance from contact 2 (wire 202-BK(Black)) and contact 1 (wire G758-PU(Purple)) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly. Proceed to Test Step 5.
- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0628 FMI 04 is present.

Expected Result:

The CID 0628 FMI 04 is active.

Results:

- YES – The CID 0628 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0628 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02452048

MID 081 - CID 0650 - FMI 02

SMCS Code: 1408-038

Conditions Which Generate This Code:

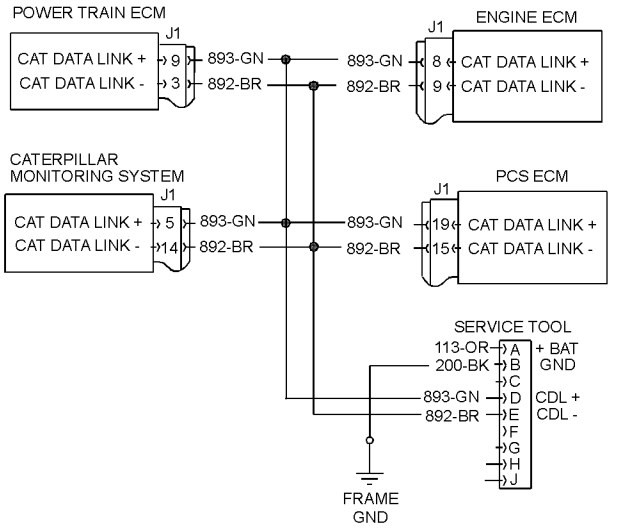


Illustration 56 g01223827

Schematic for the Cat Data Link

This diagnostic code will be recorded if the power train ECM has received no valid harness code from the Caterpillar Monitoring System. The diagnostic code is transmitted on the Cat Data Link (wires 892-BR(Brown) and 893-GN(Green)).

Note: Ensure that the diagnostic code is active and that the diagnostic code indicator is active.

Test Step 1. CHECK THE HARNESS CODE

A. Turn the key start switch to the OFF position.

B. Disconnect the machine harness from the control module.

C. Measure the continuity from contact 3 to frame ground. Measure the continuity from contact 9 to frame ground.

Expected Result:

There is NOT continuity.

Results:

- YES – There is NOT continuity. The circuitry for the harness has failed.

  Repair: Repair the harness or replace the harness. Clear the diagnostic code.

  STOP.

- NO – There is continuity. The circuitry for the harness is functioning correctly.

  Repair: The power train ECM may have failed. This is unlikely.
  Proceed to Test Step 2.

Test Step 2. VERIFY THAT THE POWER TRAIN ECM HAS FAILED

A. Connect the machine harness to the control module.

B. Turn the key start switch to the ON position.

C. Verify that the diagnostic code is present. Verify that the diagnostic code is active.

D. Turn the key start switch to the OFF position.

E. Turn the key start switch to the ON position.

F. Verify that the diagnostic code is present. Verify that the diagnostic code is active.

Expected Result:

The diagnostic code is active.

Results:

- YES – The diagnostic code is active. The power train ECM has failed.

  Repair: It is unlikely that the power train ECM has failed. Exit this test procedure and perform this test procedure again. If the cause of the problem is not found, replace the power train ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The diagnostic code is not active.

Repair: Clear the diagnostic code. Watch for a recurrence of this diagnostic code.

STOP.

i02457493

MID 081 - CID 0650 - FMI 09

SMCS Code: 1408-038

Conditions Which Generate This Code:

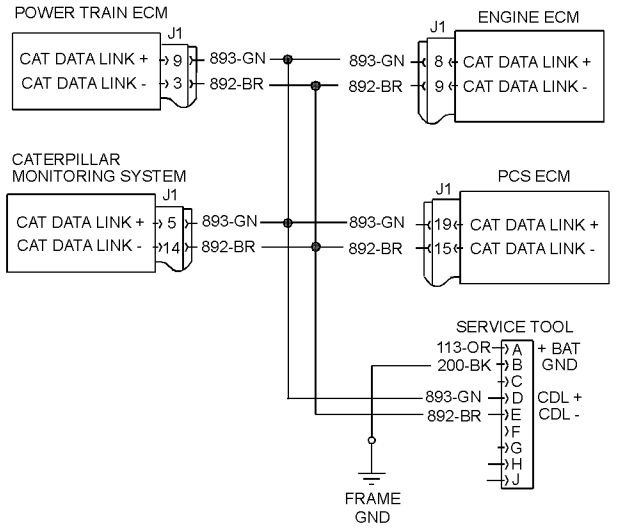


Illustration 57 g01223827

Schematic of the Cat Data Link

This diagnostic code is recorded when the Caterpillar Monitoring System does not receive expected information from the power train ECM for a period of more than five seconds.

System Response:

This failure results in events that are logged against an ECM that can not be explained directly. The Caterpillar Monitoring System cannot communicate with this ECM or the ECM appears to communicate intermittently.

Test Step 1. VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS.

A. Verify that the following information is correct:

- The part number of the flash software for the Caterpillar Monitoring System
- The part number of the flash software for the power train ECM
- The part number of the Caterpillar Monitoring System
- The part number of the power train ECM

Note: Consult your Caterpillar Dealer for the correct part numbers of the flash software.

Expected Result:

All of the part numbers are correct.

Results:

- OK – All of the part numbers are correct.Proceed to Test Step 2.
- NOT OK – All of the part numbers are not correct.

  Repair: The installed Caterpillar Monitoring System or the power train ECM have the wrong part number or the incorrect flash software is installed. Replace the incorrect Caterpillar Monitoring System or the power train ECM with a module that has the correct part number. Flash the correct software. See the Testing and Adjusting, “Electronic Control Module (ECM)-Flash Program” section for additional information.

  STOP.

Test Step 2. INSPECT THE HARNESS CONNECTIONS.

A. Turn the disconnect switch to the OFF position.

B. Inspect all harness connections that are related to the Cat Data Link. Make sure that the connectors are clean and tight.

C. Check the connectors for proper mating. Ensure that all the seals are present and in place.

D. Check the harness for signs of damage or abrasion.

E. Check the wires at the connector. Ensure that the wires are secured tightly into the connector. **Take care not to pull the wire out of the connector.**

F. Check the exposed wires at the connectors for nicks or signs of abrasion.

G. Check for moisture inside the connector.

H. Check the connectors for dirty contacts or corroded contacts.

I. Check each pin and each socket of the machine harness connectors. Ensure that the contacts are properly installed. The contacts should mate correctly when the two pieces of the connector are placed together.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and free of corrosion.Proceed to Test Step 3.
- NOT OK – The machine harness connectors are in need of repair.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR SHORTS TO GROUND

A. The disconnect switch remains in the OFF position.

B. Disconnect the machine harness connectors from all electronic control modules that use the Cat Data Link.

C. At the machine harness for the Caterpillar Monitoring System, measure the resistance between frame ground and connector contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct.Proceed to Test Step 4.
- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  Repair: There is a short between frame ground and contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK FOR SHORT TO THE +BATTERY CIRCUIT

A. The disconnect switch remains in the OFF position.

B. All related electronic control modules remain disconnected from the machine harness.

C. At the machine harness connector for the Caterpillar Monitoring System, perform the checks that are listed here:

- Measure the resistance between the connector contact J1-1 (wire 113-OR(Orange)) and connector contact J1-9 (wire 893-GN(Green)).
- Measure the resistance between connector contact J1-1 (wire 113-OR(Orange)) and connector contact J1-3 (wire 892-BR(Brown)).

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The harness circuit resistance is correct. Proceed to Test Step 5.
- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  Repair: There is a short between the +battery circuit and contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK FOR OPEN HARNESS

A. The disconnect switch remains in the OFF position.

B. All related electronic control modules remain disconnected from the machine harness.

C. Check the resistance of the Cat Data Link circuit in the machine harness:

- Measure the resistance between connector contact J1-9 (wire 893-GN(Green)) of the CMS and connector contact J1-9 (wire 893-GN(Green)) of the power train ECM.
- Measure the resistance between connector contact J1-3 (wire 892-BR(Brown)) of the CMS and connector contact J1-3 (wire 892-BR(Brown)) of the power train ECM.

Expected Result:

The resistance measures less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The Cat Data Link circuit in the machine harness is correct. Proceed to Test Step 6.

- NOT OK – The resistance is greater than 5 ohms. The machine harness has failed.

  Repair: The Cat Data Link circuit is open in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK FOR ADDITIONAL DIAGNOSTIC CODES FOR THE OTHER ELECTRONIC CONTROL MODULES.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. One at a time, reconnect the electronic control modules that use the Cat Data Link.

C. Turn the disconnect switch and the key start switch to the ON position.

D. After each of the electronic control modules has been reconnected, check for diagnostic codes that are logged against that electronic control module.

Expected Result:

Diagnostic codes are not present for the other electronic control modules.

Results:

- OK – Diagnostic codes are not present for the other electronic control modules. The power train ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the failure is not found, replace the ECM.

  STOP.

- NOT OK – Diagnostic codes are present for the other electronic control modules. The Caterpillar Monitoring System has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform this procedure again. If the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace” section.

  STOP.

i02457509

MID 081 - CID 0650 - FMI 12

SMCS Code: 1408-038

Conditions Which Generate This Code:

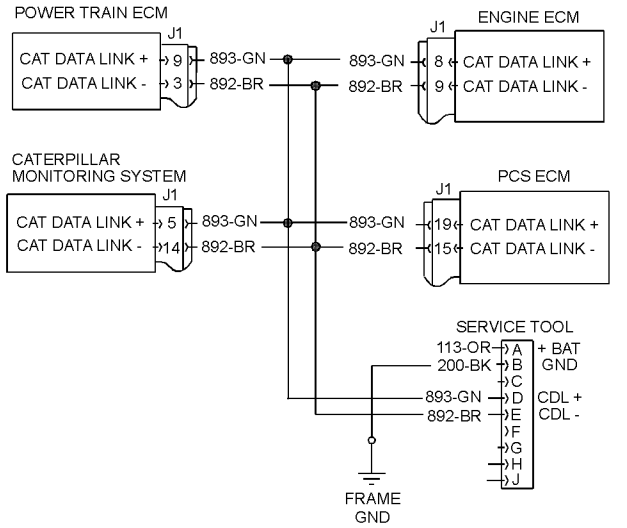


Illustration 58 g01223827

Schematic of the Cat Data Link

This diagnostic code is recorded when the Caterpillar Monitoring System is unable to communicate with the power train ECM through the Cat Data Link. Because there is no response from the ECM or the response is incorrect.

System Response:

This failure results in events that are logged against an ECM that can not be explained. The Caterpillar Monitoring System cannot communicate with this ECM or the ECM appears to work intermittently.

Test Step 1. VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS.

A. Verify that the following information is correct:

- The part number of the flash software for the Caterpillar Monitoring System
- The part number of the flash software for the power train ECM
- The part number of the Caterpillar Monitoring System
- The part number of the power train ECM

Note: Consult your Caterpillar Dealer for the correct part numbers of the flash software.

Expected Result:

All of the part numbers are correct.

Results:

- OK – All of the part numbers are correct.Proceed to Test Step 2.
- NOT OK – All of the part numbers are not correct.

  Repair: The installed Caterpillar Monitoring System or the power train ECM have the wrong part number or the incorrect flash software is installed. Replace the incorrect Caterpillar Monitoring System or the power train ECM with a module that has the correct part number. Flash the correct software. See the Testing and Adjusting, “Electronic Control Module (ECM)-Flash Program” section for additional information.

  STOP.

Test Step 2. INSPECT THE HARNESS CONNECTIONS.

A. Turn the disconnect switch to the OFF position.

B. Inspect all harness connections that are related to the Cat Data Link. Make sure that the connectors are clean and tight.

C. Check the connectors for proper mating. Ensure that all the seals are present and in place.

D. Check the harness for signs of damage or abrasion.

E. Check the wires at the connector. Ensure that the wires are secured tightly into the connector. **Take care not to pull the wire out of the connector.**

F. Check the exposed wires at the connectors for nicks or signs of abrasion.

G. Check for moisture inside the connector.

H. Check the connectors for dirty contacts or corroded contacts.

I. Check each pin and check each socket of the machine harness connectors. Ensure that the contacts are properly installed. The contacts should mate correctly when the two pieces of the connector are placed together.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and free of corrosion.Proceed to Test Step 3.
- NOT OK – The machine harness connectors are in need of repair.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR SHORTS TO GROUND

A. The disconnect switch remains in the OFF position.

B. Disconnect the machine harness connectors from all electronic control modules that use the Cat Data Link.

C. At the machine harness for the Caterpillar Monitoring System, measure the resistance between frame ground and connector contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct.Proceed to Test Step 4.
- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  Repair: There is a short between frame ground and contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK FOR SHORT TO THE +BATTERY CIRCUIT

A. The disconnect switch remains in the OFF position.

B. All related electronic control modules remain disconnected from the machine harness.

C. At the machine harness connector for the Caterpillar Monitoring System, perform the checks that are listed here:

- Measure the resistance between the connector contact J1-1 (wire 113-OR(Orange)) and connector contact J1-9 (wire 893-GN(Green)).
- Measure the resistance between connector contact J1-1 (wire 113-OR(Orange)) and connector contact J1-3 (wire 892-BR(Brown)).

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The harness circuit resistance is correct. Proceed to Test Step 5.
- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  Repair: There is a short between the +battery circuit and contacts J1-9 (wire 893-GN(Green)) and J1-3 (wire 892-BR(Brown)) of the Cat Data Link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK FOR OPEN HARNESS

A. The disconnect switch remains in the OFF position.

B. All related electronic control modules remain disconnected from the machine harness.

C. Check the resistance of the Cat Data Link circuit in the machine harness:

- Measure the resistance between connector contact J1-9 (wire 893-GN(Green)) of the Caterpillar Monitoring System and connector contact J1-9 (wire 893-GN(Green)) of the power train ECM.
- Measure the resistance between connector contact J1-3 (wire 892-BR(Brown)) of the Caterpillar Monitoring System and connector contact J1-3 (wire 892-BR(Brown)) of the power train ECM.

Expected Result:

The resistance measures less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The Cat Data Link circuit in the machine harness is correct. Proceed to Test Step 6.
- NOT OK – The resistance is greater than 5 ohms. The machine harness has failed.

  Repair: The Cat Data Link circuit is open in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK FOR ADDITIONAL DIAGNOSTIC CODES FOR THE OTHER ELECTRONIC CONTROL MODULES.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. One at a time, reconnect the electronic control modules that use the Cat Data Link.

C. Turn the disconnect switch and the key start switch to the ON position.

D. After each of the electronic control modules has been reconnected, check for diagnostic codes that are logged against that electronic control module.

Expected Result:

Diagnostic codes are not present for the other electronic control modules.

Results:

- OK – Diagnostic codes are not present for the other electronic control modules. The power train ECM has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the failure is not found, replace the ECM.

  STOP.

- NOT OK – Diagnostic codes are present for the other electronic control modules. The Caterpillar Monitoring System has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform this procedure again. If the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace” section.

  STOP.

i02452136

MID 081 - CID 0670 - FMI 00

SMCS Code: 4809-038-P9

Conditions Which Generate This Code:

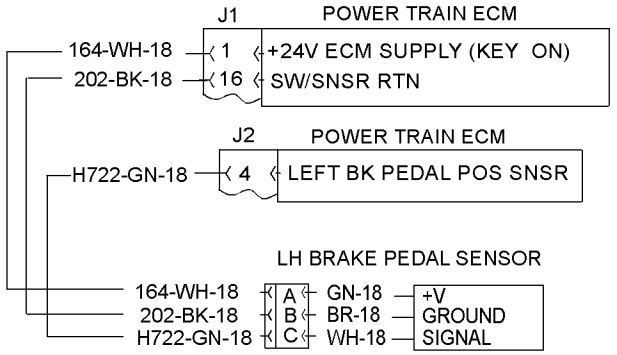


Illustration 59 g01225086

Schematic of the Left Hand Brake Pedal Position Sensor

This diagnostic code is associated with the Position Sensor (Left Hand Brake Pedal). The FMI 00 means that the ECM has determined that the signal of the sensor is above the normal range.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The signal circuit of the sensor is shorted to the + battery circuit.
- The sensor needs to be calibrated.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR

A. Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

Results:

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.Proceed to Test Step 2.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  Repair: Replace the damaged part.
  Proceed to Test Step 7.

Test Step 2. CHECK FOR POWER AT THE SENSOR

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the voltage supply wire (contact A).

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A to frame ground.

Expected Result:

The voltage is +24 volts.

Results:

- OK – The voltage is 24 volts. Proceed to Test Step 3.
- NOT OK – The voltage is not 24 volts. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR

A. The machine harness remains connected to the sensor.

B. Turn the key start switch and the disconnect switch to the OFF position.

C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (contact A).

D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

E. Measure the resistance from contact B to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL OF THE SENSOR

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The 7X-1710 Multimeter Probe remains along the ground wire (contact B).

C. At the back of the harness connector for the sensor, insert the other 7X-1710 Multimeter Probe along the signal wire (contact C).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Note: On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0670 FMI 00 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 5. CHECK THE SIGNAL AT THE ECM

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-4 (wire H722-GN(Green)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Note: On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0670 FMI 00 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-4 (wire H722-GN(Green)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 8.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 7. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

C. Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

Note: On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

D. Check the status of the diagnostic code.

Expected Result:

The CID 0670 FMI 00 is not active.

Results:

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation.

  STOP.

- NOT OK – CID 0670 FMI 00 is still active.

  Repair: Exit this procedure. Perform this procedure again.

  STOP.

Test Step 8. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0670 FMI 00.

Expected Result:

The CID 0670 FMI 00 is not active at the maximum range of the sensor.

Results:

- OK – The CID 0670 FMI 00 is not active at the maximum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.

- NOT OK – The CID 0670 FMI 00 is active at the maximum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02452150

MID 081 - CID 0670 - FMI 01

SMCS Code: 4809-038-P9

Conditions Which Generate This Code:

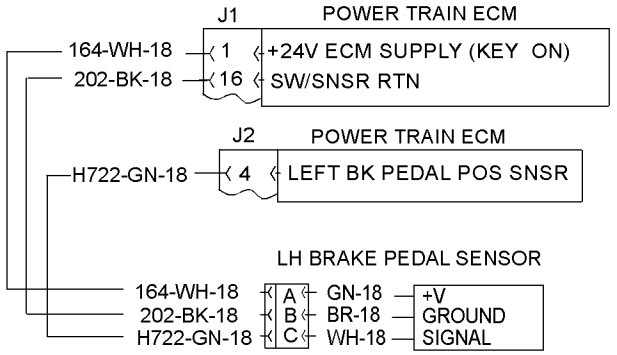


Illustration 60 g01225086

Schematic of the Left Hand Brake Pedal Position Sensor

This diagnostic code is associated with the Position Sensor (Left Hand Brake Pedal). The FMI 01 means that the ECM has determined that the signal of the sensor is below the normal range.

The possible causes of this failure are listed below:

- The position sensor has failed.
- The signal circuit of the sensor is shorted to the ground.
- The sensor needs to be calibrated.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR

A. Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

Results:

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.Proceed to Test Step 2.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  Repair: Replace the damaged part.
  Proceed to Test Step 7.

Test Step 2. CHECK FOR POWER AT THE SENSOR

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the voltage supply wire (contact A).

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A to frame ground.

Expected Result:

The voltage is +24 volts.

Results:

- OK – The voltage is 24 volts. Proceed to Test Step 3.
- NOT OK – The voltage is not 24 volts. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR

A. The machine harness remains connected to the sensor.

B. Turn the key start switch and the disconnect switch to the OFF position.

C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (contact A).

D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

E. Measure the resistance from contact B to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL OF THE SENSOR

A. Turn the key start switch and the disconnect switch to the OFF position.

B. At the back of the harness connector for the sensor, remove the 7X-1710 Multimeter Probe from contact A and insert the probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert the 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Note: On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0670 FMI 01 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 5. CHECK THE SIGNAL AT THE ECM

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-4 (wire H722-GN(Green)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Note: On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0670 FMI 01 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-4 (wire H722-GN(Green)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 8.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 7. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

C. Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

Note: On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

D. Check the status of the diagnostic code.

Expected Result:

The CID 0670 FMI 01 is not active.

Results:

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation.

  STOP.

- NOT OK – CID 0670 FMI 01 is still active.

  Repair: Exit this procedure. Perform this procedure again.

  STOP.

Test Step 8. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0670 FMI 01.

Expected Result:

The CID 0670 FMI 01 is not active at the minimum range of the sensor.

Results:

- OK – The CID 0670 FMI 01 is not active at the minimum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.

- NOT OK – The CID 0670 FMI 01 is active at the minimum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02452160

MID 081 - CID 0670 - FMI 03

SMCS Code: 4809-038-P9

Conditions Which Generate This Code:

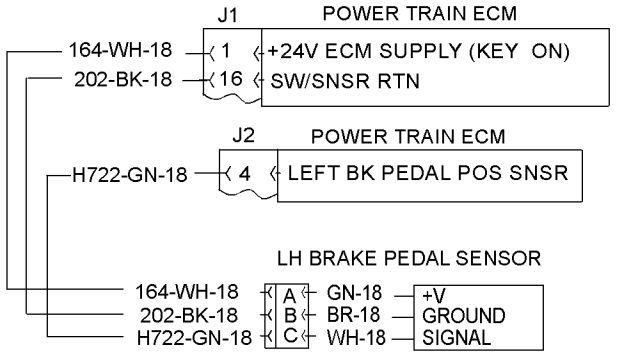


Illustration 61 g01225086

Schematic of the Left Hand Brake Pedal Position Sensor

This diagnostic code is associated with the Position Sensor (Left Hand Brake Pedal). The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0670 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. Turn the key start switch and the disconnect switch to the ON position.

C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the voltage supply wire (contact A).

D. Measure the voltage from contact A to frame ground.

Expected Result:

The voltage is 24 DCV.

Results:

- OK – The voltage is 24 DCV.Proceed to Test Step 2.
- NOT OK – The voltage is not 24 DCV. The + battery circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

A. The machine harness remains connected to the sensor.

B. Turn the key start switch and the disconnect switch to the OFF position.

C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (contact A).

D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

E. Measure the resistance from contact B to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness from the sensor.

C. At the harness connector for the sensor, connect a jumper wire between contact B and contact C.

D. Disconnect the machine harness connector(s) from the ECM.

E. At the harness connector for the ECM, measure the resistance between contact J2-4 (wire H722-GN(Green)) and contact J1-16 (wire 202-BK(Black)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

  Repair: There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.

C. The machine harness connector(s) remains disconnected from the ECM.

D. At the machine harness connector for the ECM, measure the resistance from the signal contact J2-4 (wire H722-GN(Green)) of the machine harness to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.
- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

  Repair: The short is between signal contact J2-4 (wire H722-GN(Green)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

A. Reconnect the machine harness connectors to the ECM. Reconnect the machine harness connector to the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

Expected Result:

The signal from the sensor is valid.

Results:

- OK – The signal from the sensor is valid.Proceed to Test Step 6.
- NOT OK – The signal from the sensor is not valid.

  Repair: The sensor has failed. Replace the sensor.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0670 FMI 03.

Expected Result:

The CID 0670 FMI 03 is active.

Results:

- YES – The CID 0670 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0670 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02452171

MID 081 - CID 0670 - FMI 04

SMCS Code: 4809-038-P9

Conditions Which Generate This Code:

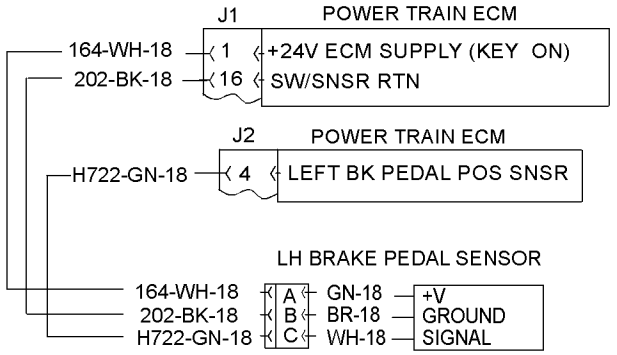


Illustration 62 g01225086

Schematic of the Left Hand Brake Pedal Position Sensor

This diagnostic code is associated with the Position Sensor (Left Hand Brake Pedal). The FMI 04 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0670 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Ensure that the diagnostic code is active.

C. Observe the status of the diagnostic code. Disconnect the sensor from the machine harness.

Expected Result:

The CID 0670 FMI 04 remains active. The FMI has not changed and the “04” is still active.

Results:

- OK – The diagnostic code remains active. The sensor is correct.Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

  Repair: Replace the sensor.

  STOP.

Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the sensor.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector for the ECM, measure the resistance from the signal contact J2-4 (wire H722-GN(Green)) of the machine harness to all possible sources of ground. Measure the resistance to all contacts of the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

  Repair: The short is between signal contact J2-4 (wire H722-GN(Green)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the contacts.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0670 FMI 04.

Expected Result:

The CID 0670 FMI 04 is active.

Results:

- YES – The CID 0670 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0670 FMI 04 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02452186

MID 081 - CID 0670 - FMI 13

SMCS Code: 4809-038-P9

Conditions Which Generate This Code:

Note: The ECM sensor supply provides power to the switch. The switch does not connect directly to the frame ground. The switch connects to the return circuit of the ECM. The ECM internally connects the return wire to frame ground.

This diagnostic code is recorded when the ECM detects the signal of the switch as being out of calibration.

In order to correct this diagnostic code, calibrate the switch. Perform the calibration procedure for the switch. See Testing and Adjsuting, “Position Sensor (Left Hand Brake Pedal (Electronic Technician) - Calibrate” for more information.

System Response:

The diagnostic code of CID 0670 FMI 13 will be logged in the internal memory of the ECM and a level 1 warning will be generated.

CALIBRATION

A. Perform the calibration procedure for the switch.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

  STOP.

- NO – The calibration was not successful.

  Repair: Repeat the calibration procedure for the switch. See Testing and Adjusting, “Position Sensor (Left Brake Pedal) (Electronic Technician) - Calibrate” for more information.

  STOP.

i07070286

MID 081 - CID 0672 - FMI 01

SMCS Code: 3141-038-OJ

Conditions Which Generate This Code:

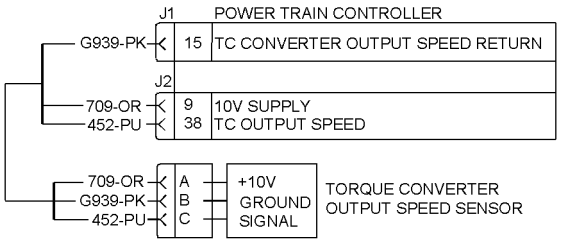


Illustration 63 g06214259

Schematic of the Torque Converter Output Speed Sensor

This diagnostic code is associated with the Speed Sensor (Torque Converter Output). The FMI 01 means that the ECM has determined that the signal of the sensor is below the normal range.

The possible causes of this failure are listed below:

- The position sensor has failed.
- The signal circuit of the sensor is shorted to the ground.
- The sensor needs to be calibrated.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR

A. Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

Results:

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.Proceed to Test Step 2.

- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  Repair: Replace the damaged part.
  Proceed to Test Step 7.

Test Step 2. CHECK FOR POWER AT THE SENSOR

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the voltage supply wire (contact A).

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A to frame ground.

Expected Result:

The voltage is +10 DCV.

Results:

- OK – The voltage is 10 DCV.Proceed to Test Step 3.
- NOT OK – The voltage is not 10 DCV. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR

A. The machine harness remains connected to the sensor.

B. Turn the key start switch and the disconnect switch to the OFF position.

C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (contact A).

D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

E. Measure the resistance from contact B to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL OF THE SENSOR

A. Turn the key start switch and the disconnect switch to the OFF position.

B. At the back of the harness connector for the sensor, remove the 7X-1710 Multimeter Probe from contact A and insert the probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert the 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Note: On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0672 FMI 01 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly.Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 5. CHECK THE SIGNAL AT THE ECM

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-38 (wire 452-PU(Purple)) and J1-15 (wire G939-PK(Pink)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Note: On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0672 FMI 01 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly.Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-38 (wire 452-PU(Purple)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 8.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 7. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

C. Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

Note: On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

D. Check the status of the diagnostic code.

Expected Result:

The CID 0672 FMI 01 is not active.

Results:

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation.

  STOP.
- NOT OK – CID 0672 FMI 01 is still active.

  Repair: Exit this procedure. Perform this procedure again.

  STOP.

Test Step 8. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0672 FMI 01.

Expected Result:

The CID 0672 FMI 01 is not active at the minimum range of the sensor.

Results:

- OK – The CID 0672 FMI 01 is not active at the minimum range of the sensor. The diagnostic code

does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0672 FMI 01 is active at the minimum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02457527

MID 081 - CID 0678 - FMI 03

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

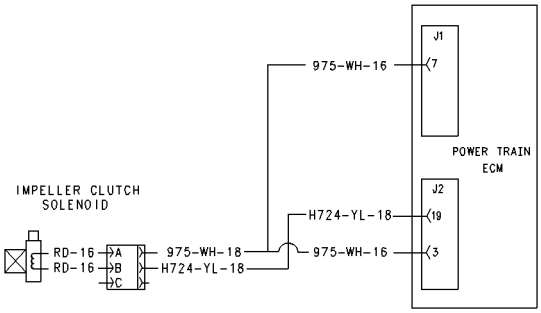


Illustration 64 g00696021

Schematic of the Impeller Clutch Solenoid

This diagnostic code is associated with the Impeller Clutch Solenoid. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0678 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the impeller clutch will not engage. The controlled throttle shifting function is always active.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J2-19 (wire H724-YL(Yellow)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-19 (H724-YL(Yellow)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 0678 FMI 03 is active.

Expected Result:

The CID 0678 FMI 03 is active.

Results:

- YES – The CID 0678 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0678 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02457534

MID 081 - CID 0678 - FMI 05

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

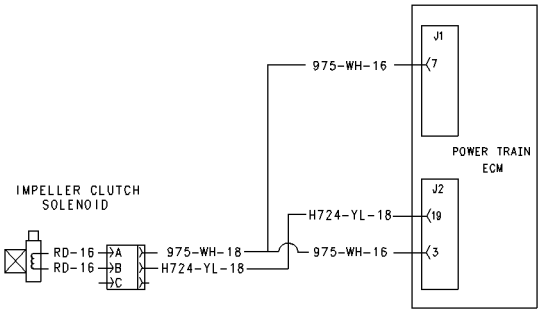


Illustration 65 g00696021

Schematic of the Impeller Clutch Solenoid

This diagnostic code is associated with the Impeller Clutch Solenoid. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0678 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the impeller clutch will not engage. The controlled throttle shifting function is always active. The function of the reduced rimpull is inoperable.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact A (wire H724-YL) (wire H724-YL(Yellow)) to contact Contact B (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 0678 FMI 05.

Expected Result:

The CID 0678 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.

- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to

verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J2-19 (wire H724-YL(Yellow)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire H724-YL(Yellow) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0678 FMI 05.

Expected Result:

The CID 0678 FMI 05 is active.

Results:

- YES – The CID 0678 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0678 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664463

MID 081 - CID 0678 - FMI 06

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

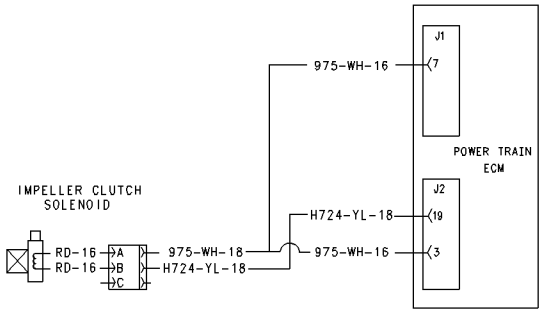


Illustration 66 g00696021

Schematic of the Impeller Clutch Solenoid

This diagnostic code is associated with the Impeller Clutch Solenoid. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.

- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 678 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the impeller clutch will not engage. The controlled throttle shifting function is always active. The function of the reduced rimpull is inoperable.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 678 FMI 06 changes to CID 0678 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 0678 FMI 06 changes to CID 0678 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 0678 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J2-19 (wire H724-YL(Yellow)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-19 (wire H724-YL(Yellow)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0678 FMI 06.

Expected Result:

The CID 0678 FMI 06 is active.

Results:

- YES – The CID 0678 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0678 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i01665259

MID 081 - CID 0678 - FMI 13

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

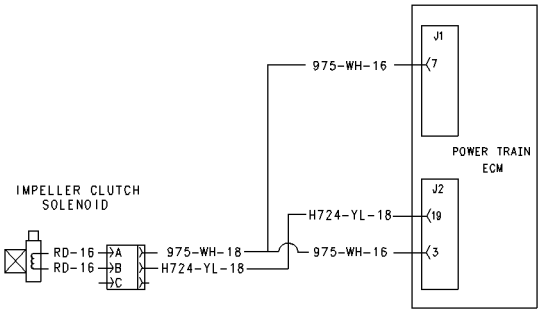


Illustration 67 g00696021

Schematic of the Impeller Clutch Solenoid

This diagnostic code is associated with the Impeller Clutch Solenoid. The FMI 13 means that the ECM has determined that the solenoid needs calibration. Once the calibration for the Impeller Clutch Solenoid has been performed successfully, this diagnostic code will disappear. This failure is active on a new ECM.

Possible causes of this diagnostic code are listed below:

- The solenoid has failed.
- The ECM has been replaced or new software has been installed.
- The ECM has failed.

System Response:

When this diagnostic code occurs, the torque converter pedal will not affect the modulation of the impeller clutch. Reduced rimpull is not available. Direction shifts may be harsh.

Note: Ensure that you have repaired any condition that would cause other active diagnostic codes that are related to this solenoid. For example, the CID 0678 FMI 03 or FMI 05 are not active when the CID 0678 FMI 13 is active. If the other diagnostic codes are active, troubleshoot those codes first. Then perform this procedure.

Note: Ensure that the diagnostic code of CID 0678 FMI 13 is active before performing this procedure.

CHECK THE CALIBRATION

A. Perform the calibration procedure. Refer to the Testing and Adjusting section of the Service Manual for the correct procedure.

B. Observe the status of the CID 0678 FMI 13.

Expected Result:

The CID 0678 FMI 13 is active.

Results:

- YES – The CID 0678 FMI 13 is active. The diagnostic code has not been corrected. Verify that the correct software has been flashed into the ECM, or that the correct ECM is installed on the machine. Then repeat the calibration.

  Repair: If the diagnostic code is still active and the cause of the diagnostic code is not found replace the ECM. It is unlikely that the ECM has failed. Verify that the solenoid and associated circuits are correct before you replace the ECM.

  STOP.

- NO – The CID 0678 FMI 13 is not active. The calibration corrected the condition that caused the diagnostic code.

  Repair: Resume normal operation.

  STOP.

i01664187

MID 081 - CID 0679 - FMI 03

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

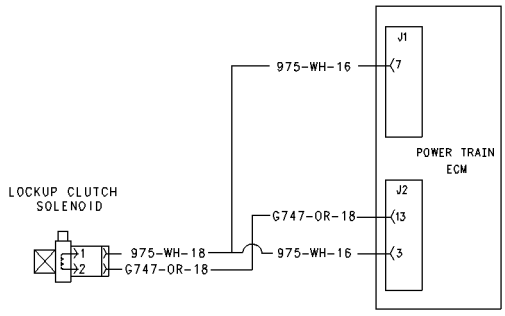


Illustration 68 g00838515

Schematic of the Lockup Clutch Solenoid

This diagnostic code is associated with the Lockup Clutch Solenoid. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0679 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the lockup clutch will not disengage.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J2-13 (wire G747-OR(Orange)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-13 (G747-OR(Orange)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 0679 FMI 03 is active.

Expected Result:

The CID 0679 FMI 03 is active.

Results:

- YES – The CID 0679 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0679 FMI 03 is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02457542

MID 081 - CID 0679 - FMI 05

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

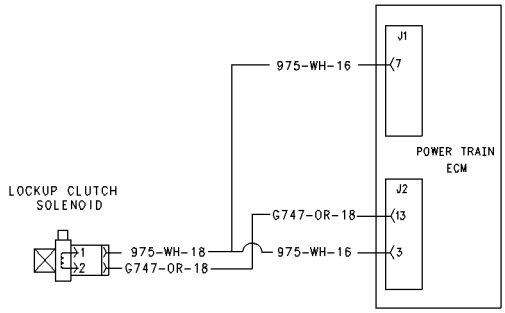


Illustration 69 g00838515

Schematic of the Lockup Clutch Solenoid

This diagnostic code is associated with the Lockup Clutch Solenoid. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0679 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, the lockup clutch will not disengage.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact 1 (wire G747-OR) (wire G747-OR(Orange)) to contact Contact 2 (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 0679 FMI 05.

Expected Result:

The CID 0679 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J2-13 (wire G747-OR(Orange)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in one of the following wires of the machine harness:

  - wire G747-OR(Orange)
  - wire 975-WH(White)

  Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0679 FMI 05.

Expected Result:

The CID 0679 FMI 05 is active.

Results:

- YES – The CID 0679 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0679 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02457549

MID 081 - CID 0679 - FMI 06

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

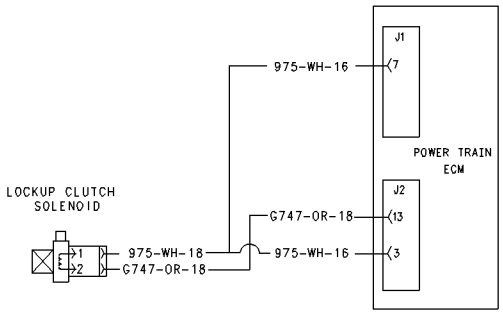


Illustration 70 g00838515

Schematic of the Lockup Clutch Solenoid

This diagnostic code is associated with the Lockup Clutch Solenoid. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0679 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

There is no change in system operation.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 0679 FMI 06 changes to CID 0679 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 0679 FMI 06 changes to CID 0679 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 0679 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J2-13 (wire G747-OR(Orange)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-13 (wire G747-OR(Orange)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0679 FMI 06.

Expected Result:

The CID 0679 FMI 06 is active.

Results:

- YES – The CID 0679 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0679 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01665264

MID 081 - CID 0679 - FMI 13

SMCS Code: 3139-038-VC

Conditions Which Generate This Code:

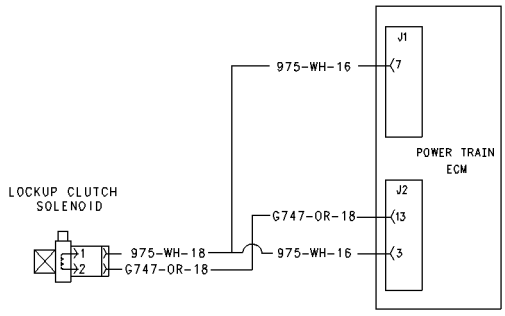


Illustration 71 g00838515

Schematic of the Lockup Clutch Solenoid

This diagnostic code is associated with the Lockup Clutch Solenoid. The FMI 13 means that the ECM has determined that the solenoid needs calibration. Once the calibration for the Lockup Clutch Solenoid has been performed successfully, this diagnostic code will disappear. This failure is active on a new ECM.

Possible causes of this diagnostic code are listed below:

- The solenoid has failed.
- The ECM has been replaced or new software has been installed.
- The ECM has failed.

System Response:

When this diagnostic code occurs, the reduced rimpull is not available. Direction shifts may be harsh.

Note: Ensure that you have repaired any condition that would cause other active diagnostic codes that are related to this solenoid. For example, the CID 0679 FMI 03 or FMI 05 are not active when the CID 0679 FMI 13 is active. If the other diagnostic codes are active, troubleshoot those codes first. Then perform this procedure.

Note: Ensure that the diagnostic code of CID 0679 FMI 13 is active before performing this procedure.

CHECK THE CALIBRATION

A. Perform the calibration procedure. Refer to the Testing and Adjusting section of the Service Manual for the correct procedure.

B. Observe the status of the CID 0679 FMI 13.

Expected Result:

The CID 0679 FMI 13 is active.

Results:

- YES – The CID 0679 FMI 13 is active. The diagnostic code has not been corrected. Verify that the correct software has been flashed into the ECM, or that the correct ECM is installed on the machine. Then repeat the calibration.

  Repair: If the diagnostic code is still active and the cause of the diagnostic code is not found replace the ECM. It is unlikely that the ECM has failed. Verify that the solenoid and associated circuits are correct before you replace the ECM.

  STOP.

- NO – The CID 0679 FMI 13 is not active. The calibration corrected the condition that caused the diagnostic code.

  Repair: Resume normal operation.

  STOP.

i02452210

MID 081 - CID 0826 - FMI 03

SMCS Code: 1439-038-VC

Conditions Which Generate This Code:

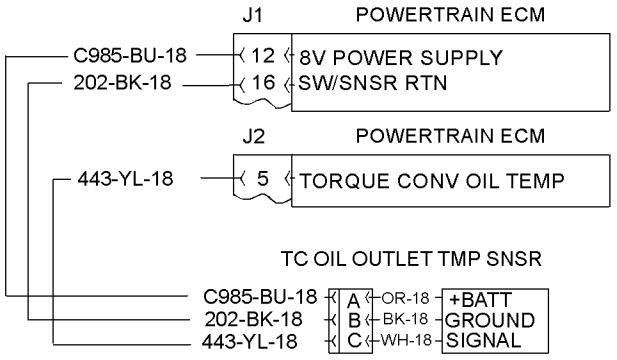


Illustration 72 g01225027

Schematic of the Torque Converter Oil Temperature Sensor

This diagnostic code is associated with the torque converter oil temperature sensor. The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0826 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along contact A (wire C985-BU(Blue)) for the voltage supply.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A (wire C985-BU(Blue)) to contact B (wire 202-BK(Black)).

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 8 DCV. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE SENSOR.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. At the back of the harness connector for the sensor, remove the 7X-1710 Multimeter Probe from contact A and insert the probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert the 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-5 (wire 443-YL(Yellow)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-5 (wire 443-YL(Yellow)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The circuit is correct.Proceed to Test Step 5.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0826 FMI 03.

Expected Result:

The CID 0826 FMI 03 is not active.

Results:

- OK – The CID 0826 FMI 03 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.
- NOT OK – The CID 0826 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02452220

MID 081 - CID 0826 - FMI 04

SMCS Code: 1439-038-VC

Conditions Which Generate This Code:

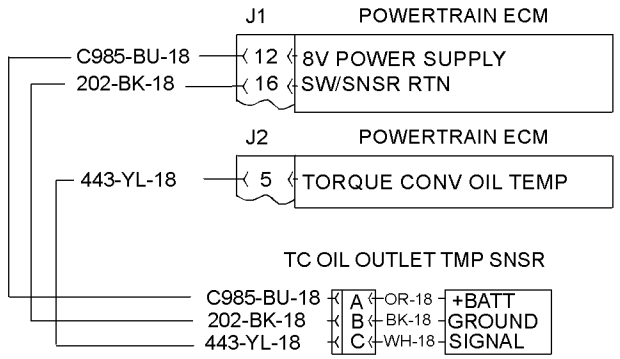


Illustration 73 g01225027

Schematic of the Torque Converter Oil Temperature Sensor

This diagnostic code is associated with the torque converter oil temperature sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0826 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. INSPECT THE SENSOR.

A. Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

Expected Result:

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

Results:

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.Proceed to Test Step 3.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  Repair: Replace the damaged part.
  Proceed to Test Step 2.

Test Step 2. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

A. Turn the disconnect switch and the key start switch to the ON position.

B. Perform the calibration of the position sensor.

C. Check the status of the diagnostic code.

Expected Result:

The CID 0826 FMI 04 is not active.

Results:

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation.

  STOP.
- NOT OK – CID 0826 FMI 04 is still active. Exit the calibration procedure.Proceed to Test Step 3.

Test Step 3. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along contact A (wire C985-BU(Blue)) for the voltage supply.

C. Turn the key start switch and the disconnect switch to the ON position.

D. Measure the voltage from contact A (wire C985-BU(Blue)) to contact B (wire 202-BK(Black)).

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 4.
- NOT OK – The voltage is NOT 8 DCV. The circuit is open.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The 7X-1710 Multimeter Probe remains along contact B (wire 202-BK(Black)).

C. At the back of the harness connector for the sensor, insert the other 7X-1710 Multimeter Probe along contact C (wire 443-YL(Yellow)).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0826 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  Repair: Replace the sensor.

  STOP.

Test Step 5. CHECK THE SIGNAL AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the 7X-1710 Multimeter Probes into the back of the ECM connector along J2-5 (wire 443-YL(Yellow)) and J1-16 (wire 202-BK(Black)).

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the 146-4080 Digital Multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0826 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J2-5 (wire 443-YL(Yellow)) and all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.

- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

E. Check the status of the CID 0826 FMI 04.

Expected Result:

The CID 0826 FMI 04 is not active at the maximum range of the sensor.

Results:

- OK – The CID 0826 FMI 04 is not active at the maximum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

  STOP.

- NOT OK – The CID 0826 FMI 04 is active at the maximum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

i02452232

MID 081 - CID 1022 - FMI 03

SMCS Code: 1439-038-LBX

Conditions Which Generate This Code:

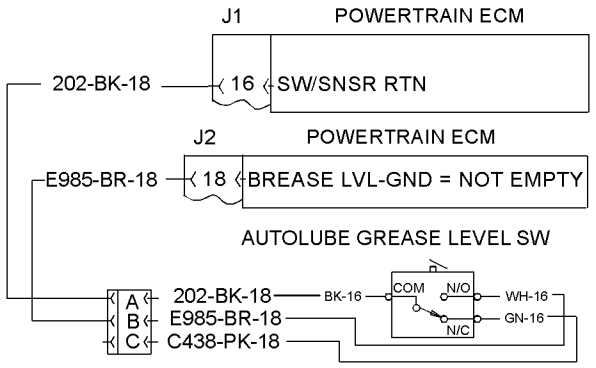


Illustration 74 g01225061

Schematic of the Autolube Grease Level Switch

This diagnostic code is associated with the parking brake pressure switch. The switch is connected to two inputs of the ECM. One contact is open and the other contact is grounded during proper operation.

This FMI 03 means that the ECM has determined that the normally open contact and the normally closed contact are open.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1022 FMI 03 is active before performing this procedure.**

Test Step 1. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact A of the harness connector on the switch.

C. Connect the other lead from a multimeter to contact B of the harness connector on the switch.

D. Measure the resistance between contact A and contact B . Note the resistance.

E. Disconnect the lead from contact B and connect the lead to contact C.

F. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is greater than 5 ohms, and the resistance from contact A to contact C is less than 5 ohms.

Results:

- YES – The resistance from contact A to contact B is greater than 5 ohms, and the resistance from contact A to contact C is less than 5 ohms. Proceed to Test Step 2.
- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 2. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Activate the switch by starting the engine and disengaging the park brake.

C. Connect one lead from a multimeter to contact A of the harness connector on the switch.

D. Connect the other lead from a multimeter to contact B of the harness connector on the switch.

E. Measure the resistance between contact A and contact B. Note the resistance.

F. Disconnect the lead from contact B and connect the lead to contact C.

G. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A to contact C is greater than 5 ohms.

Results:

- YES – The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A and contact C is greater than 5 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 3.
- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE HARNESS

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector from the pressure switch.

C. Measure the resistance between frame ground of the machine and contact A (wire 202-BK(Black)) of the machine harness connector for the pressure switch.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-16 (wire 202-BK(Black)) and J2-18 (wire E985-BR(Brown)) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5 ohms.

Results:

- YES – Each resistance measurement is greater than 5 ohms.Proceed to Test Step 5.

- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-16 (wire 202-BK(Black)) and the circuit with the lowest resistance or the short is between J2-18 (wire E985-BR(Brown)) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 5. CHECK THE SWITCH CIRCUITS IN THE HARNESS

A. The machine harness remains disconnected from the ECM and the switch.

B. At the harness connector for the switch, connect a jumper wire between contact A (wire 202-BK(Black)) and contact B (wire E985-BR(Brown)).

C. At the harness connector for the ECM, measure the resistance from contact J1-16 (wire 202-BK(Black)) to contact J2-18 (wire E985-BR(Brown)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.Proceed to Test Step 6.

- NOT OK – The resistance is greater than 5 ohms. The circuit is open.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 1022 FMI 03 is present.

Expected Result:

The CID 1022 FMI 03 is active.

Results:

- YES – The CID 1022 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. SeeTesting and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1022 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02452242

MID 081 - CID 1022 - FMI 04

SMCS Code: 1439-038-LBX

Conditions Which Generate This Code:

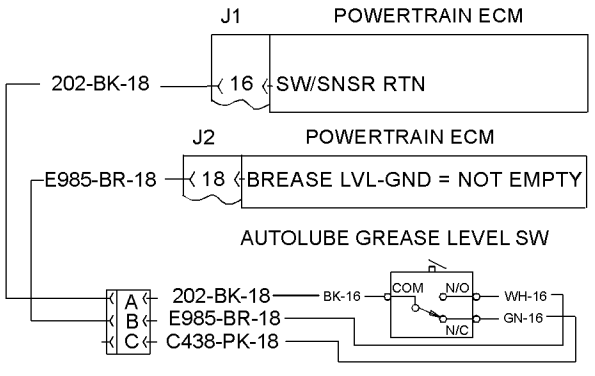


Illustration 75 g01225061

Schematic of the Autolube Grease Level Switch

This diagnostic code is associated with the autolube grease level switch. The switch is connected to two inputs of the ECM. The inputs are “Normally Open” and “Normally Closed” . One of the inputs is open and the other input is grounded during proper operation.

The FMI 04 means that the ECM has determined that the “Normally Open” and “Normally Closed” circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1022 FMI 04 is active before performing this procedure.**

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch and the disconnect switch to the ON position.

Expected Result:

The CID 1022 FMI 04 has been replaced by CID 1022 FMI 03.

Results:

- OK – The CID 1022 FMI 04 has been replaced by CID 1022 FMI 03. The machine harness and the ECM are correct.Proceed to Test Step 3.
- NOT OK – The CID 1022 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-16 (wire 202-BK(Black)) and J2-18 (wire E985-BR(Brown)) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms.Proceed to Test Step 3.
- NO – One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-16 (wire 202-BK(Black)) and the circuit with the lowest resistance or the short is between J2-18 (wire E985-BR(Brown)) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact A of the harness connector on the switch.

C. Connect the other lead from a multimeter to contact B of the harness connector on the switch.

D. Measure the resistance between contact A and contact B . Note the resistance.

E. Disconnect the lead from contact B and connect the lead to contact C.

F. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact C is less than 5 ohms, and the resistance from contact (A) to contact B is greater than 5000 ohms.

Results:

- YES – The resistance from contact A to contact C is less than 5 ohms, and the resistance from contact A to contact B is greater than 5000 ohms. Proceed to Test Step 4.
- NO – The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Activate the switch.

C. Connect one lead from a multimeter to contact A (wire 202-BK(Black)) of the harness connector on the switch.

D. Connect the other lead from a multimeter to contact B (wire E985-BR(Brown)) of the harness connector on the switch.

E. Measure the resistance between contact A and contact B. Note the resistance.

F. Disconnect the lead from contact B and connect the lead to contact C.

G. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A to contact C is greater than 5000 ohms.

Results:

- YES – The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A and contact C is greater than 5 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly.Proceed to Test Step 5.
- NO – The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  STOP.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 1022 FMI 04 is present.

Expected Result:

The CID 1022 FMI 04 is active.

Results:

- YES – The CID 1022 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing And Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1022 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664084

MID 081 - CID 1401 - FMI 03

SMCS Code: 3174-038

Conditions Which Generate This Code:

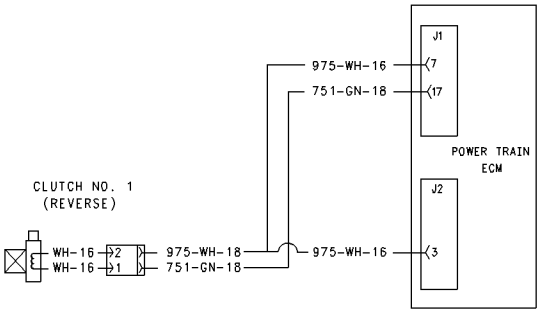


Illustration 76 g00686186

Schematic of the Transmission Solenoid 1

This diagnostic code is associated with the Transmission Solenoid 1. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1401 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J1-17 (wire 751-GN(Green)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-17 (751-GN(Green)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 1401 FMI 03 is active.

Expected Result:

The CID 1401 FMI 03 is active.

Results:

- YES – The CID 1401 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1401 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664220

MID 081 - CID 1401 - FMI 05

SMCS Code: 3174-038

Conditions Which Generate This Code:

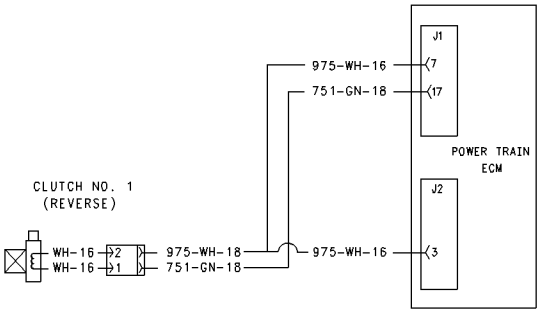


Illustration 77 g00686186

Schematic of the Transmission Solenoid 1

This diagnostic code is associated with the Transmission Solenoid 1. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1401 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact 1 (wire 751-GN) (wire 751-GN(Green)) to contact Contact 2 (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 1401 FMI 05.

Expected Result:

The CID 1401 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J1-17 (wire 751-GN(Green)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire 751-GN(Green) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1401 FMI 05.

Expected Result:

The CID 1401 FMI 05 is active.

Results:

- YES – The CID 1401 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 1401 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664349

MID 081 - CID 1401 - FMI 06

SMCS Code: 3174-038

Conditions Which Generate This Code:

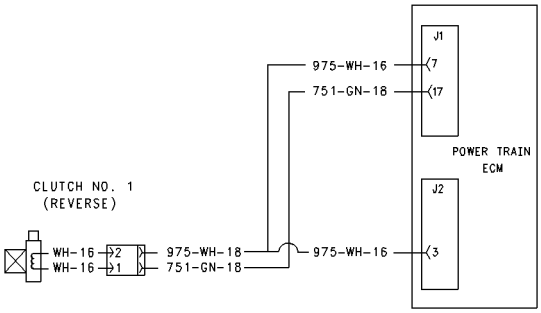


Illustration 78 g00686186

Schematic of the Transmission Solenoid 1

This diagnostic code is associated with the Transmission Solenoid 1. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1401 FMI 06 is active before performing this procedure.**

Note: Use the 146 - 4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 1401 FMI 06 changes to CID 1401 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 1401 FMI 06 changes to CID 1401 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 1401 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-17 (wire 751-GN(Green)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-17 (wire 751-GN(Green)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1401 FMI 06.

Expected Result:

The CID 1401 FMI 06 is active.

Results:

- YES – The CID 1401 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1401 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664131

MID 081 - CID 1402 - FMI 03

SMCS Code: 3174-038

Conditions Which Generate This Code:

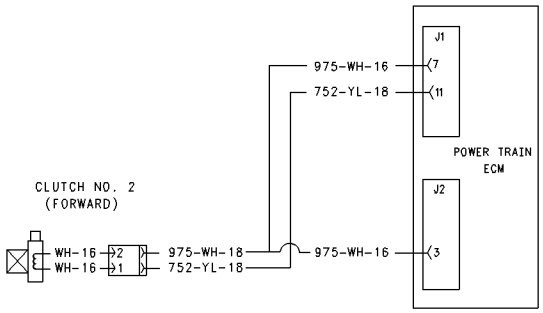


Illustration 79 g00687503

Schematic of the Transmission Solenoid 2

This diagnostic code is associated with the Transmission Solenoid 2. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1402 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J1-11 (wire 752-YL(Yellow)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-11 (752-YL(Yellow)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 1402 FMI 03 is active.

Expected Result:

The CID 1402 FMI 03 is active.

Results:

- YES – The CID 1402 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1402 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664234

MID 081 - CID 1402 - FMI 05

SMCS Code: 3174-038

Conditions Which Generate This Code:

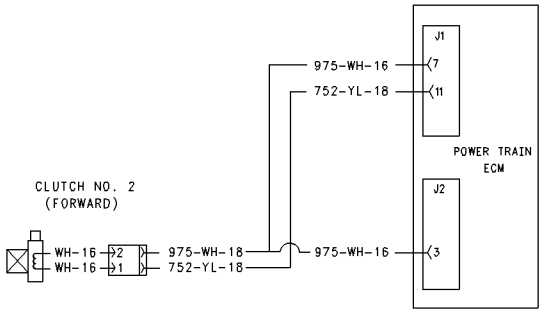


Illustration 80 g00687503

Schematic of the Transmission Solenoid 2

This diagnostic code is associated with the Transmission Solenoid 2. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1402 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact 1 (wire 752-YL) (wire 752-YL(Yellow)) to contact Contact 2 (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 1402 FMI 05.

Expected Result:

The CID 1402 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J1-11 (wire 752-YL(Yellow)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire 752-YL(Yellow) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1402 FMI 05.

Expected Result:

The CID 1402 FMI 05 is active.

Results:

- YES – The CID 1402 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1402 FMI 05 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i01664365

MID 081 - CID 1402 - FMI 06

SMCS Code: 3174-038

Conditions Which Generate This Code:

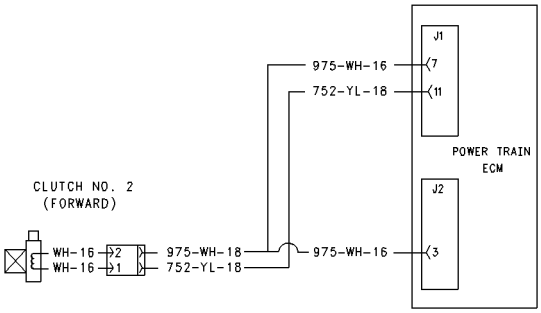


Illustration 81 g00687503

Schematic of the Transmission Solenoid 2

This diagnostic code is associated with the Transmission Solenoid 2. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1402 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 1402 FMI 06 changes to CID 1402 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 1402 FMI 06 changes to CID 1402 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 1402 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-11 (wire 752-YL(Yellow)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-11 (wire 752-YL(Yellow)) and the circuit with the low resistance measurement.

Repair: Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1402 FMI 06.

Expected Result:

The CID 1402 FMI 06 is active.

Results:

- YES – The CID 1402 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1402 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664146

MID 081 - CID 1403 - FMI 03

SMCS Code: 3174-038

Conditions Which Generate This Code:

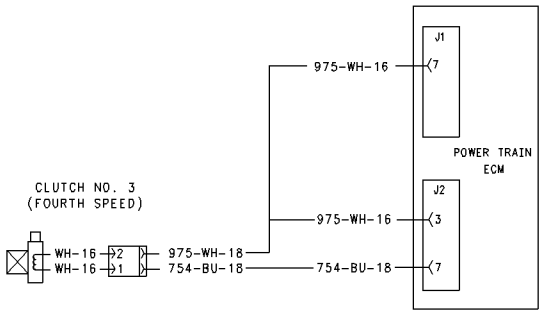


Illustration 82 g00687599

Schematic of the Transmission Solenoid 3

This diagnostic code is associated with the Transmission Solenoid 3. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1403 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J2-7 (wire 754-BU(Blue)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-7 (754-BU(Blue)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 1403 FMI 03 is active.

Expected Result:

The CID 1403 FMI 03 is active.

Results:

- YES – The CID 1403 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1403 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664252

MID 081 - CID 1403 - FMI 05

SMCS Code: 3174-038

Conditions Which Generate This Code:

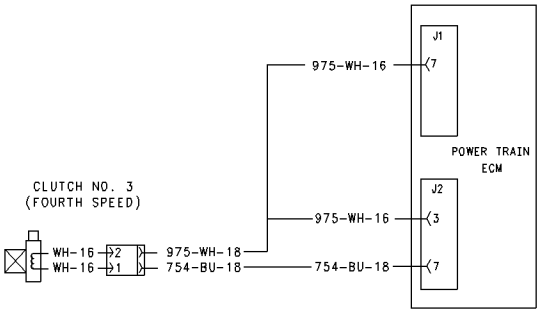


Illustration 83 g00687599

Schematic of the Transmission Solenoid 3

This diagnostic code is associated with the Transmission Solenoid 3. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1403 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact 1 (wire 754-BU) (wire 754-BU(Blue)) to contact Contact 2 (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 1403 FMI 05.

Expected Result:

The CID 1403 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J2-7 (wire 754-BU(Blue)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire 754-BU(Blue) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1403 FMI 05.

Expected Result:

The CID 1403 FMI 05 is active.

Results:

- YES – The CID 1403 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1403 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664369

MID 081 - CID 1403 - FMI 06

SMCS Code: 3174-038

Conditions Which Generate This Code:

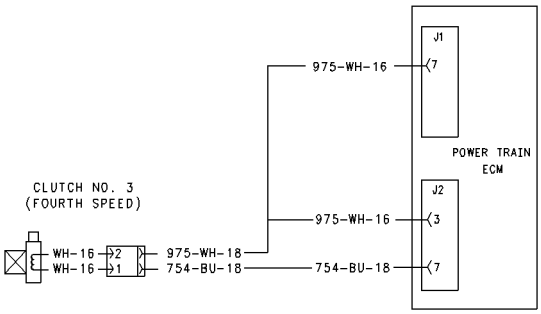


Illustration 84 g00687599

Schematic of the Transmission Solenoid 3

This diagnostic code is associated with the Transmission Solenoid 3. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1403 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 1403 FMI 06 changes to CID 1403 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 1403 FMI 06 changes to CID 1403 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 1403 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J2-7 (wire 754-BU(Blue)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-7 (wire 754-BU(Blue)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1403 FMI 06.

Expected Result:

The CID 1403 FMI 06 is active.

Results:

- YES – The CID 1403 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1403 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664154

MID 081 - CID 1404 - FMI 03

SMCS Code: 3174-038

Conditions Which Generate This Code:

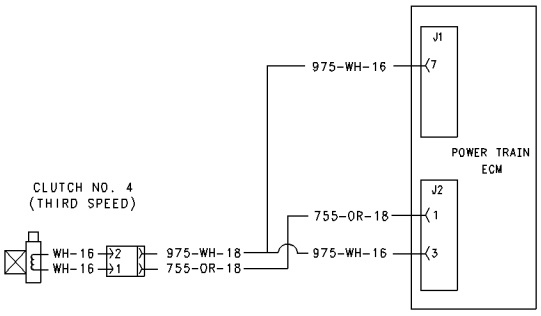


Illustration 85 g00687633

Schematic of the Transmission Solenoid 4

This diagnostic code is associated with the Transmission Solenoid 4. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1404 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J2-1 (wire 755-OR(Orange)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-1 (755-OR(Orange)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 1404 FMI 03 is active.

Expected Result:

The CID 1404 FMI 03 is active.

Results:

- YES – The CID 1404 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1404 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664262

MID 081 - CID 1404 - FMI 05

SMCS Code: 3174-038

Conditions Which Generate This Code:

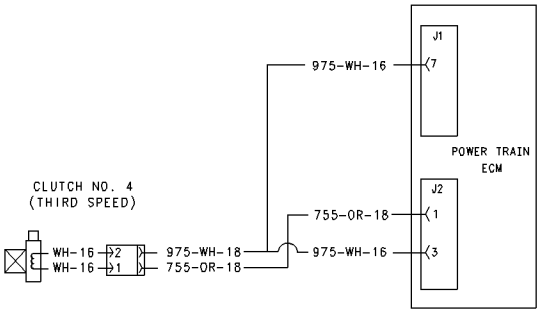


Illustration 86 g00687633

Schematic of the Transmission Solenoid 4

This diagnostic code is associated with the Transmission Solenoid 4. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1404 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact 1 (wire 755-OR) (wire 755-OR(Orange)) to contact Contact 2 (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 1404 FMI 05.

Expected Result:

The CID 1404 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J2-1 (wire 755-OR(Orange)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire 755-OR(Orange) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1404 FMI 05.

Expected Result:

The CID 1404 FMI 05 is active.

Results:

- YES – The CID 1404 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1404 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664400

MID 081 - CID 1404 - FMI 06

SMCS Code: 3174-038

Conditions Which Generate This Code:

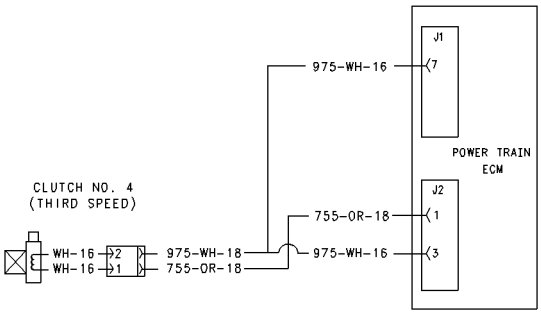


Illustration 87 g00687633

Schematic of the Transmission Solenoid 4

This diagnostic code is associated with the Transmission Solenoid 4. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1404 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 1404 FMI 06 changes to CID 1404 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 1404 FMI 06 changes to CID 1404 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 1404 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J2-1 (wire 755-OR(Orange)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-1 (wire 755-OR(Orange)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1404 FMI 06.

Expected Result:

The CID 1404 FMI 06 is active.

Results:

- YES – The CID 1404 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1404 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664164

MID 081 - CID 1405 - FMI 03

SMCS Code: 3174-038

Conditions Which Generate This Code:

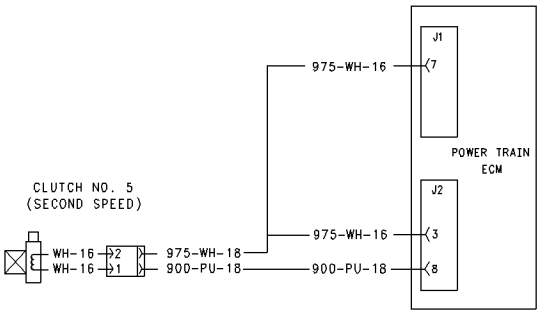


Illustration 88 g00687661

Schematic of the Transmission Solenoid 5

This diagnostic code is associated with the Transmission Solenoid 5. The FMI 03 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1405 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J2-8 (wire 900-PU(Purple)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-8 (900-PU(Purple)) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 1405 FMI 03 is active.

Expected Result:

The CID 1405 FMI 03 is active.

Results:

- YES – The CID 1405 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1405 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664270

MID 081 - CID 1405 - FMI 05

SMCS Code: 3174-038

Conditions Which Generate This Code:

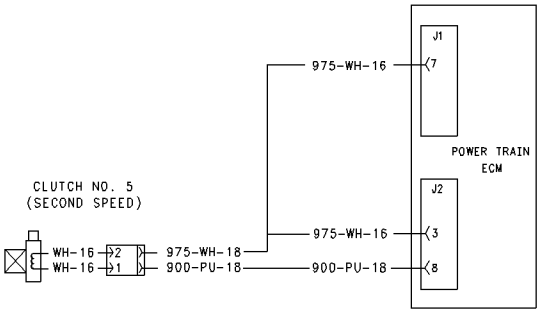


Illustration 89 g00687661

Schematic of the Transmission Solenoid 5

This diagnostic code is associated with the Transmission Solenoid 5. The FMI 05 means that the ECM has determined that the current of the solenoid is below normal.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1405 FMI 05 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact Contact 1 (wire 900-PU) (wire 900-PU(Purple)) to contact Contact 2 (wire 975-WH) (wire 975-WH(White)).

D. Observe the status of the CID 1405 FMI 05.

Expected Result:

The CID 1405 FMI 05 remains active. The FMI has not changed and the “05” is still active.

Results:

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J2-8 (wire 900-PU(Purple)) to contact J1-7, J2-3 (wire 975-WH(White)).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire 900-PU(Purple) or in wire 975-WH(White) of the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1405 FMI 05.

Expected Result:

The CID 1405 FMI 05 is active.

Results:

- YES – The CID 1405 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1405 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01664450

MID 081 - CID 1405 - FMI 06

SMCS Code: 3174-038

Conditions Which Generate This Code:

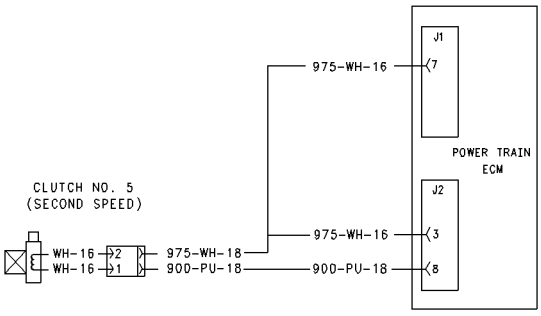


Illustration 90 g00687661

Schematic of the Transmission Solenoid 5

This diagnostic code is associated with the Transmission Solenoid 5. The FMI 06 means that the ECM has determined that the current of the solenoid is above normal.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1405 FMI 06 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

System Response:

When this diagnostic code occurs, only the gears that use the solenoids that have faults are not available.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

CID 1405 FMI 06 changes to CID 1405 FMI 05 when the solenoid is disconnected.

Results:

- YES – CID 1405 FMI 06 changes to CID 1405 FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

  STOP.

- NO – CID 1405 FMI 06 remains active.Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J2-8 (wire 900-PU(Purple)) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-8 (wire 900-PU(Purple)) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1405 FMI 06.

Expected Result:

The CID 1405 FMI 06 is active.

Results:

- YES – The CID 1405 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 1405 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

Testing And Adjusting Section

Testing and Adjusting

i05812177

Wiring Harness (Open Circuit) - Test

SMCS Code: 1408-081

An open circuit is a failure that results in no current flow. An open circuit can be caused by:

- Poor connections
- Broken wires

Open Circuit Test

Table 16

Troubleshooting Steps	Values	Results
1. Identify Open Circuit A. Identify the connectors and wires in the suspect circuits. Use the machine Electrical Schematic. B. Turn off the keyswitch and the disconnect switch. C. Disconnect the component and the ECM from the harness. D. At one of the disconnected harness connections, place a jumper wire from the suspect wire contact to frame ground. E. At the other connector of the harness, measure the resistance from the suspect wire contact to frame ground(1).	< 5 Ω	**OK -** The resistance is < 5 Ω. The circuit is not open. STOP **Not OK -** The resistance is ≥ 5K Ω. The circuit is open(2). **Repair:** Repair or replace the harness. STOP

(1) Use a calibrated digital multimeter for this check.
(2) A resistance ≥ 5 Ω but < 5K Ω, indicates a loose or corroded connection. A resistance ≥ 5K Ω indicates an open.

i06512758

Wiring Harness (Open Circuit) - Test

SMCS Code: 1408-081

Electrical problems are often caused by open or shorted wires.

Open circuit – An electrical circuit failure that results in no current flow. An open circuit can be caused by failed wires or poor connections.

Note: Resistance in a normally closed circuit will be < 5 Ω.

TEST FOR A OPEN CIRCUIT

1. Identify the connectors and wire numbers of the suspect circuit.
2. Turn the keyswitch and the disconnect switch off.
3. Disconnect the component and the electronic control module (ECM) from the harness.

4. At one of the disconnected harness connections, place a jumper wire from the contact of the suspect wire to frame ground.
5. At the other harness connector, use multimeter probes to measure the resistance from the contact of the suspect wire to frame ground.

   If the resistance is < 5 Ω, the circuit is OK.

   If the resistance is ≥ 5.0 Ω, the circuit is open. Repair or replace the harness.

Reference: The machine Electrical Schematic

i05574489

Wiring Harness (Short Circuit) - Test

SMCS Code: 1408-081

Electrical problems are often caused by open or shorted wires.

Short circuit – When one part of a circuit contacts another part of the same circuit, the flow is diverted from the desired path.

TEST FOR A SHORT CIRCUIT

1. Turn the battery disconnect switch and the start switch to the OFF position.
2. Disconnect all ends of the harness.
3. Turn the dial of a calibrated digital multimeter to the 200 Ω range.
4. Measure the resistance.

   a. Use one multimeter probe to contact the connector of the suspected faulty electrical wire.

   b. Use the other multimeter probe to contact all other the electrical wires, one at a time, in the same harness.

      If there is continuity between any of the electrical wires, the multimeter will have a reading < 5 Ω. Continuity between any of the other wires in the harness indicates that there is a short between those wires. Repair or replace the harness.

   c. Use the multimeter to test for continuity across the ground (Frame).

      If there is continuity between any of the electrical wires and ground, the multimeter will have a reading < 5 Ω. If there is continuity between any of the wires and ground, there is a short between the wire and the ground. Repair or replace the harness.

Reference: Machine Electrical Schematic

i05817010

Wiring Harness (Short Circuit) - Test

SMCS Code: 1408-081

A short circuit is a circuit failure resulting in undesired current, usually a circuit bypass across a load.

For example: a short across the circuit wires for a lamp produces too much current in the wires, but no current to the lamp. The lamp circuit is shorted.

Note: Normal circuit resistance can vary, but the normal resistance between a particular circuit and other unrelated circuits is always ≥ 5K Ω.

Short Circuit Test

Table 17

Troubleshooting Test Steps	Values	Results
1. Identify Short Circuit A. Identify the connectors and wire numbers of the suspect circuits(1). B. Turn off the keyswitch and disconnect switch. C. Disconnect the component and ECM from the harness. D. At the harness connector for the ECM, place a multimeter probe on the suspect wire contact. E. Use the other multimeter probe to check the resistance across all other ECM connector contacts and frame ground.	≥ 5K Ω	**OK -** All resistance is ≥ 5K Ω. STOP **Not OK -** A resistance is < 5 Ω . There is a short between the suspect wire and the low resistance wire(2). **Repair:** Repair or replace the harness. STOP

(1) Use the machine Electrical Schematic.
(2) A resistance ≥ 5 Ω but < 5K Ω , indicates a loose or corroded connection. A resistance ≥ 5K Ω indicates an open.

i01622667

Electrical Connector - Inspect

SMCS Code: 1408-040-CY

Intermittent electrical problems are often caused by poor connections. Use the following checks as a reference for inspecting connectors.

1. Check the connection of the connectors.

- Ensure that the locking rings are properly locked.
- Ensure that locking clips are used on Sure Seal connectors.
- Ensure that the center of the connector is tight.
- Ensure that the connector pins and sockets align properly.

2. Check the wires at the connector.

- Ensure that the wires enter the back of the connector straight.
- Ensure that each wire is properly crimped into the proper connector contact.
- Ensure that each connector contact is properly locked into the connector contact. When the connector contact is locked properly, the contact (wire) cannot be pulled out of the connector body without excessive force.

3. Check each wire for nicks or signs of abrasion in the insulation.

4. Check for moisture at the connector.

- Check for damaged connector seals or lost connector seals.
- Check for missing or loose wire hole plugs.
- Check for wires that do not enter the connector properly.
- If the wires enter the connector at an angle, there may not be a good seal between the connector and the wire insulation.
- Moisture can enter the connector through the wire insulation.

5. Check for dirty contacts or corroded contacts.

- Clean contacts with a cotton swab or a soft brush and denatured alcohol only.

6. Check each pin and each socket.

- Check each contact of the connector for a snug fit by using a new pin and socket. The new contact should stay connected if the connector is held with the contacts that are facing down.

i07088594

Electrical Connector - Inspect

SMCS Code: 1408-040-CY

Reference: Special Instruction, SEHS9615, “Servicing DT Connectors”.

Reference: Special Instruction, REHS0148, “Listing Of Deutsch Connector Components”

Reference: Special Instruction, SEHS9065, “Use Of CE Connector Tools”.

Reference: Service Magazine, SEPD0342,27 January 97, “Field Repair Of Single Wire Breaks In Harnesses (Sealed Splice)”.

Reference: Service Magazine, SEPD0371,28 July 97, “Protection Of Unsealed Electrical Terminations For Machines In Corrosive Applications”.

Reference: Service Magazine, SEPD0473,24 May 99, “New DT Connector Plugs With Improved Seal Retention”.

Reference: Service Magazine, SEPD0545,09 October 00, “Dielectric Grease Should Not Be Used In Electrical Connectors”.

Reference: Pocket Guide, SEBD0402, “Guidelines For Routing And Installing Wire Harness Assemblies”.

This information will assist in detecting problems with connectors and wiring. If a problem is found, correct the condition and verify that the problem is resolved.

Disconnecting and reconnecting connectors sometimes resolve intermittent electrical problems. Check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code changed due to disconnecting and reconnecting a connector, the likely reasons are:

- Loose terminals
- Improperly crimped terminals
- Moisture
- Corrosion
- Inadequate mating of a connection

Guidelines

- Use a 1U-5804 Crimp Tool (12-GA TO 18-GA) to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. See Tool Operating Manual, SEHS9615, “Servicing Deutsch HD and DT Style Connectors”.
- Use a 147-6456 Wedge Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire to access to a circuit for measurements.
- If a wire is cut, always install a new terminal for the repair.

Tests

Check Connectors for Moisture and Corrosion

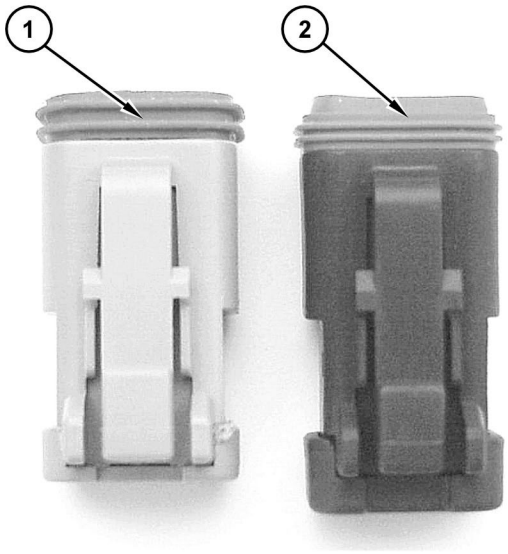


Illustration 91 g01960167

(1) Former seal design
(2) Current seal design

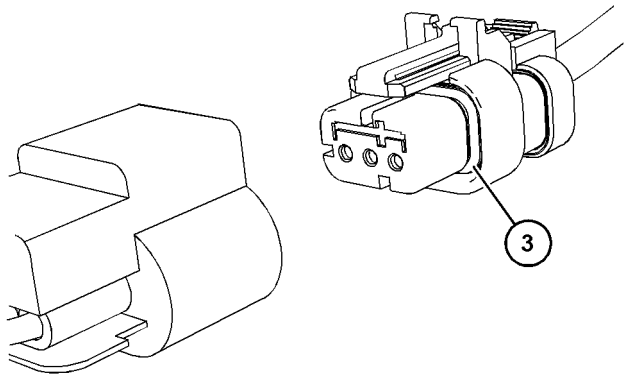


Illustration 92 g06220529

(3) Seal for a three-pin connector (typical example)

The plug end of the DT connector has a seal at the mating end of the connector. This replaceable seal has been improved on black connectors to help prevent slipping. This improvement will help keep moisture and dirt from entering the connector.

The current seal design (2) is not interchangeable with the former design (1). The receptacle has also changed to the new colors.

1. Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. This deformation will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

2. Disconnect the suspect connector and inspect the connector seal. Ensure that the seals are in good condition. If necessary, replace the connector.

3. Thoroughly inspect the connectors for evidence of moisture entry.

Some minor seal abrasion on connector seals is normal. Minor seal abrasion will not allow the entry of moisture. If moisture or corrosion is evident in the connector, the source of the moisture entry must be corrected. If the source of the moisture entry is not repaired, the problem will recur. Simply drying the connector will not fix the problem. Check the following items for the possible moisture entry path:

- Missing seals
- Improperly installed seals
- Nicks in exposed insulation
- Improperly mated connectors

Moisture can also travel to a connector through the inside of a wire. If moisture is found in a connector, thoroughly check the connector harness for damage. Also check other connectors that share the harness for moisture.

4. Repair or replace any bad connector. Correct any moisture problems.

Check the Wire Insulation for Damage

1. Carefully inspect each wire for signs of abrasion, of nicks, and of cuts. Inspect the wires for the following conditions:

- Exposed insulation
- Rubbing of a wire against the chassis
- Rubbing of a wire against a sharp point

2. Check all of the wiring harness fasteners to verify that the harness is properly secured. Check all of the fasteners to verify that the harness is not compressed. Pull back the harness sleeves to check for a flattened portion of wire. A fastener that has been overtightened will flatten the harness. This damages the wires that are inside the harness.

3. Repair or replace any wire with insulation damage.

Inspect the Connector Terminals

Visually inspect each terminal in the connector.

1. Verify that the terminals are not corroded.

2. Verify that the terminals are not damaged.

3. Verify that the terminals are properly aligned in the connector.

4. Verify that the terminals are properly located in the connector.

5. Replace any bad terminal.

Perform a Pull Test on Each Wire Terminal Connection

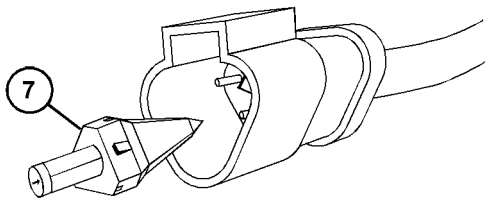


Illustration 93 g06220531

1. Ensure that the locking wedge for the connector is installed properly. Terminals cannot be retained inside the connector if the locking wedge is not installed properly.
2. Perform the 45 N (10 lb) pull test on each wire.

   Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.
3. Replace any bad terminals.

Check Individual Pin Retention into the Socket

Inspect pin retention.

1. Verify that the sockets provide good retention for the pins.
2. Disconnect the harness. Insert a new pin into each socket one at a time to check for a good grip on the pin by the socket.
3. Replace any bad pins or sockets.

Check the Locking Mechanism of the Connectors

1. Ensure that the connectors lock properly.
2. Lock the connectors, ensure that the two halves cannot be pulled apart.
3. Verify that the latch tab of the connector is properly latched.
4. Verify that the latch tab of the connector returns to the locked position.
5. Replace any bad connectors.

Perform the Wiggle Test with Cat® Electronic Technician (Cat ET)

1. Select the wiggle test from the diagnostic tests on Cat ® ET.
2. Choose the appropriate group of parameters to monitor.
3. Press the “Start” button.
4. Wiggle the wiring harness to reproduce intermittent problems.

   If an intermittent problem exists, the status will be highlighted and an audible beep will be heard.
5. Repair or replace any loose connections.

i01622947

Electronic Control Module (ECM) - Replace

SMCS Code: 7610-510-DTN

Prior to the replacement of the ECM, ensure that replacement is necessary. The ECM is seldom the cause of a failure. Always check that power is available to all of the contacts of the ECM that are marked with “+ Battery” .

Note: Corrupted configuration software or the wrong software may cause an ECM to incorrectly report diagnostic codes. Prior to replacing the ECM, flash the ECM with the correct configuration software in order to verify that the failure is not related to the corrupted software. See Testing and Adjusting, “Electronic Control Module - Flash Program”.

Procedure

1. Turn the disconnect switch and the key start switch to the OFF position.
2. Disconnect the machine harness connectors from the ECM.
3. Verify that the part number of the replacement ECM is correct.
4. Install the replacement ECM.
5. Connect the machine harness to the ECM.
6. Turn the disconnect switch and the key start switches to the ON position.

7. If necessary, use the Electronic Technician (ET) to install the configuration software. Refer to the Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program” section of this manual.

8. Verify that the ECM operates correctly.

i02325799

Electronic Control Module (ECM) - Flash Program

SMCS Code: 7610-591-DTN

Perform the following procedure in order to flash program the ECM. The ECM is flashed in order to upgrade the software. Flash programming of the ECM must also be done if the ECM has been replaced. The Caterpillar Electronic Technician (ET) contains the program WinFlash. WinFlash is used in order to load software into the ECM. The following procedure is used in order to FLASH software into the ECM.

1. Procedure

a. Connect the data link cable between the communication adapter and the electronic technician.

b. Connect the data link cable between the communication adapter and the diagnostic connector of the machine.

c. Turn the disconnect switch and the key start switch to the ON position.

d. Set the implement lockout to the LOCKED position.

e. Ensure that the transmission direction switch is in the NEUTRAL position.

f. Ensure that the engine is not running.

g. Use WinFlash in order to load the software.

i02442965

Electronic Control Module (ECM) - Configure

SMCS Code: 7610-587-DTN

Follow these instructions to get to the configuration screen:

1. Connect the communications adapter and the computer to the diagnostic service tool connector.

2. Start the Caterpillar Electronic Technician (ET).

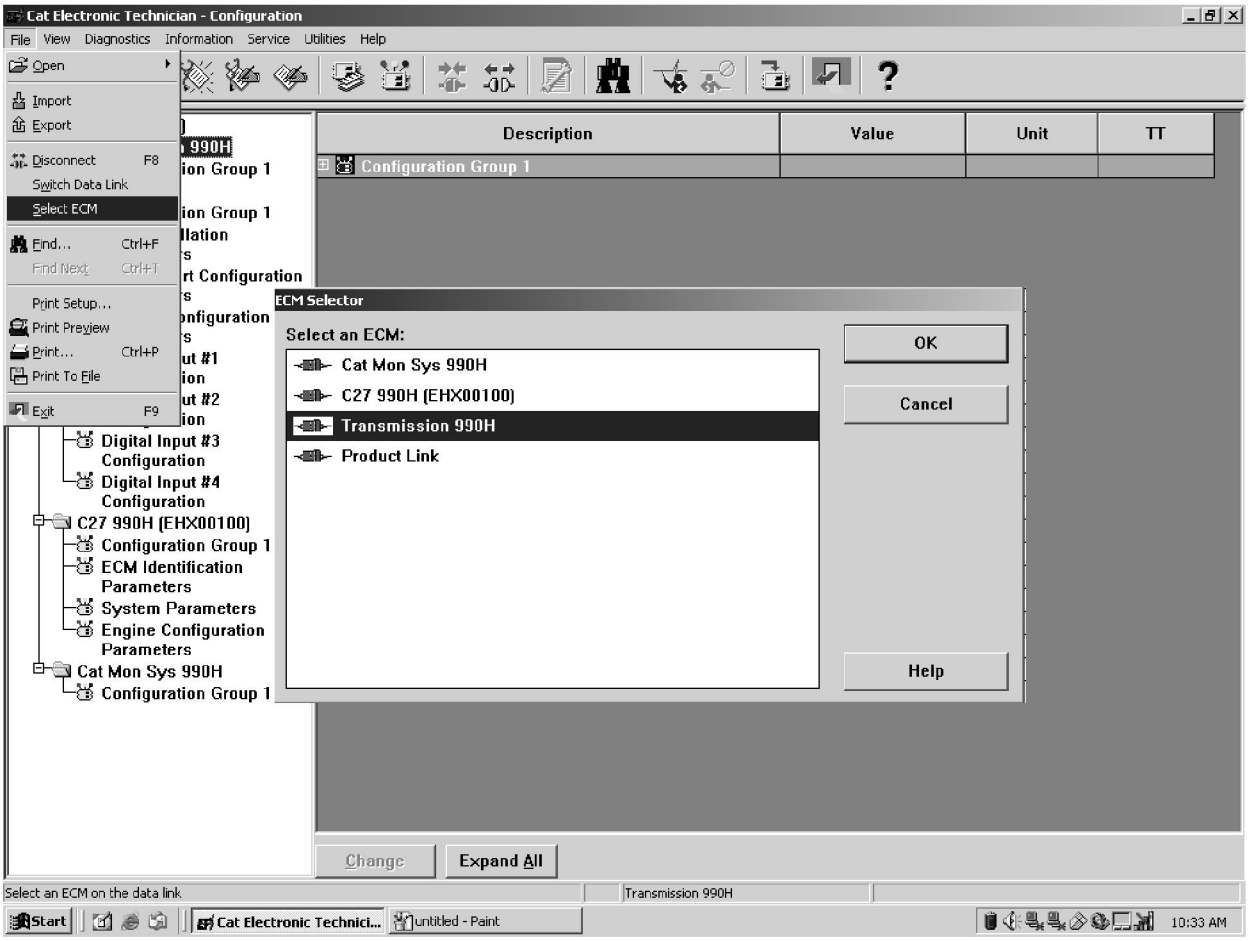


Illustration 94 g01227741

Typical screen to select an ECM

3. Select “File” . Go to “Select an ECM” . Choose the “Power Train Control” .

4. Go to the “Service” Menu. Select “Configuration” .

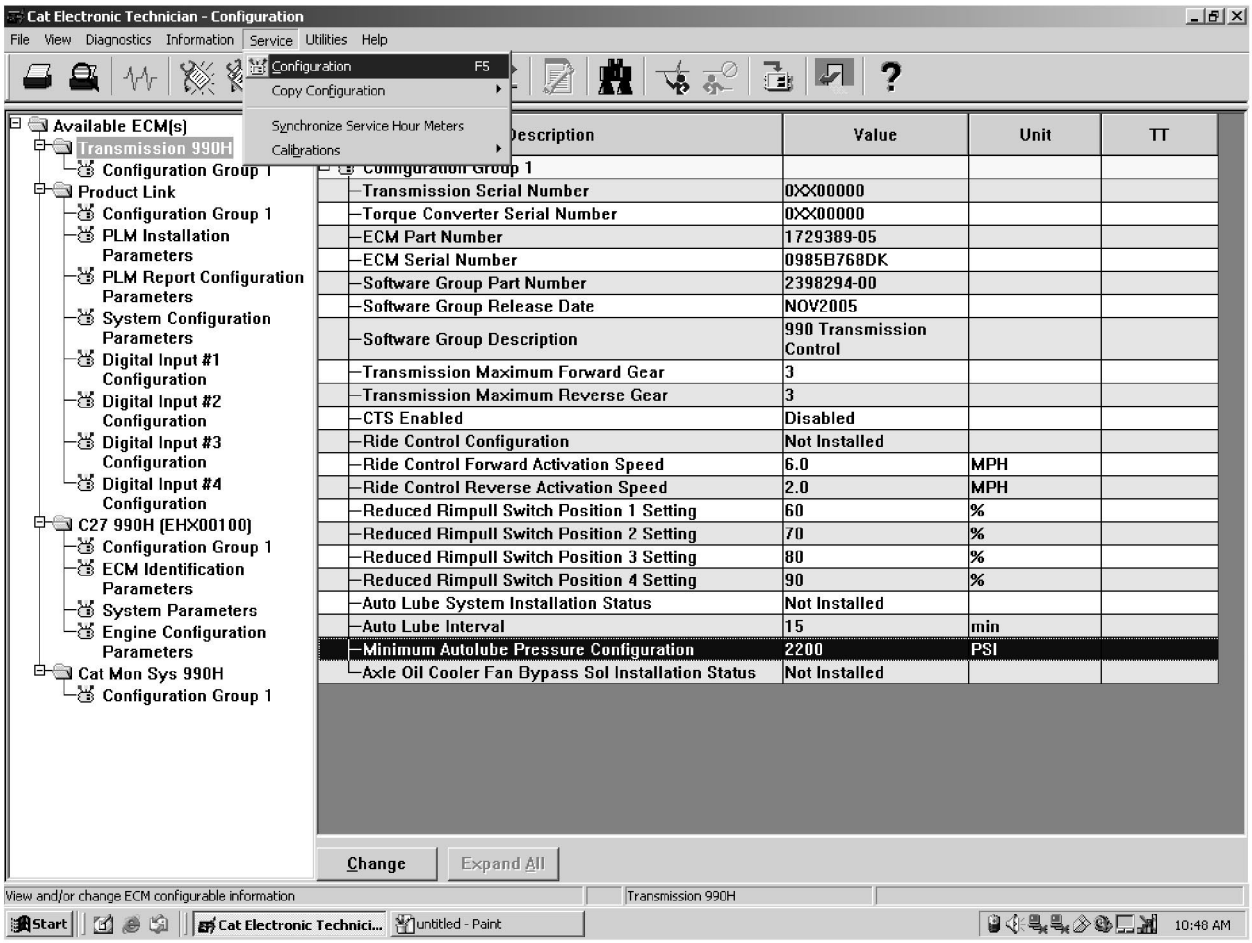


Illustration 95 g01227742

Typical ET Configuration screen

5. Select a configuration category in order to display the parameters. Certain operations or characteristics can be changed.

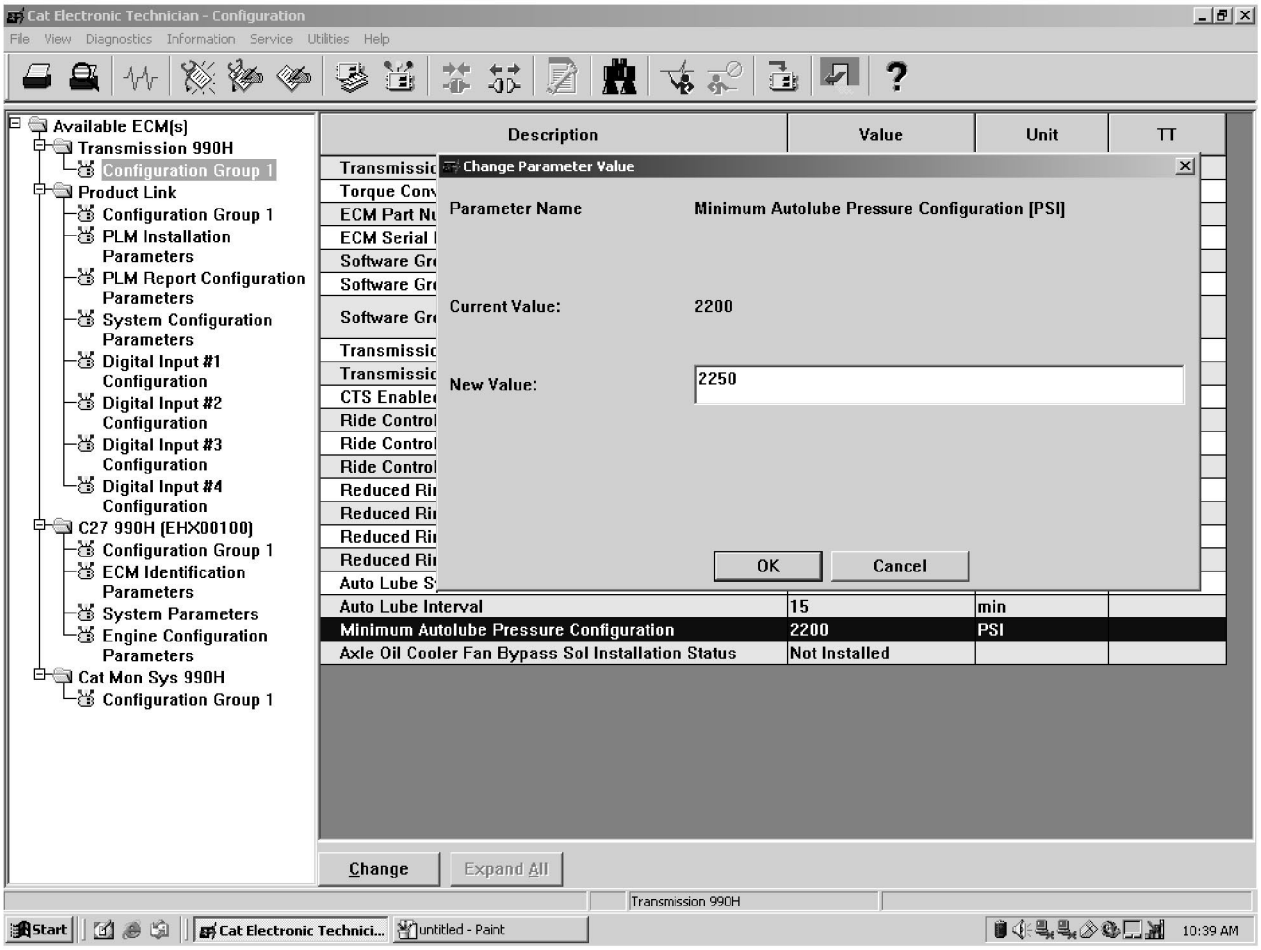


Illustration 96 g01227743

Typical User Configurable screen

6. Select the desired parameter for change.
7. “Click” on the “New Value” dropdown in order to change the parameter.
8. Select the new parameter.
9. “Click” on “OK” in order to confirm the new parameter.

i02407706

Ride Control Activation Speed (Electronic Technician) - Adjust

SMCS Code: 5004-025-VF

Machine Preparation

1. Park the machine on a smooth, level surface.
2. Shift the transmission direction control switch to the NEUTRAL position.
3. Lower the bucket or the work tool to the ground.
4. Engage the parking brake.
5. Place blocks in front of the wheels and behind the wheels.
6. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.
7. Shut off the engine.

Note: This calibration procedure can be performed without a running engine.

8. Turn the key start switch and the disconnect switch to the ON position.

Procedure for Adjusting the Ride Control Activation Speed in Caterpillar Electronic Technician (ET)

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

Table 18

Required Tools		
Part Number	**Description**	**Quantity**
139-4166	Data Link Cable	1
7X-1425	Cable	1
4C-6805	Adapter	1
171-4400	Communication Adapter Tool	1

The software program that will be used for this test procedure is the Caterpillar Electronic Technician (ET). The Caterpillar Electronic Technician is a software program that can be used on an IBM-compatible personal computer.

Reference: For more information about the use of Electronic Technician, refer to Testing and Adjusting, “Using Caterpillar Electronic Technician (ET) to Determine Diagnostic Codes” for the machine that is being serviced.

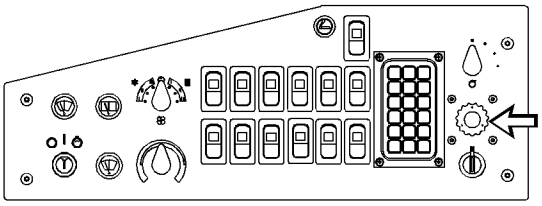


Illustration 97 g01202824

Location of the Service Connector

1. Connect the laptop computer to the service connector in the cab. The service connector is located on the right side instrument panel above the key start switch.

Note: The Caterpillar Electronic Technician (ET) will allow the activation speed for the ride control to be adjusted in 0.1 km/h (0.06 mph) increments. The engagement speed may be adjusted between 2 km/h (1.2 mph) to 23 km/h (14.3 mph). The factory setting for the activation speed (forward) is 10.0 km/h (6.2 mph). The factory setting for the activation speed (reverse) is 3.0 km/h (1.9 mph).

2. Open the software program (ET). Select the “Transmission 990H” or the “Transmission 844H” from the “ECM Selector” menu.

3. Select the “Service” menu item from the toolbar. Select the “Configuration” menu item.

Note: Activation of the software for the ride control without installation of the hardware for the ride control will introduce faults for the ride control switch and the solenoid.

4. Highlight the option for the ride control activation speed on the configuration screen. Click on the “Change” button in the bottom left of the screen. Enter the new value for the setting of the engagement speed. Click the “OK” button.



Illustration 98 g01111261

5. Click the “Yes” button.

6. The value of the engagement speed for the ride control has been changed.

7. Close the software program (ET). Shut down the laptop computer. Disconnect the computer from the service connector in the cab.

i02407676

Calibration

SMCS Code: 3139-524-VC; 4269-524-PSN; 7610-524-DTN

General Information for using the Caterpillar Monitoring System

The power train electronic control module (ECM) uses the main display module on the Caterpillar Monitoring System for showing diagnostic information to service personnel. Diagnostic information concerning the power train ECM is sent on the Cat Data Link to the Caterpillar Monitoring System. Service personnel must be familiar with the Caterpillar Monitoring System in order to troubleshoot the power train ECM.

The Caterpillar Monitoring System has several different modes of operation. For troubleshooting and calibrating the power train ECM, service personnel must place the Caterpillar Monitoring System in certain modes of operation.

Reference: For more information on the Caterpillar Monitoring System, refer to the Service Manual module Systems Operation, “Monitoring System (Power Train Functions)” for the machine that is being serviced.

Reference: For more information on troubleshooting with the Caterpillar Monitoring System, refer to the Service Manual Module Testing and Adjusting, “Using Caterpillar Monitoring System to Determine Diagnostic Codes” for the machine that is being serviced.

4C-8195 Control Service Tool allows service personnel to access service information. The service tool attaches to the four-pin connector. The connector is located on the right side instrument panel.

Note: Transmission Calibration Mode for the 990H Wheel Loader and the 844H Wheel Dozer is mode 8.

Perform the steps that follow in order to access Transmission Calibration Mode (8) for the power train ECM:

1. Connect 4C-8195 Control Service Tool to the service connector.
2. Turn the key start switch and the disconnect switch to the ON position.
3. Depress the “MODE” switch on the 4C-8195 Control Service Tool. The Caterpillar Monitoring System will scroll to different display modes in the display area while the “MODE” switch is depressed. Display mode 6 is used by the power train ECM. The “MODE” switch should be held until “-8-” is shown in the display area on the Caterpillar Monitoring System.
4. Depress the “SCROLL” switch until the display area is in the desired submode. The submodes that are available are listed in Table 19 that follows.

Table 19

Transmission Calibration Mode (8) Calibration Submodes	
Submode Number	**Description of Submode**
27	Calibration for the engagement pressure for the lockup clutch of the torque converter
28	Calibration for the impeller clutch solenoid
29	Calibration for the torque converter pedal position sensor

i02407735

Fill Pressure for the Impeller Clutch of the Torque Converter (Electronic Technician) - Calibrate

SMCS Code: 3139-524-VC

Procedure for the Pressure Calibration of the Impeller Clutch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth, level surface.
2. Shift the transmission direction control switch to the NEUTRAL position.
3. Lower the bucket or the work tool to the ground.
4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Shut off the engine.

8. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

9. Start the engine.

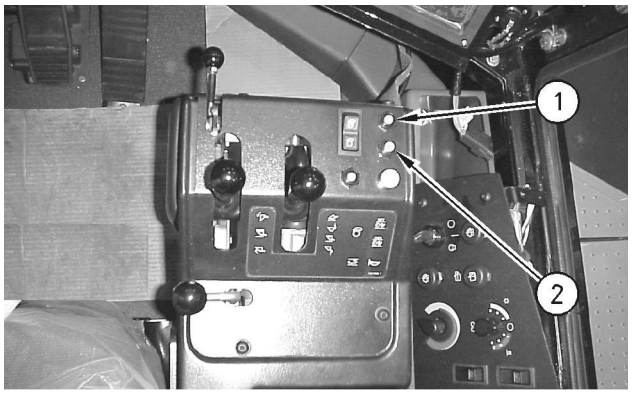


Illustration 99 g00854115

(1) SET/DECEL switch
(2) RESUME/ACCEL switch

10. You can use SET/DECEL button (1) to maintain the high idle. RESUME/ACCEL button (2) can be used to resume high idle.

Table 20

Required Tools		
Part Number	**Description**	**Quantity**
139-4166	Data Link Cable	1
7X-1425	Cable	1
4C-6805	Adapter	1
171-4400	Communication Adapter Tool	1

The software program that will be used for this test procedure is the Caterpillar Electronic Technician (ET). The Caterpillar Electronic Technician is a software program that can be used on an IBM-compatible personal computer.

Reference: For more information about the use of Electronic Technician, refer to Testing and Adjusting, “Using Caterpillar Electronic Technician (ET) to Determine Diagnostic Codes” for the machine that is being serviced.

1. Open the software program (ET). Select the “Transmission 990H” menu item or the “Transmission 844H” menu item.

2. Select the “Service” menu in order to begin the calibration procedure. Then select “Calibrations” . A second menu will be displayed. Select “Impeller Clutch Solenoid Calibration” from the second menu.

3. The next screen is the initial calibration screen. Once “Impeller Clutch Solenoid Calibration” has been selected, the screen displays the incremental instructions for calibration. The top display area displays status parameters that are monitored during the calibration. The middle display area displays information about the status of the calibration. The bottom display area displays incremental instructions for the calibration. The step that currently needs to be carried out is in bold text. All other steps are displayed in gray text.

4. Press the “**Next>**” button in order to start the calibration. The “**Next>**” button is disabled, until the current step has been successfully completed. A check will be placed in the box that is left of the step, after the current step is complete. After the successful completion of a step, press the “**Next>**” button in order to begin the following step. Continue this process in order to complete the calibration procedure.

5. The ECM detects possible error messages during the calibration. When an error is detected the ECM will stop the calibration. The error message will be displayed in the middle display area. The error message will read “E009 - Aborted by ECM” .

6. The calibration procedure is automatic. The bar that shows the progress of the calibration will be displayed in order to increment the completed steps for calibration. When the calibration is complete, the “**Cancel**” button will change to a “**Restart**” button. The middle display area will display the message “Calibration Successful” .

7. When the calibration is complete select the “**Restart**” button in order to run the test again or select another menu option.

8. To exit the calibration, select the “File” menu and then select the “Exit” .

i02407758

Engagement Pressure for the Lockup Clutch of the Torque Converter (Electronic Technician) - Calibrate

SMCS Code: 3139-524-VC

If the pressure for engagement of lockup clutch is not correct, the life of the lockup clutch can be greatly affected. Use the Electronic Technician to set the pressure of the clutch. In this process, the service technician adjusts the electrical current that is sent to this clutch solenoid valve in order to obtain the pressure for the engagement of lockup clutch that is specified.

The lockup clutch system must be calibrated if any of the following conditions have occurred:

- A solenoid valve has been replaced or cleaned.
- A different power train ECM has been installed.
- A lockup clutch has been rebuilt.
- The power train ECM is flashed and a 679F13 fault is active.

Reference: For additional information on the clutch solenoid modulating valves, refer to the Service Manual module Systems Operation, “Modulating Valve (Torque Converter Lockup Clutch)” for the machine that is being serviced.

Calibration Procedure for Engagement of Torque Converter Lockup Clutch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Do not connect or disconnect hose fittings to or from the quick disconnect nipples when there is pressure in the system. This will prevent damage to the seals that are in the fitting.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Park the machine on a smooth, level surface.

2. Shift the transmission direction switch to the NEUTRAL position. Shift the transmission speed switch to any speed position.

3. Lower the bucket or the work tool to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Shut off the engine.

8. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Table 21

Required Tools		
Part Number	**Description**	**Quantity**
1U-5481 (1)	Pressure Gauge Group	1
1U-5482	Hoses From the Pressure Adapter Group	1
139-4166	Data Link Cable	1
7X-1425	Cable	1
4C-6805	Adapter	1
171-4400	Communication Adapter Tool	1

(1) The 198-4240 Pressure Indicator Tool Gp is also available.

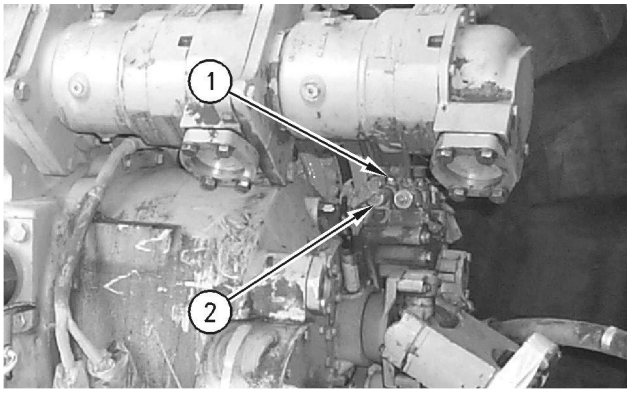


Illustration 100 g00853898

(1) Pressure tap for the lockup clutch
(2) Lockup clutch solenoid valve

1. Install a hose from 1U-5482 Pressure Adapter Group to pressure tap (1).



Illustration 101 g00685910

(3) 1U-5481 Pressure Gauge Group

2. Attach the opposite end of the hose assembly to the 0 to 3400 kPa (0 to 580 psi) pressure gauge in the 1U-5481 Pressure Gauge Group (3).

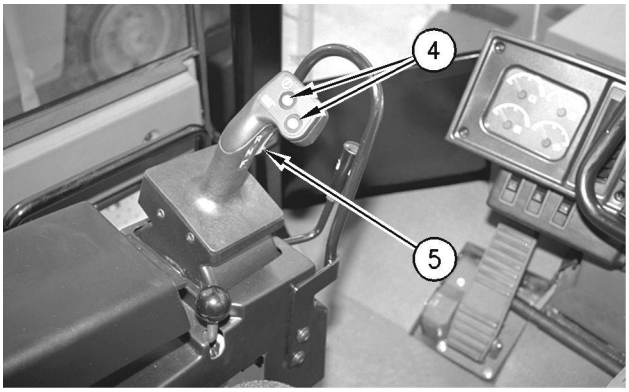


Illustration 102 g00685913

STIC Steering Control

(4) Upshift/downshift switch
(5) Transmission direction control switch

3. Make sure that transmission direction control switch (5) is in the NEUTRAL position.

4. Make sure that the parking brake is engaged.

5. Start the engine.

6. Warm the transmission oil to approximately 40 °C (104 °F).

Note: The transmission oil temperature gauge should be at the center position.

7. Operate the engine at low idle.

Note: If a new clutch solenoid modulating valve was installed, shift the transmission for at least 12 times into a speed or a direction that uses the clutch solenoid modulating valve. Refer to Illustration 100 in order to identify the clutch solenoid modulating valve and the corresponding clutch. Allow sufficient time for the corresponding clutch to be fully pressurized.

8. Increase the engine speed to high idle.

Note: You can use the SET/DECEL switch to maintain the high idle. The RESUME/ACCEL switch can be used to resume high idle.

Table 22

Engagement Pressure for the Torque Converter Lock-up Clutch	
Model	**Lockup Clutch**
990H Wheel Loader and 844H Wheel Dozer	2030 ± 240 kPa (295 ± 35 psi)

Note: The software program that will be used for this test procedure is the Caterpillar Electronic Technician (ET). The Caterpillar Electronic Technician is a software program that can be used on an IBM-compatible personal computer.

Reference: For more information about the use of Electronic Technician, refer to Testing and Adjusting, “Using Caterpillar Electronic Technician (ET) to Determine Diagnostic Codes” for the machine that is being serviced.

9. Open the software program (ET). Select the “Transmission 990H” menu item or the “Transmission 844H” menu item.

10. Select the “Service” menu in order to begin the calibration procedure. Then select “Calibrations” . A second menu will be displayed. Select “Lockup Clutch Engagement Calibration” from the second menu.

11. The next screen is the initial calibration screen. The calibration screen displays the incremental instructions for calibration. The top display area displays status parameters that are monitored during the calibration. The middle display area displays information about the status of the calibration. The bottom display area displays incremental instructions for the calibration. The step that currently needs to be carried out is in bold text. All other steps are displayed in gray text.

12. Press the “**Next>**” button in order to start the calibration. The “**Next>**” button is disabled, until the current step has been successfully completed. A check will be placed in the box that is left of the step, after the current step is complete. After the successful completion of a step, press the “**Next>**” button in order to begin the following step. Continue this process in order to complete the calibration procedure.

13. Once the calibration for the clutch pressure begins, refer to Table 22 for the clutch pressure. The pressure for the clutch should match the pressure in Table 22 . If the pressure does not match Table 22 , adjust the pressure. Press buttons “**<<**” , “**<**” , “**>**” , or “**>>**” at the bottom of the screen in order to adjust the flow of current to the clutch solenoid. When the desired pressure is reached press the “**Next>**” button in order to continue the calibration.

14. A dialog box will appear after the calibration of the clutch is complete. The dialog box displays the selected calibration and the status. After viewing the status, select the “**Restart**” button or the “**Finish**” button.

15. To exit the calibration, select the “File” menu and then select “Exit” .

i02407847

Position Sensor (Left Brake Pedal) (Electronic Technician) - Calibrate

SMCS Code: 4809-524

Procedure for the Calibration of the Torque Converter Pedal Position Sensor for the Impeller Clutch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth, level surface.

2. Shift the transmission direction control switch to the NEUTRAL position.

3. Lower the bucket or the work tool to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Shut off the engine.

Note: This calibration procedure can be performed without a running engine.

8. Turn the key start switch and the disconnect switch to the ON position.

9. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Table 23

Required Tools		
Part Number	**Description**	**Quantity**
139-4166	Data Link Cable	1
7X-1425	Cable	1
4C-6805	Adapter	1
171-4400	Communication Adapter Tool	1

The software program that will be used for this test procedure is the Caterpillar Electronic Technician (ET). The Caterpillar Electronic Technician is a software program that can be used on an IBM-compatible personal computer.

Reference: For more information about the use of Electronic Technician, refer to Testing and Adjusting, “Using Caterpillar Electronic Technician (ET) to Determine Diagnostic Codes” for the machine that is being serviced.

1. Open the software program (ET). Select the “Transmission 990” menu item or the “Transmission 844” menu item.

2. Select the “Service” menu in order to begin the calibration procedure. Then select “Calibrations” . A second menu will be displayed. Select “Torque Converter Pedal Calibration” from the second menu.

3. The next screen is the initial calibration screen. Once “Torque Converter Pedal Calibration” has been selected, the screen displays the incremental instructions for calibration. The top display area displays status parameters that are monitored during the calibration. The middle display area displays information about the status of the calibration. The bottom display area displays incremental instructions for the calibration. The step that currently needs to be carried out is in bold text. All other steps are displayed in gray text.

4. Press the “**Next>**” button in order to start the calibration. The “**Next>**” button is disabled, until the current step has been successfully completed. A check will be placed in the box that is left of the step, after the current step is complete. After the successful completion of a step, press the “**Next>**” button in order to begin the following step. Continue this process in order to complete the calibration procedure.

5. The ECM detects possible error messages during the calibration. When an error is detected the ECM will stop the calibration. The error message will be displayed in the middle display area. Refer to Table 24 for possible error messages.

Table 24

Error Messages
“Torque Converter Pedal Depressed Too High”
“Torque Converter Pedal Depressed Too Low”
“Torque Converter Pedal Range Too Large”
“Torque Converter Pedal Range Too Small”

6. When the calibration is complete select the “**Restart**” button in order to run the test again or select another menu option.

7. To exit the calibration, select the “File” menu and then select “Exit” .

i02460108

Reduced Rimpull Setting (Electronic Technician) - Adjust

SMCS Code: 3140-025

Table 25

Required Tools		
Part Number	**Description**	**Quantity**
139-4166	Data Link Cable	1
7X-1425	Cable	1
4C-6805	Adapter	1
171-4400	Communication Adapter Tool	1

The software program that will be used for this test procedure is the Caterpillar Electronic Technician (ET). The Caterpillar Electronic Technician is a software program that can be used on an IBM-compatible personal computer.

Reference: For more information about the use of Electronic Technician, refer to Testing and Adjusting, “Using Caterpillar Electronic Technician (ET) to Determine Diagnostic Codes” for the machine that is being serviced.

Machine Preparation

1. Park the machine on a smooth, level surface.

2. Shift the transmission direction control switch to the NEUTRAL position.

3. Lower the bucket or the work tool to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

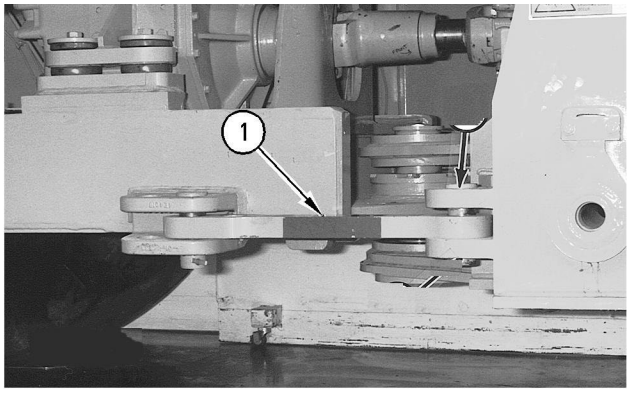


Illustration 103 g00853003

(1) Steering frame lock in LOCKED position

6. Install the steering frame lock.

7. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

8. Shut off the engine.

Note: This calibration procedure can be performed without a running engine.

9. Turn the key start switch and the disconnect switch to the ON position.

Procedure for Setting the Values of the Reduced Rimpull Select Switch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

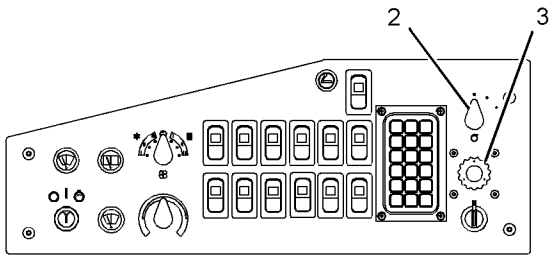


Illustration 104 g01202894

(2) Reduced rimpull select switch
(3) Service connector

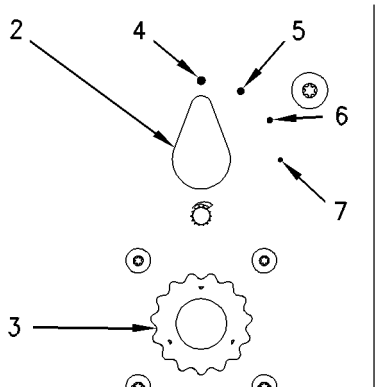


Illustration 105 g00853011

(2) Reduced rimpull select switch
(3) Service connector
(4) Position 4
(5) Position 3
(6) Position 2
(7) Position 1

1. Connect the laptop computer to the service connector (3) in the cab. The service connector is located on the right side console of the operator's station.

Note: The Caterpillar Electronic Technician (ET) will allow a reduced rimpull setting at a lower position to be set to a value that is higher than the value of a reduced rimpull setting at a higher position. Make sure that the values of the reduced rimpull settings increase from the lowest setting to the highest setting.

Note: The maximum reduced rimpull setting is 97%. The minimum reduced rimpull setting is 23%.

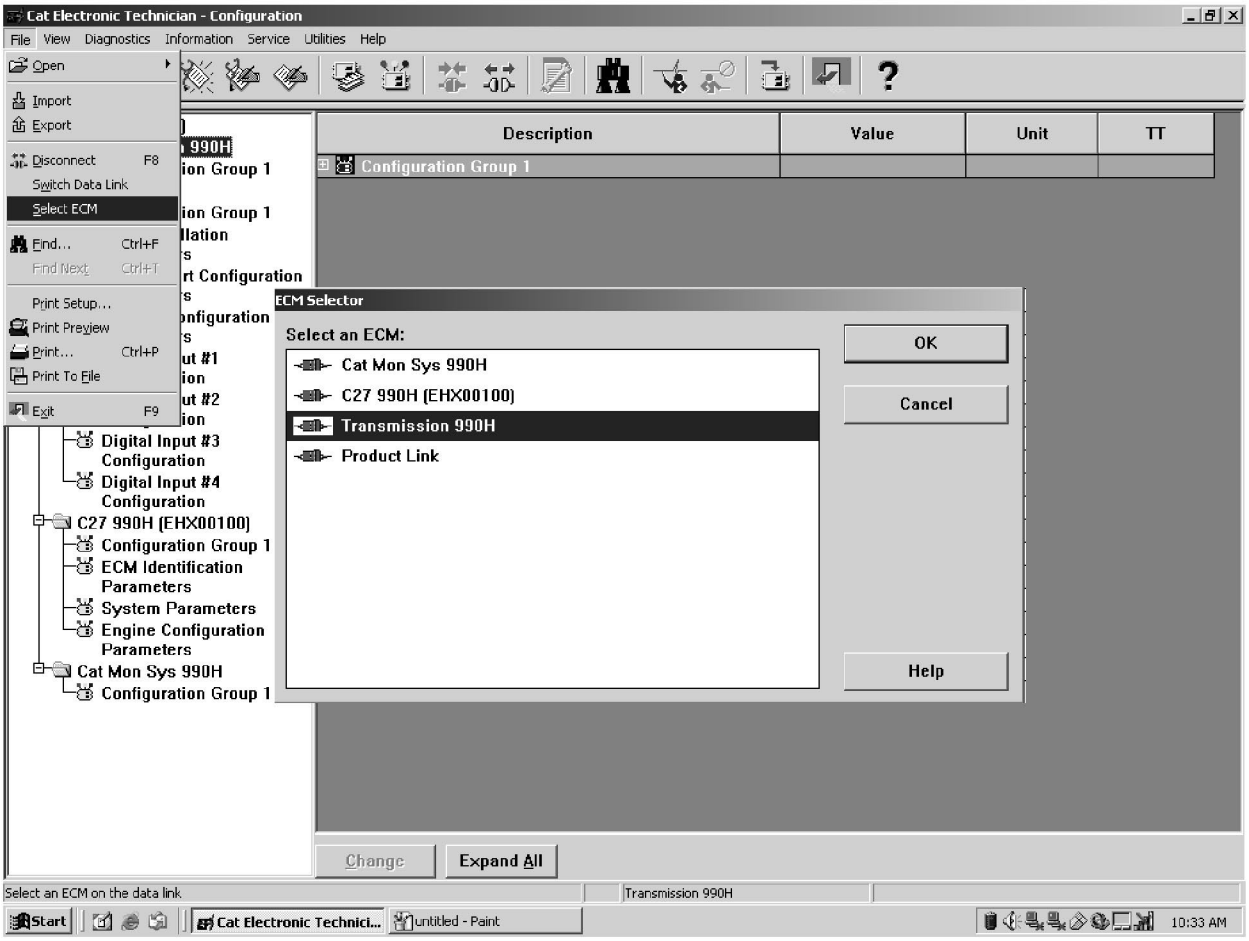


Illustration 106 g01227741

Typical Screen to select an ECM

2. Open the software program (ET). Select the “Transmission 990” or the “Transmission 844” from the “ECM Selector” menu.

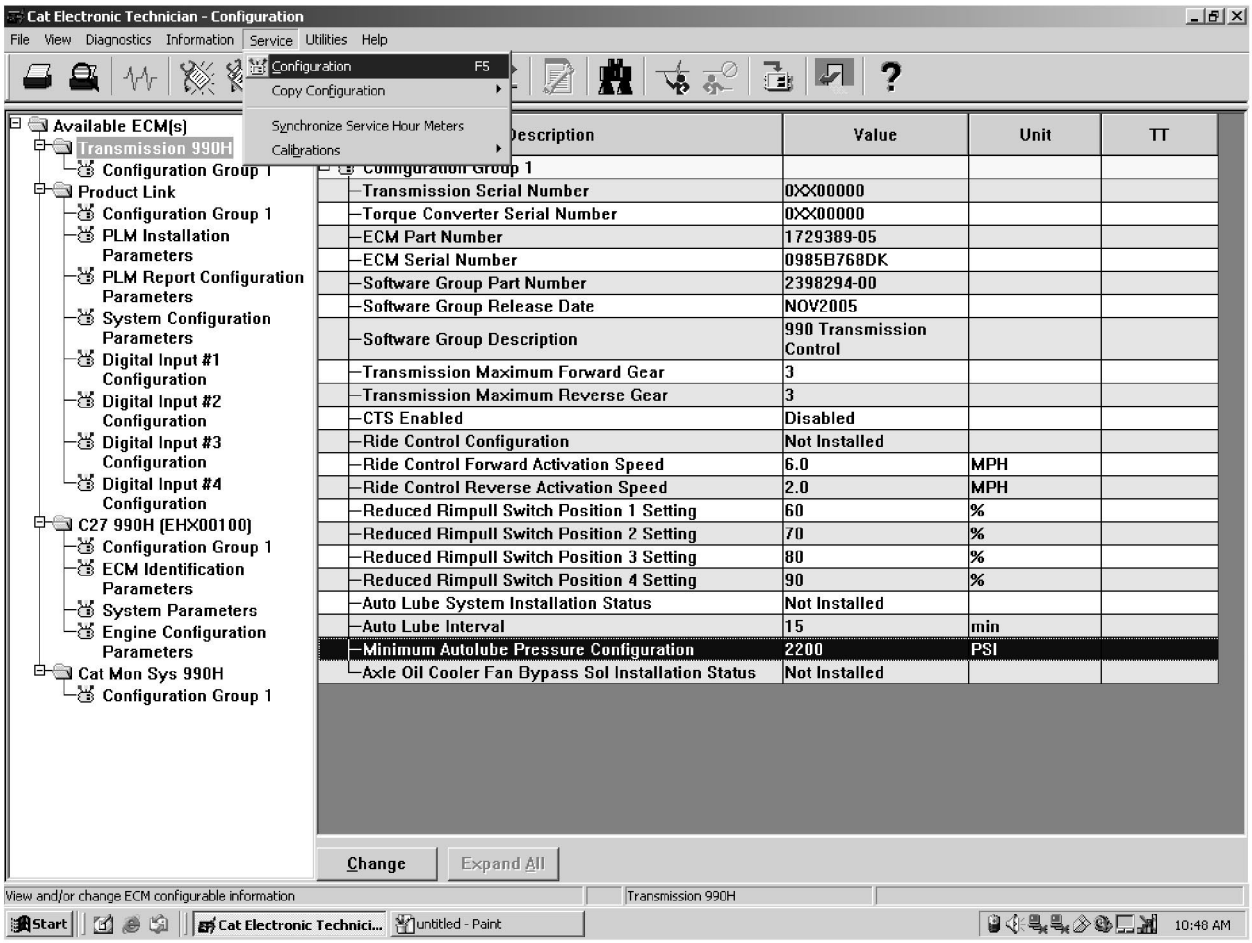


Illustration 107 g01227742

Typical ET Configuration screen

3. Select the “Service” menu item from the toolbar.
Select the “Configuration” menu item.

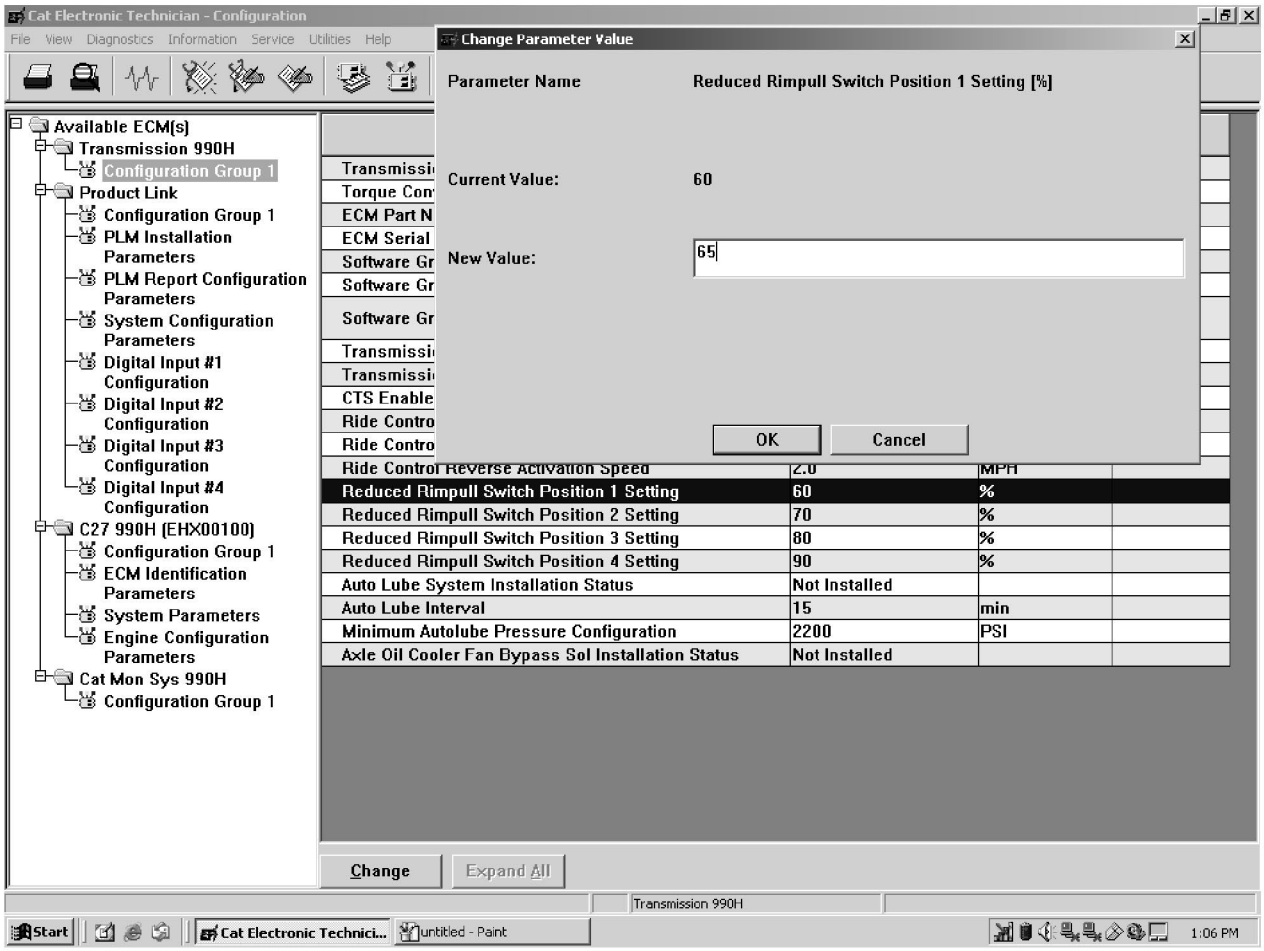


Illustration 108 g01228427

Typical User Configurable screen

4. The reduced rimpull settings are near the bottom of the screen. Highlight the setting to change. Click on the “Change” button in the bottom left of the screen. (Double-click on the selection will perform this same action.) Enter the new value for the reduced rimpull setting. Click the “OK” button.

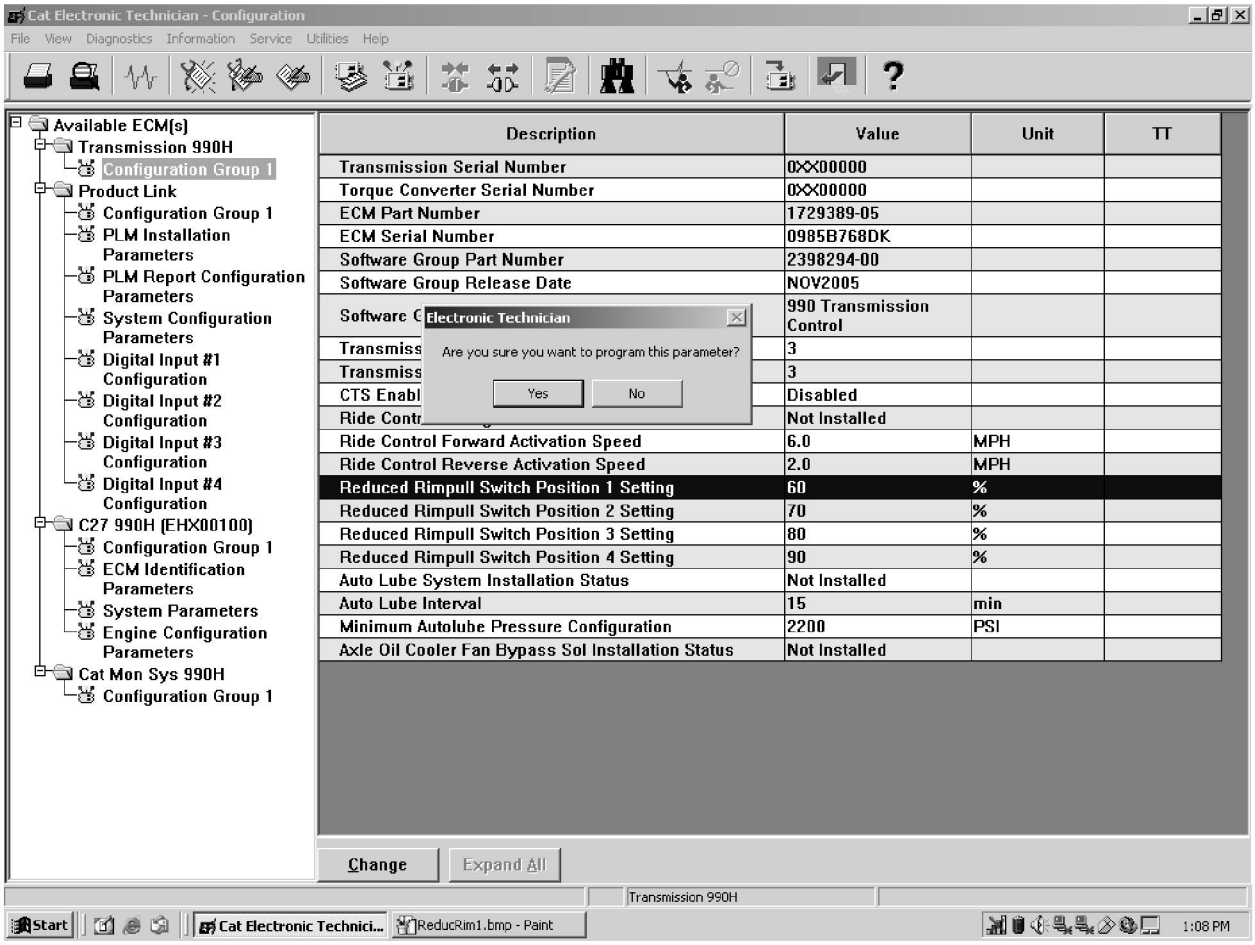


Illustration 109 g01228429

Parameter Change User Confirmation

5. The Cat ET will prompt for confirmation of the parameter change. “Are you sure you want to program this parameter?” Click the “Yes” button in order to confirm the change.

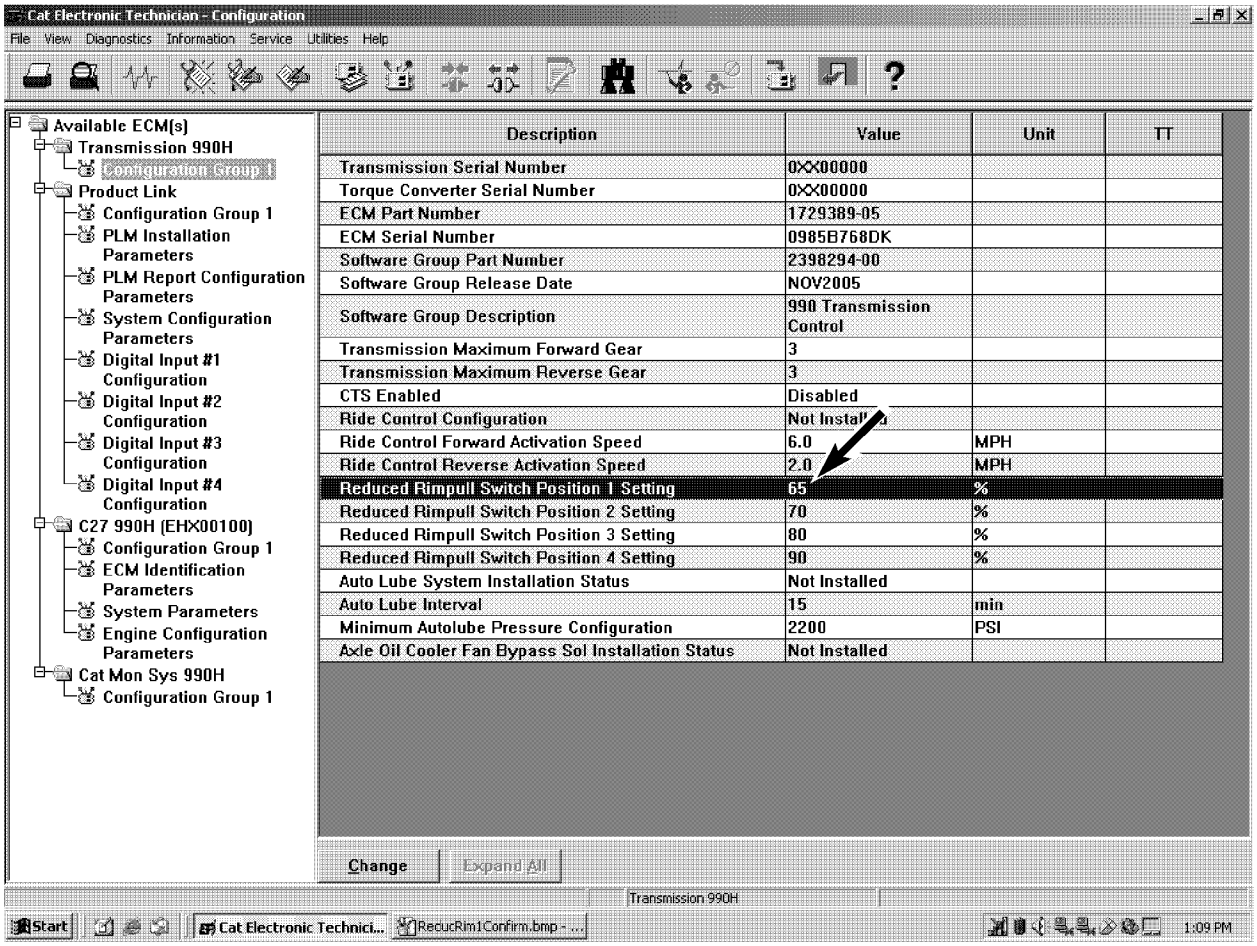


Illustration 110 g01228425

6. The value of the reduced rimpull setting for the "Position 1" switch has been changed.

7. Repeat Steps 2 through 6 for each of the reduced rimpull switches that require a change.

8. Close the software program (ET). Shut down the laptop computer. Disconnect the computer from the service connector in the cab.

i02407893

Fill Pressure for the Impeller Clutch of the Torque Converter (Operator Monitor) - Calibrate

SMCS Code: 3139-524-VC

Reference: For information on the setup of the Caterpillar Monitoring System, refer to Testing and Adjusting, "Calibration" for the machine that is being serviced.

Use submode 28 to calibrate the impeller clutch pressure.

Procedure for the Pressure Calibration of the Impeller Clutch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth, level surface.

2. Shift the transmission direction control switch to the NEUTRAL position.

3. Lower the bucket or the work tool to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Shut off the engine.

8. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Table 26

Required Tools		
Part Number	**Description**	**Quantity**
4C-8195	Control Service Tool	1
1U-5481(1)	Pressure Gauge Group	1
1U-5482	Hoses From the Pressure Adapter Group	6

(1) The 198-4240 Pressure Indicator Tool Gp is also available.

9. Use the 4C-8195 Control Service Tool to enter Transmission Calibration Mode (6) via the “MODE” switch. Then enter submode 28 by using the “SCROLL” switch.

10. Start the engine.

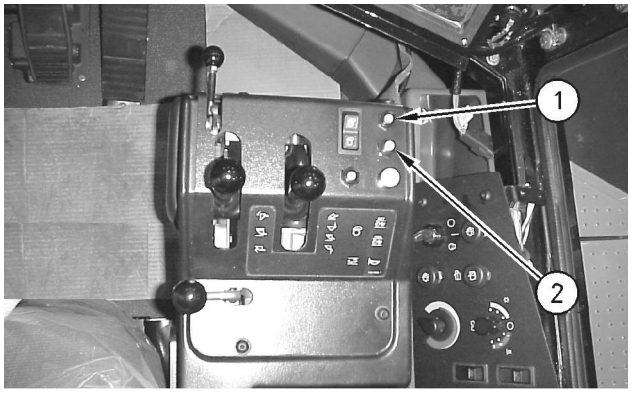


Illustration 111 g00854115

(1) SET/DECEL switch
(2) RESUME/ACCEL switch

11. The machine should be in the NEUTRAL position. Set the parking brake. Increase the engine speed to high idle.

Note: You can use SET/DECEL switch (1) to maintain the high idle. RESUME/ACCEL switch (2) can be used to resume high idle.

12. Use the INCREMENT (+) position of the “CLEAR” switch in order to start the calibration procedure.

13. When the display on the Caterpillar Monitoring System reads “28_EXX” , an error has been detected in the setup.

14. When the display shows “28_0->” , toggle the “CLEAR” switch in order to begin the calibration procedure. Once the calibration procedure starts the display will show “28_1->” . The one will move across the screen until the calibration procedure is complete.

15. If the calibration procedure was successful, “28_—” will be displayed on the Caterpillar Monitoring System.

16. To exit submode 28, scroll to the next submode by using the “SCROLL” switch or exit Transmission Calibration Mode (6) by using the “MODE” switch.

17. Stop the engine if testing is complete.

i02407896

Engagement Pressure for the Lockup Clutch of the Torque Converter (Operator Monitor) - Calibrate

SMCS Code: 3139-524-VC

Reference: For information on the setup of the Caterpillar Monitoring System, refer to Testing and Adjusting, “Calibration” for the machine that is being serviced.

If the pressure for engagement of lockup clutch is not correct, the life of the lockup clutch can be greatly affected. Use submode 27 to set the pressure of the clutch. In this process, the service technician adjusts the electrical current that is sent to this clutch solenoid valve in order to obtain the pressure for the engagement of lockup clutch that is specified.

The lockup clutch system must be calibrated if any of the following conditions have occurred:

- A solenoid valve has been replaced or cleaned.
- A different power train ECM has been installed.
- A lockup clutch has been rebuilt.
- The power train ECM is flashed and a 679F13 fault is active.

Table 27

Error Codes for Transmission Clutch Engagement	
E01	Active Clutch Solenoid or Speed Sensor Fault Correct the Speed Sensor Fault
E04	Transmission Direction Control Switch is Not in the NEUTRAL Position
E05	Transmission Oil Temperature is Below Threshold (40°C (104°F))
E06	Engine Speed Is Not Between 2050 and 2200 RPM
E07	Parking Brake Is Not Engaged
E09	Machine Speed Is Not Zero

During the calibration of the pressure for the transmission clutch engagement, error codes “EXX” can occur. The error codes will appear in the display area of the Caterpillar Monitoring System. The error codes will appear if a problem occurs during the calibration. Check the error codes in Table 27 .

Calibration Procedure for Engagement of Torque Converter Lockup Clutch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Do not connect or disconnect hose fittings to or from the quick disconnect nipples when there is pressure in the system. This will prevent damage to the seals that are in the fitting.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Park the machine on a smooth, level surface.
2. Shift the transmission direction switch to the NEUTRAL position. Shift the transmission speed switch to any speed position.
3. Lower the bucket or the work tool to the ground.
4. Engage the parking brake.
5. Place blocks in front of the wheels and behind the wheels.
6. Install the steering frame lock.
7. Shut off the engine.
8. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Table 28

Required Tools		
Part Number	**Description**	**Quantity**
4C-8195	Control Service Tool	1
1U-5481(1)	Pressure Gauge Group	1
1U-5482	Hoses From the Pressure Adapter Group	6

(1) The 198-4240 Pressure Indicator Tool Gp is also available.

Note: The steps of this procedure must be performed exactly, as described below. This procedure may terminate if any unknown functions or any unexpected functions are activated. This procedure may terminate if a fault (CID FMI) is present. Do not move any switch positions, any levers or any pedals unless you are instructed differently.

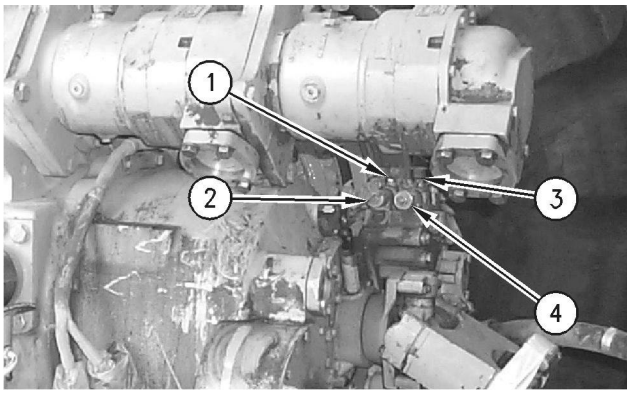


Illustration 112 g00852835

(1) Pressure tap for the lockup clutch
(2) Lockup clutch solenoid valve
(3) Pressure tap for the impeller clutch
(4) Impeller clutch solenoid valve

1. Install a hose from 1U-5482 Pressure Adapter Group to pressure tap (1).



Illustration 113 g00853408

(5) 1U-5481 Pressure Gauge Group

2. Attach the opposite end of the hose assembly to the 0 to 3400 kPa (0 to 580 psi) pressure gauge in the 1U-5481 Pressure Gauge Group (5).

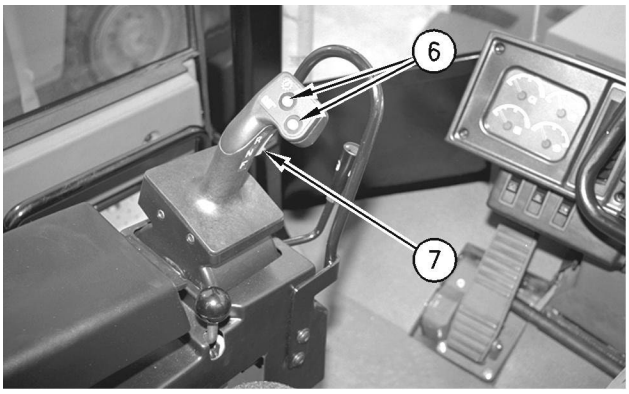


Illustration 114 g00853410

STIC Steering Control

(6) Upshift/downshift switch
(7) Transmission direction control switch

3. Make sure that transmission direction control switch (7) is in the NEUTRAL position.

4. Make sure that the parking brake is engaged.

5. Start the engine.

6. Warm the transmission oil to approximately 40 °C (104 °F).

Note: The transmission oil temperature gauge should be at the center position.

7. Operate the engine at low idle.

Note: If a new clutch solenoid modulating valve was installed, shift the transmission for at least 12 times into a speed or a direction that uses the clutch solenoid modulating valve. Refer to Illustration 112 in order to identify the clutch solenoid modulating valve and the corresponding clutch. Allow sufficient time for the corresponding clutch to be fully pressurized.

8. Increase the engine speed to high idle.

Note: You can use the SET/DECEL switch to maintain the high idle. The RESUME/ACCEL switch can be used to resume high idle.

Table 29

Clutch Engagement Calibration Submode	
Submode 27	Engagement of the Lockup Clutch

9. Use the 4C-8195 Control Service Tool to enter Transmission Calibration Mode 6. Then enter submode 27. Enter the submode by using the “SCROLL” switch.

Table 30

Engagement Pressure for the Torque Converter Lock-up Clutch	
Model	**Lockup Clutch**
990H Wheel Loader and 844H Wheel Dozer	2030 ± 240 kPa (295 ± 35 psi)

10. If all the conditions are correct for calibration, the pressure for the clutch is shown in the display area of the Caterpillar Monitoring System. The unit of the value that is displayed is shown in one-tenth of kPa. Multiply the value that is shown in the display by 10 to determine the true specified value in kPa. Record the value.

In the remaining steps, adjustments are made so that this pressure is the actual pressure gauge reading. The pressure is also listed in Table 30 .

Note: If the conditions are not correct for calibration, the pressure is not shown in the display area. Instead, an error code (“EXX”) appears. The calibration will not run until all necessary conditions are met. Correct the error code and perform these procedures again. Refer to Table 27 for a list of the error codes and the meaning of the error codes.

11. When all conditions are met and the pressure is shown in the display area, shift transmission direction control switch (7) to the FORWARD position. This pressurizes the torque converter lockup clutch.

12. The value that is shown in the display area will change and a number that corresponds to the electrical current of the particular clutch solenoid modulating valve is shown. The INCREMENT (+) and DECREMENT (−) positions of the “CLEAR” switch can now be used to adjust the electrical current of the clutch solenoid modulating valve. The electrical current of the clutch solenoid modulating valve controls the pressure.

While you are observing the pressure gauge that was installed in Step 2, use the “CLEAR” switch in order to adjust the pressure of engagement until the pressure gauge reading matches the pressure of engagement from Table 30 .

13. Shift the transmission direction control switch to the NEUTRAL position. This completes the calibration of the selected clutch.

14. To exit this submode, use the “SCROLL” switch to scroll to the next submode, or exit Transmission Calibration Mode by using the “MODE” switch.

i02408240

Position Sensor (Left Brake Pedal) (Operator Monitor) - Calibrate

SMCS Code: 4809-524

Reference: For information on the setup of the Caterpillar Monitoring System, refer to Testing and Adjusting, “Calibration” for the machine that is being serviced.

Use submode 29 to calibrate the parameters of travel for the torque converter pedal. The position sensor is located under the left brake pedal.

Procedure for the Calibration of the Torque Converter Pedal Position Sensor for the Impeller Clutch

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth, level surface.

2. Shift the transmission direction control switch to the NEUTRAL position.

3. Lower the bucket or the work tool to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Shut off the engine.

Note: This calibration procedure can be performed without a running engine.

8. Turn the key start switch and the disconnect switch to the ON position.

9. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

10. Use the 4C-8195 Control Service Tool to enter Transmission Calibration Mode (6) via the “MODE” switch. Then enter submode 29 by using the “SCROLL” switch.

11. Use the INCREMENT (+) and DECREMENT (−) positions of the “CLEAR” switch in order to start the calibration procedure.

12. The display should show “29_ —” in order to begin calibration of the torque converter.

13. Toggle the position of the CLEAR switch until the display shows “29_C00” .

14. Fully release the torque converter pedal and then press the INCREMENT (+) switch. The display on the Caterpillar Monitoring System will show “29_ C01” .

15. Fully depress the torque converter pedal and then press the INCREMENT (+) switch. The display on the Caterpillar Monitoring System should change to “29_C02” .

Note: The foot pedal must be fully depressed in order to ensure that the full range of travel is recorded.

16. Fully release the torque converter pedal and then toggle the INCREMENT (+) switch. The display on the Caterpillar Monitoring System should change to “29_—” if the calibration was successful. The display will read “29_EXX” if the calibration was unsuccessful. Check the error codes in Table 31 .

Table 31

Error Codes	
E01	“Depressed Pedal Too High”
E02	“Depressed Pedal Too Low”
E03	“Range of Pedal Too Large”
E04	“Range of Pedal Too Small”

17. To exit submode 29, scroll to the next submode by using the “SCROLL” switch or exit the Transmission Calibration Mode by using the “MODE” switch.

i01543791

Solenoid Valve (Transmission Clutch) - Test

SMCS Code: 3174-081

This test will determine if the solenoid coil is energized and the solenoid plunger is shifting in order to permit the flow of oil.

Hearing the click of a solenoid or using a screwdriver to check that the solenoid coil is energized does not ensure that the solenoid plunger has shifted. The following test will determine if the solenoid plunger is shifting.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

⚠ WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death.

The rotating shaft is located under the implement and steering pumps. Do not allow personnel into the pump bay area behind the cab when the engine is running.

1. Park the machine on a smooth level surface.

2. Shift the transmission direction control for the STIC to the NEUTRAL position.

3. Lower the bucket and/or the attachment to the ground. Lower the blade and/or the attachment to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Table 32

Speed Range and Direction	Energized Solenoids	Engaged Clutches
Third Speed Forward	3 and 2	3 and 2
Second Speed Forward	4 and 2	4 and 2
First Speed Forward	5 and 2	5 and 2
Neutral	3	3
First Speed Reverse	5 and 1	5 and 1
Second Speed Reverse	4 and 1	4 and 1
Third Speed Reverse	3 and 1	3 and 1

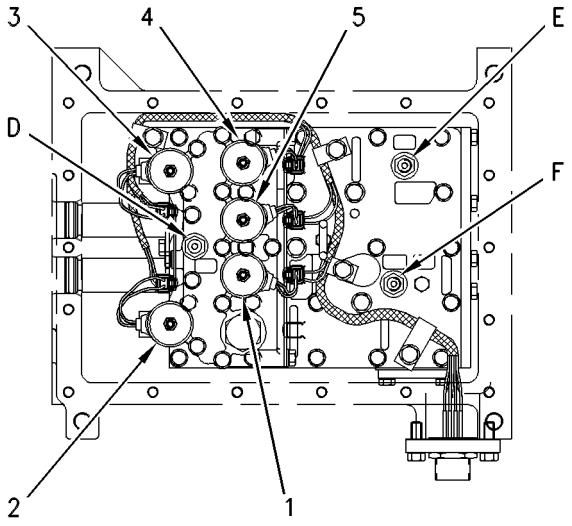


Illustration 115 g00400904

Location of Solenoid Valves for 990 Wheel Loader

(1) Number 1 solenoid (REVERSE). (2) Number 2 solenoid (FORWARD). (3) Number 3 solenoid (THIRD SPEED). (4) Number 4 solenoid (SECOND SPEED). (5) Number 5 solenoid (FIRST SPEED). (D) Torque converter inlet pressure tap P3. (E) Speed clutch pressure tap P1. (F) Direction clutch pressure tap P2.

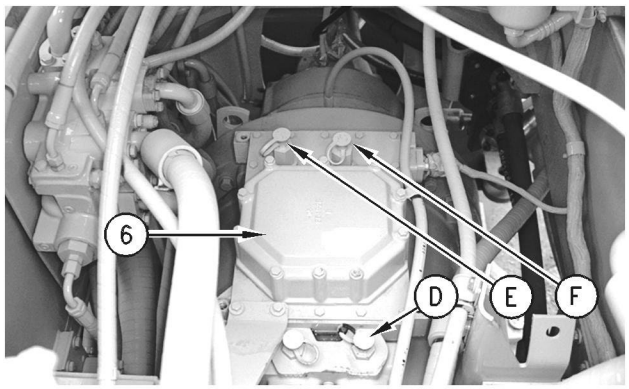


Illustration 116 g00400907

Location of Solenoid Valves for the 990 Series II Wheel Loader and 844 Wheel Tractor

(6) Cover for the solenoid valves. (D) Torque converter inlet pressure tap P3. (E) Speed clutch pressure tap P1. (F) Direction clutch pressure tap P2.

8. Install a hose and a 4130 kPa (600 psi) pressure gauge on pressure tap (F).

9. Engage the parking brake and shift the transmission into neutral. Start the engine and operate the engine at low idle.

10. Depress the right service brake pedal and hold the right service brake pedal. Release the parking brake. Press the downshift gear speed switch until the transmission is in first speed. Watch the pressure gauge and move the direction control switch from the NEUTRAL position to the FORWARD position.

The needle on the pressure gauge should drop. Then, the needle will return to the original pressure reading. With the transmission in FORWARD position, press the upshift gear speed switch through the remaining forward speed positions and return the switch to first speed. The same pressure drop should be noted in all speeds. This checks the operation of all the speed clutches.

11. Depress the right service brake pedal and hold the right service brake pedal. Release the parking brake. Press the downshift gear speed switch until the transmission is in first speed. Move the direction control switch to the FORWARD position.

Watch the pressure gauge and move the direction control switch to the REVERSE position. The needle on the pressure gauge should drop. Then, the needle will return to the original pressure reading. Now, move the direction control switch to the FORWARD position. The same pressure drop should be observed. This checks the operation of both direction clutches.

If a pressure drop is noted, the solenoid and the related electrical circuit are functioning.

If a pressure drop is not noted, use a screwdriver to check that the solenoid coil is energized. If the screwdriver is attracted to the solenoid coil, this indicates that the solenoid coil is energized. The problem is in the solenoid cartridge. The problem could be a bent solenoid stem, a screen that is dirty or plugged, or a spring that is weak or broken.

If the screwdriver does not indicate that the solenoid coil is energized, the problem is in the electrical circuit.

Reference: For additional information on electrical system troubleshooting, refer to Service Manual, SENR5704, “Electronic Transmission Control System”.

i01745900

Torque Converter Impeller Clutch Pressure - Test

SMCS Code: 3102-081-PX

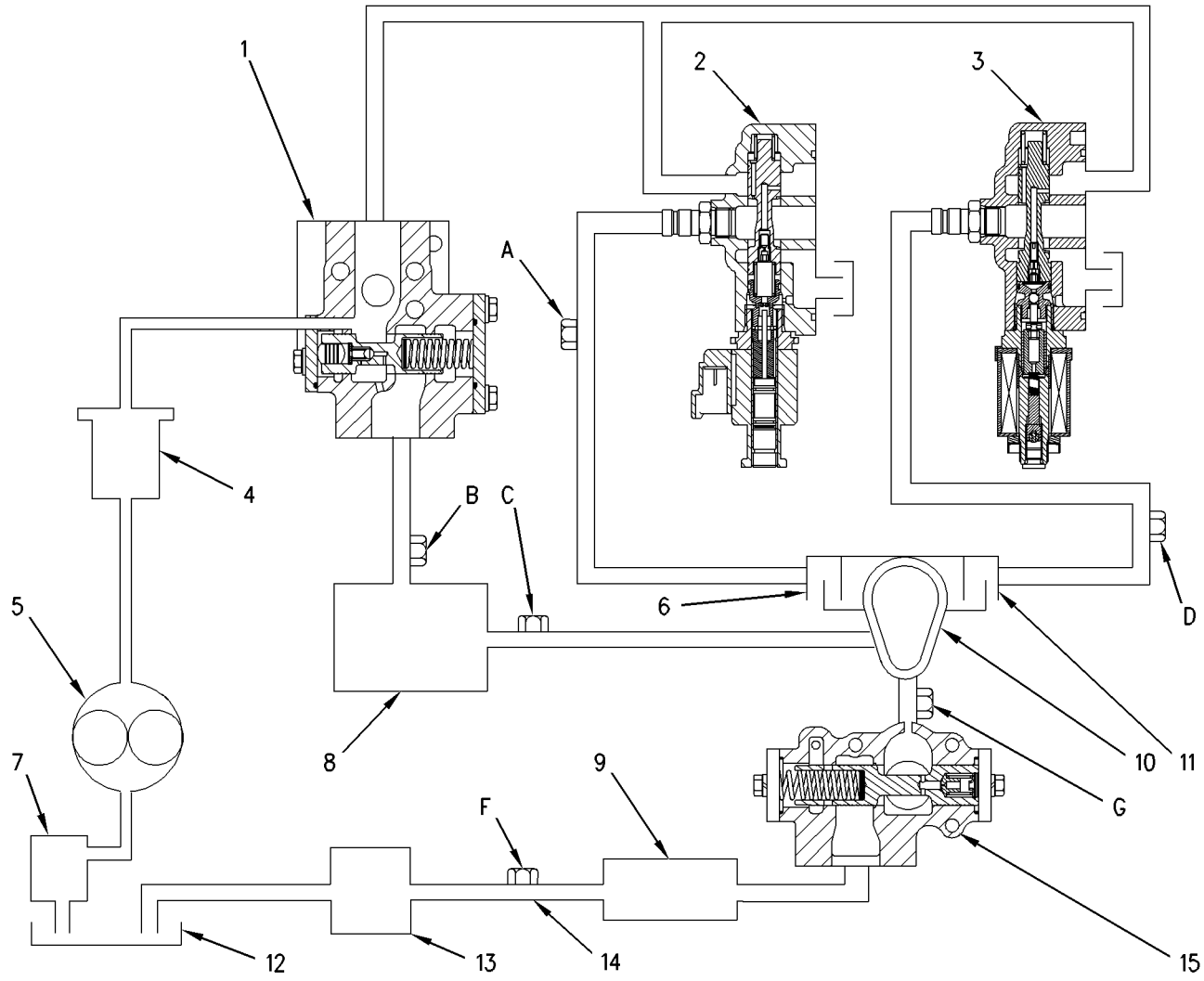


Illustration 117 g00858063

Hydraulic System Schematic

(1) Priority valve
(2) Modulating valve (lockup clutch)
(3) Modulating valve (impeller clutch)
(4) Oil filter
(5) Oil pump
(6) Lockup clutch
(7) Magnetic screen
(8) Transmission hydraulic control
(9) Oil cooler
(10) Torque converter
(11) Impeller clutch
(12) Reservoir in output transfer gear case
(13) Planetary lubrication
(14) Outlet line from oil cooler to planetary lubrication
(15) Torque converter outlet relief valve
(A) Pressure tap for lockup clutch
(B) Oil pump output pressure tap P1
(C) Torque converter inlet pressure tap P3
(D) Pressure tap for impeller clutch
(F) Lubrication pressure tap
(G) Torque converter outlet pressure tap

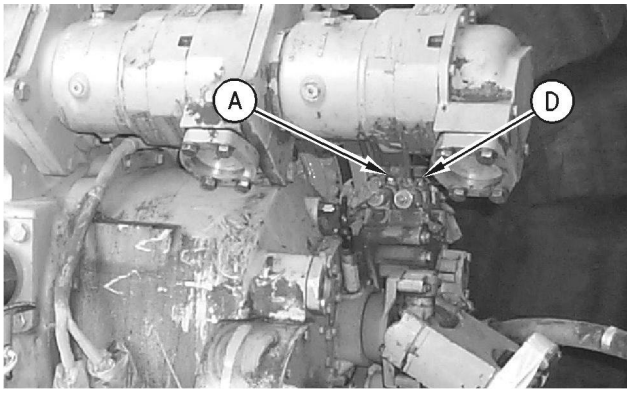


Illustration 118 g00855968

Torque Converter

(A) Pressure tap for lockup clutch
(D) Pressure tap for impeller clutch

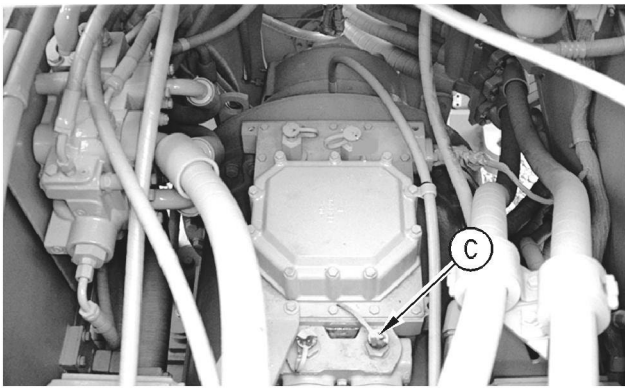


Illustration 119 g00393020

Transmission

(C) Torque converter inlet pressure tap P3

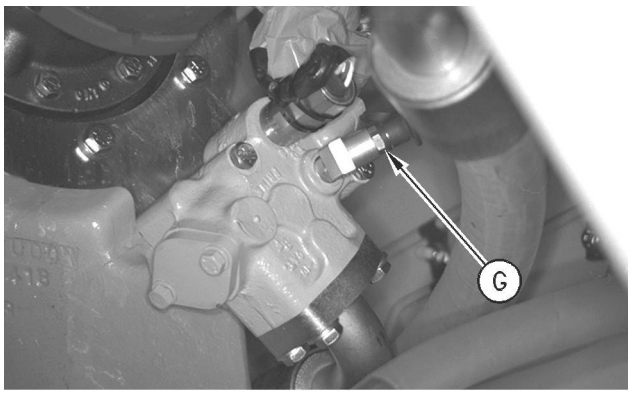


Illustration 120 g00393021

Torque Converter Cover

(G) Torque converter outlet pressure tap

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth level surface.
2. Shift the transmission direction control to the NEUTRAL position.
3. Lower the bucket and/or the work tool to the ground. Lower the blade and/or the work tool to the ground.
4. Engage the parking brake.
5. Place blocks in front of the wheels and behind the wheels.
6. Install the steering frame lock.
7. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Note: All tests and all adjustments must be made while the transmission oil is at normal operating temperature.

NOTICE

Do not connect or disconnect hose fittings to or from the quick disconnect nipples when there is pressure in the system. This will prevent damage to the seals that are in the fitting.

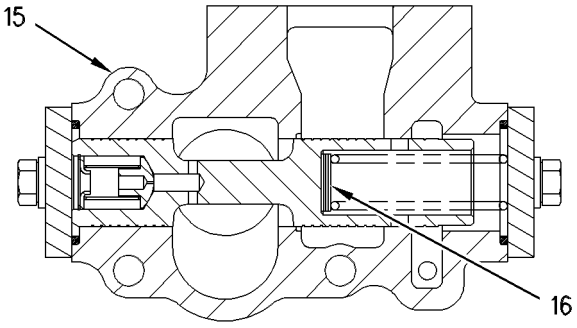


Illustration 121 g00392679

Outlet Relief Valve

(15) Torque converter outlet relief valve
(16) Spacers

Table 33

Torque Converter Pressure			
Pressure	**Pressure Tap**	**Pressure at High Idle**	**Adjustment**
Lockup Clutch	(A)	Stabilized pressure with an activated solenoid is 2030 ± 240 kPa (295 ± 35 psi). Pressure is less than 170 kPa (25 psi) when the solenoid is not activated.	-
Torque Converter Inlet P3	(C)	The maximum pressure with cold oil is 930 kPa (135 psi).	-
Impeller Clutch	(D)	The impeller clutch top pressure must be a minimum of 1950 kPa (285 psi). Pressure with the left brake pedal fully depressed is 220 ± 150 kPa (32 ± 22 psi).	-
Torque Converter Outlet	(G)	Maximum pressure is 550 kPa (80 psi). Minimum pressure is 415 kPa (60 psi). (These pressures are for a machine in third speed, with activated brakes, with installed axle shafts, and with the converter in a stall condition.)	Add spacers (16) or remove spacers (16).

Table 34

Pressure Change for One Spacer(1)			
Description	**Thickness**	**Pressure Change**	**Part**
5M-9622 Spacer	1.60 mm (.063 inch)	31.2 kPa (4.53 psi)	Output Relief Valve (15)
5M-9623 Spacer	0.91 mm (.036 inch)	18.2 kPa (2.64 psi)	
5M-9624 Spacer	0.25 mm (.010 inch)	5.0 kPa (.73 psi)	

(1) Before an adjustment is made to outlet relief valve (15), make sure that the valve springs are not weak or broken.

Table 35

Required Tools		
Part Number	**Description**	**Quantity**

(continued)

(Table 35, contd)

1U-5481(1)	Pressure Gauge Group	1
1U-5482	Pressure Adapter Group	1
4C-8195	Control Service Tool	1
7X-1701	Communication Adapter	1

(1) The 198-4240 Pressure Indicator Tool Gp is also available.

Maximum and Minimum clutch pressure

⚠ WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death.

The rotating shaft is located under the implement and steering pumps. Do not allow personnel into the pump bay area behind the cab when the engine is running.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before moving the machine to perform the test that follows.

Note: Make sure that the Left Service Brake Pedal Position Sensor is calibrated correctly before performing pressure tests. The test values can be affected if the Left Service Brake Pedal Position Sensor is not calibrated correctly.

Reference: Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program” for the calibration procedure for the Left Service Brake Pedal Position Sensor.

1. Install a hose and a 4130 kPa (600 psi) pressure gauge on pressure tap (D).

2. Engage the parking brake and shift the transmission direction control switch to the NEUTRAL position. Start the engine.

3. Move the reduced rimpull selection switch to the MAXIMUM position.

4. Run the engine at high idle and observe the pressure reading on the gauge. The minimum engagement pressure for the impeller clutch is 1950 kPa (285 psi).

5. With the engine at high idle, completely depress the left brake pedal and observe the pressure reading on the gauge. The pressure for the impeller clutch must be 220 ± 150 kPa (32 ± 22 psi).

i01745637

Torque Converter Lockup Clutch Pressure - Test

SMCS Code: 3102-081-PX

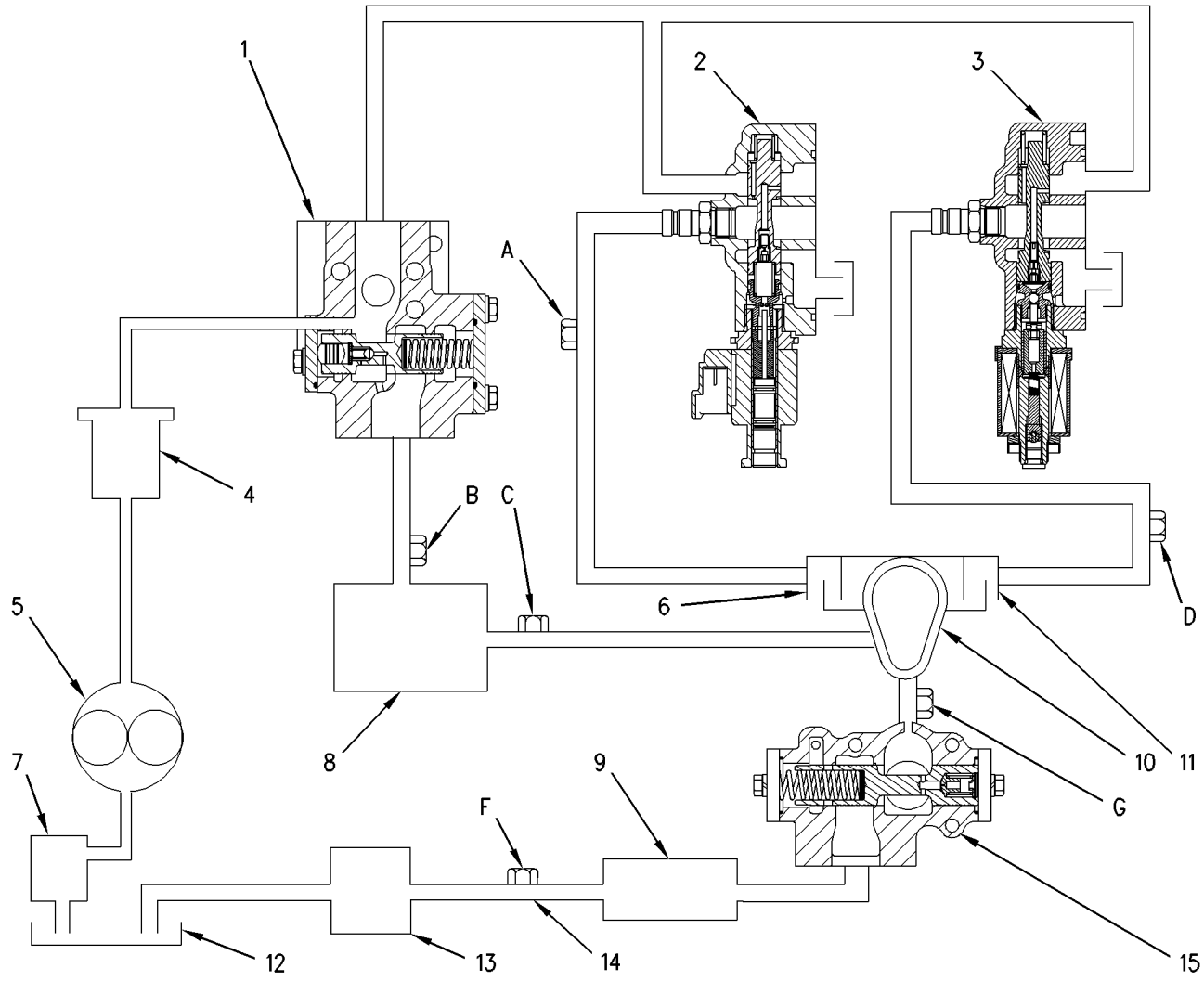


Illustration 122 g00858063

Hydraulic System Schematic

(1) Priority valve
(2) Modulating valve (lockup clutch)
(3) Modulating valve (impeller clutch)
(4) Oil filter
(5) Oil pump
(6) Lockup clutch
(7) Magnetic screen
(8) Transmission hydraulic control
(9) Oil cooler
(10) Torque converter
(11) Impeller clutch
(12) Reservoir in output transfer gear case
(13) Planetary lubrication
(14) Outlet line from oil cooler to planetary lubrication
(15) Torque converter outlet relief valve
(A) Pressure tap for lockup clutch
(B) Oil pump output pressure tap P1
(C) Torque converter inlet pressure tap P3
(D) Pressure tap for impeller clutch
(F) Lubrication pressure tap
(G) Torque converter outlet pressure tap

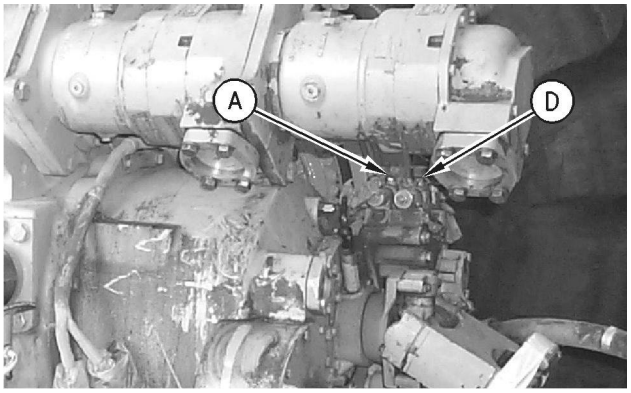


Illustration 123 g00855968

Torque Converter

(A) Pressure tap for lockup clutch
(D) Pressure tap for impeller clutch

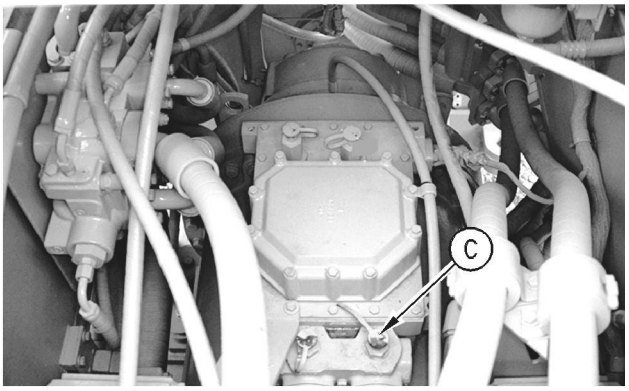


Illustration 124 g00393020

Transmission

(C) Torque converter inlet pressure tap P3

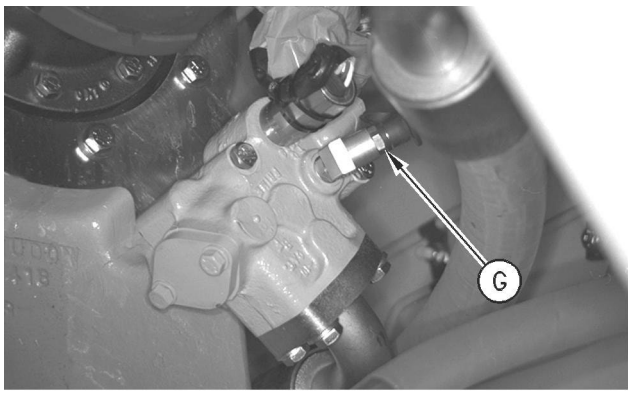


Illustration 125 g00393021

Torque Converter Cover

(G) Torque converter outlet pressure tap

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth level surface.
2. Shift the transmission direction control to the NEUTRAL position.
3. Lower the bucket and/or the work tool to the ground. Lower the blade and/or the work tool to the ground.
4. Engage the parking brake.
5. Place blocks in front of the wheels and behind the wheels.
6. Install the steering frame lock.
7. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Note: All tests and all adjustments must be made while the transmission oil is at normal operating temperature.

NOTICE

Do not connect or disconnect hose fittings to or from the quick disconnect nipples when there is pressure in the system. This will prevent damage to the seals that are in the fitting.

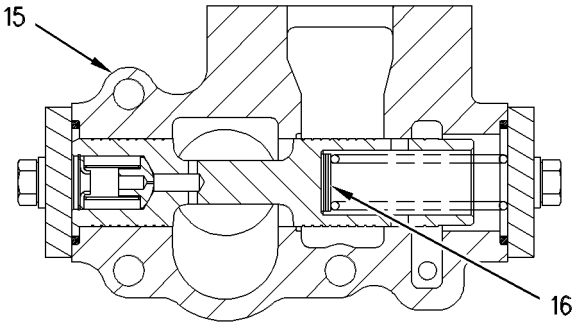


Illustration 126 g00392679

Outlet Relief Valve

(15) Torque converter outlet relief valve
(16) Spacers

Table 36

Torque Converter Pressure			
Pressure	**Pressure Tap**	**Pressure at High Idle**	**Adjustment**
Lockup Clutch	(A)	Stabilized pressure with an activated solenoid is 2030 ± 240 kPa (295 ± 35 psi). Pressure is less than 170 kPa (25 psi) when the solenoid is not activated.	-
Torque Converter Inlet P3	(C)	The maximum pressure with cold oil is 930 kPa (135 psi).	-
Impeller Clutch	(D)	The impeller clutch top pressure must be a minimum of 1950 kPa (285 psi). Pressure with the left brake pedal fully depressed is 220 ± 150 kPa (32 ± 22 psi).	-
Torque Converter Outlet	(G)	Maximum pressure is 550 kPa (80 psi). Minimum pressure is 415 kPa (60 psi). (These pressures are for a machine in third speed, with activated brakes, with installed axle shafts, and with the converter in a stall condition.)	Add spacers (16) or remove spacers (16).

Table 37

Pressure Change for One Spacer(1)			
Description	**Thickness**	**Pressure Change**	**Part**
5M-9622 Spacer	1.60 mm (.063 inch)	31.2 kPa (4.53 psi)	Output Relief Valve (15)
5M-9623 Spacer	0.91 mm (.036 inch)	18.2 kPa (2.64 psi)	
5M-9624 Spacer	0.25 mm (.010 inch)	5.0 kPa (.73 psi)	

(1) Before an adjustment is made to outlet relief valve (15), make sure that the valve springs are not weak or broken.

Table 38

Required Tools		
Part Number	**Description**	**Quantity**

(continued)

(Table 38, contd)

1U-5481(1)	Pressure Gauge Group	1
1U-5482	Pressure Adapter Group	1
4C-8195	Control Service Tool	1
7X-1701	Communication Adapter	1

(1) The 198-4240 Pressure Indicator Tool Gp is also available.

Lockup Clutch Disengaged (Minimum clutch pressure)

⚠ WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death.

The rotating shaft is located under the implement and steering pumps. Do not allow personnel into the pump bay area behind the cab when the engine is running.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before moving the machine to perform the test that follows.

1. Install a hose and a 4130 kPa (600 psi) pressure gauge on pressure tap (A).
2. Engage the parking brake and shift the transmission to the NEUTRAL position. Start the engine and run the engine at high idle.
3. Observe the pressure gauge. The pressure reading on the gauge must be 170 kPa (25 psi) or less.

Lockup Clutch Engaged (Maximum stabilized pressure)

⚠ WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death.

The rotating shaft is located under the implement and steering pumps. Do not allow personnel into the pump bay area behind the cab when the engine is running.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before moving the machine to perform the test that follows.

1. Install a hose and a 4130 kPa (600 psi) pressure gauge on pressure tap (A).
2. Move the on/off switch for the lockup clutch to the ON position.
3. Engage the parking brake and place the transmission in the NEUTRAL position. Start the engine.
4. Apply the service brakes and release the parking brake. Shift the machine into the FIRST SPEED FORWARD position.
5. Operate the machine at maximum speed and observe the pressure reading on the gauge. Make sure that the left service brake pedal or the right service brake pedal are not depressed. If the left service brake pedal or the right service brake pedal are depressed the lockup clutch will not engage. The maximum stabilized pressure must be 2030 ± 240 kPa (295 ± 35 psi).

i01650231

Reduced Rimpull Pressure - Test

SMCS Code: 3140-081-PX

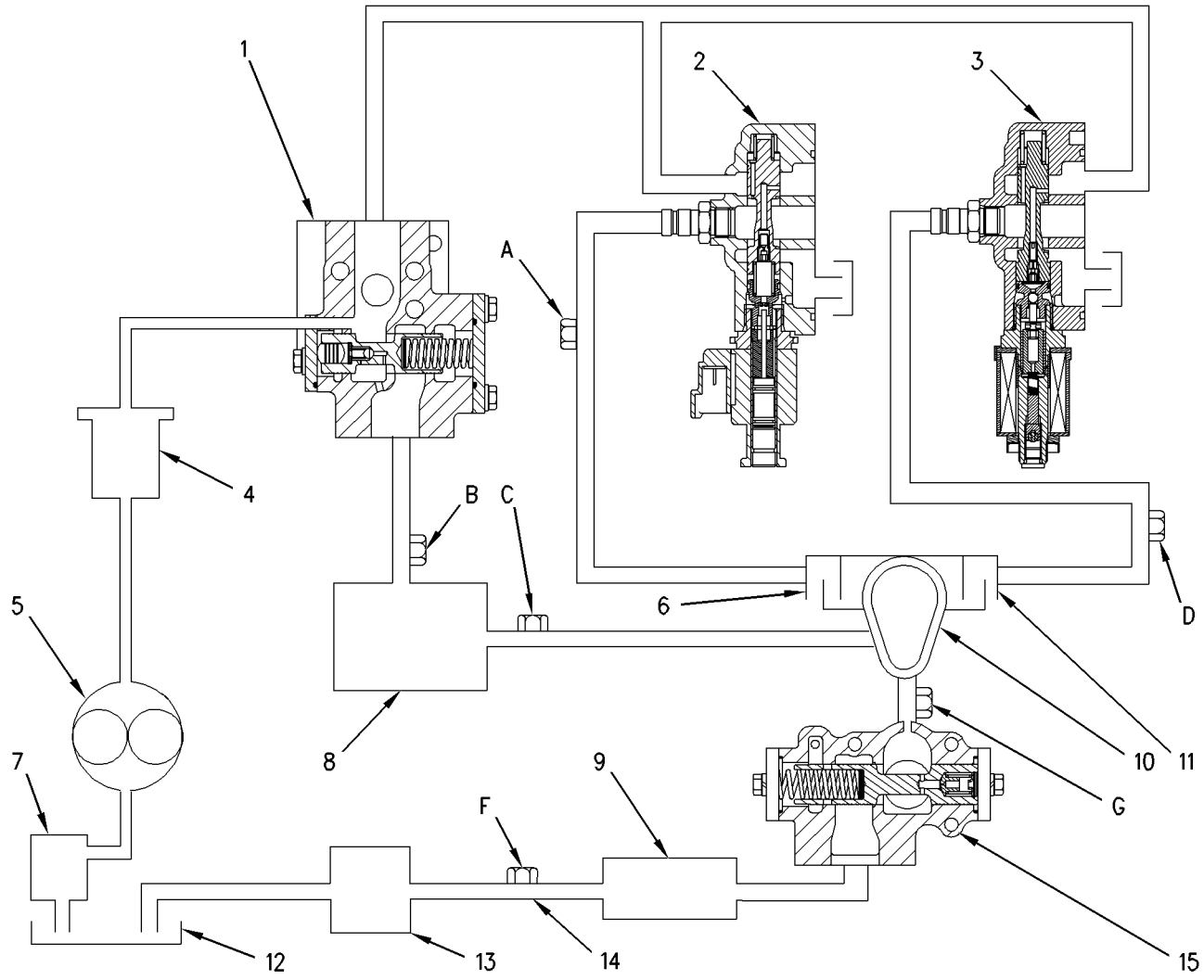


Illustration 127 g00858063

Hydraulic System Schematic

(1) Priority valve
(2) Modulating valve (lockup clutch)
(3) Modulating valve (impeller clutch)
(4) Oil filter
(5) Oil pump
(6) Lockup clutch
(7) Magnetic screen
(8) Transmission hydraulic control
(9) Oil cooler
(10) Torque converter
(11) Impeller clutch
(12) Reservoir in output transfer gear case
(13) Planetary lubrication
(14) Outlet line from oil cooler to planetary lubrication
(15) Torque converter outlet relief valve
(A) Pressure tap for lockup clutch
(B) Oil pump output pressure tap P1
(C) Torque converter inlet pressure tap P3
(D) Pressure tap for impeller clutch
(F) Lubrication pressure tap
(G) Torque converter outlet pressure tap

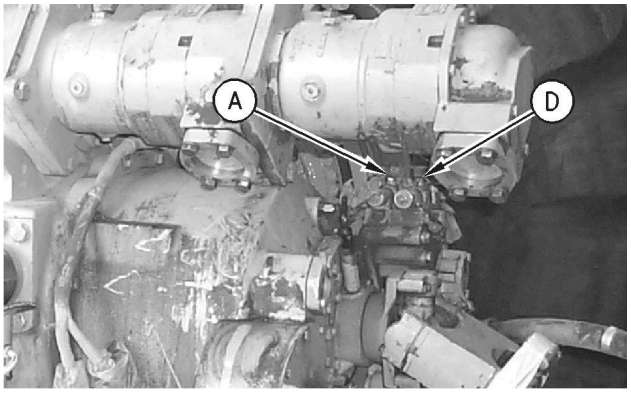


Illustration 128 g00855968

Torque Converter

(A) Pressure tap for lockup clutch
(D) Pressure tap for impeller clutch

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth level surface.
2. Shift the STIC transmission direction control switch to the NEUTRAL position.
3. Lower the bucket and/or the work tool to the ground. Lower the blade and/or the work tool to the ground.
4. Engage the parking brake.
5. Place blocks in front of the wheels and behind the wheels.
6. Install the steering frame lock.
7. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Note: All tests and all adjustments must be made while the transmission oil is at normal operating temperature.

Table 39

Required Tools		
Part Number	**Description**	**Quantity**
1U-5481	Pressure Gauge Group	1
1U-5482	Pressure Adapter Group	1

⚠ WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death.

The rotating shaft is located under the implement and steering pumps. Do not allow personnel into the pump bay area behind the cab when the engine is running.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before moving the machine to perform the test that follows.

Note: The default settings for reduced rimpull can be changed in the field. The reduced rimpull mode must be set to the default settings before a test of the four reduced rimpull settings can be performed.

Reference: Refer to Testing and Adjusting, “Reduced Rimpull Setting - Adjust” for the procedure for programming the set points for reduced rimpull. The following values are the default settings for reduced rimpull: 60 percent, 70 percent, 80 percent and 90 percent.

1. Install a hose and a 4130 kPa (600 psi) pressure gauge on pressure tap (D).

2. Engage the parking brake and place the transmission in NEUTRAL position. Start the engine.
3. Move the reduced rimpull on/off switch to the REDUCED position. The indicator light for reduced rimpull must come on.
4. Move the reduced rimpull selection switch to the MINIMUM position (small dot).
5. Increase the engine speed to high idle and observe the pressure reading on the gauge. Record the gauge reading.
6. With the engine at high idle, move the reduced rimpull selection switch to each of the remaining positions. Record the pressure reading at each of the switch positions. Refer to Table 40 below for the correct pressures.

Table 40

Impeller Clutch Pressure Reduced Rimpull Settings	
Setting	**Pressure**
60%	520 kPa (75 psi) to 1040 kPa (150 psi)
70%	810 kPa (115 psi) to 1330 kPa (195 psi)
80%	1100 kPa (160 psi) to 1620 kPa (235 psi)
90%	1390 kPa (200 psi) to 1910 kPa (280 psi)

i05983199

Torque Converter Stall - Test

SMCS Code: 3101-081-V8

The torque converter stall test helps determine if the engine is producing the correct power output. This stall test may be used in many diagnostic procedures.

⚠ WARNING

Personal injury or death can result from machine movement.

When tests and adjustments are made to the transmission or the torque converter, the parking brake must be disengaged.

To prevent movement of the machine and personal injury perform the procedure that follows.

Machine Preparation

1. Move the machine to a smooth horizontal location. Move away from working machines and personnel. Lower the attachments to the ground.
2. Allow only one operator on the machine. Keep all personnel away from the machine or in the view of the operator.
3. Engage the parking brake.

Stall Test

1. Shift the transmission to the NEUTRAL position.
2. Start the engine. Warm the transmission oil to normal operating temperature of approximately 95° ± 20°C (200° ± 35°F).
3. Place the work tool flat on the ground.
4. Fully depress the right side service brake pedal. Hold the brake pedal in the depressed position for the duration of the test.
5. Disengage the STIC control lock.
6. Release the parking brake.

NOTICE

To make sure that the transmission oil does not overheat, do not keep the torque converter in a stall condition for more than 30 seconds. After the torque converter stall test, reduce engine speed to low idle, move the transmission control to neutral and increase the engine speed to approximately 1500 rpm to cool the oil.

7. Place the transmission in THIRD GEAR.
8. Move the transmission direction switch to the FORWARD position.
9. Increase the engine speed to high idle.
10. Allow the engine speed to stabilize. Record the engine rpm.
11. Reduce the engine speed to low idle.
12. Shift the transmission to the NEUTRAL position.

The correct stall speed in third speed forward is listed in the tables that follow.

Table 41

Machine	Engine Speed (RPM)
990H	1900 ± 55
844H	1900 ± 75

Incorrect stall speeds indicate one or more of the following conditions.

- Incorrect engine performance
- Incorrect transmission performance
- Incorrect performance of the torque converter

- Change in the parasitic loads: fan circuit and pumps

i01653337

Transmission Pressures - Test and Adjust

SMCS Code: 3030-025-PX; 3030-081-PX; 3073-025-PX; 3073-081-PX

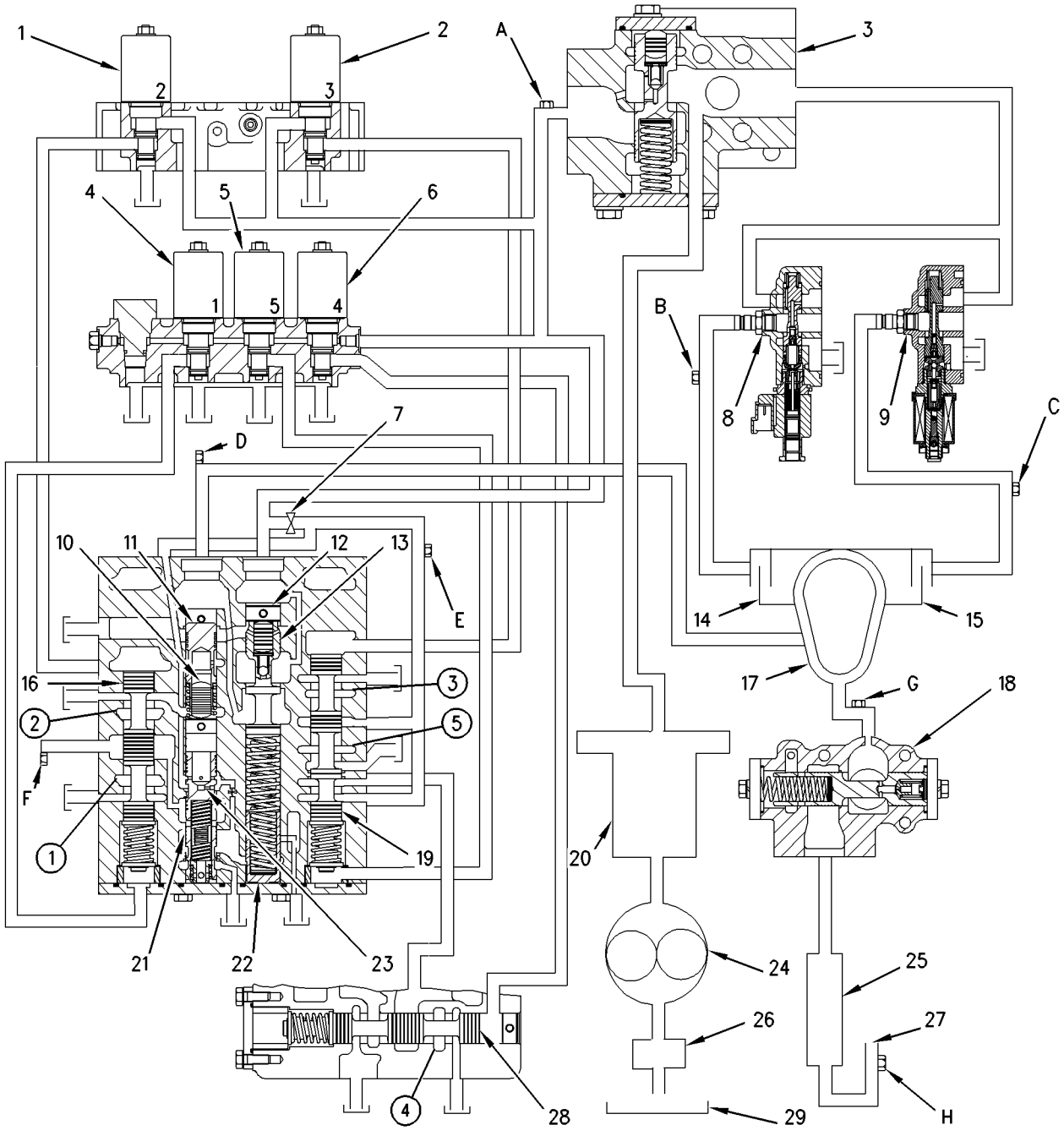


Illustration 129 g00850541

Transmission Hydraulic Controls in the NEUTRAL position and with the Engine Stopped.

(1) Number 2 clutch solenoid
(2) Number 3 clutch solenoid
(3) Priority valve
(4) Number 1 clutch solenoid
(5) Number 5 clutch solenoid
(6) Number 4 clutch solenoid
(7) Flow control orifice
(8) Lockup clutch solenoid valve
(9) Impeller clutch solenoid valve

(10) Slug
(11) Converter inlet ratio valve
(12) Slug
(13) Modulating relief valve
(14) Lockup clutch
(15) Impeller clutch
(16) Direction selection spool
(17) Torque converter
(18) Torque converter outlet relief valve
(19) Selector spool for first speed and for third speed
(20) Transmission oil filter
(21) Pressure differential valve
(22) Load piston
(23) Flow control orifice
(24) Transmission oil pump
(25) Oil cooler
(26) Magnetic screen
(27) Lubrication passage for transmission
(28) Selector spool for second speed
(29) Reservoir
(A) Pressure tap for the oil pump
(B) Pressure tap for lockup clutch
(C) Pressure tap for impeller clutch
(D) Torque converter inlet pressure tap P3
(E) Speed clutch pressure tap P1
(F) Direction clutch pressure tap P2
(G) Torque converter outlet pressure tap
(H) Transmission lubrication pressure tap

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a smooth level surface.

2. Shift the transmission direction control switch to the NEUTRAL position.

3. Lower the bucket and/or the work tool to the ground. Lower the blade and/or the work tool to the ground.

4. Engage the parking brake.

5. Place blocks in front of the wheels and behind the wheels.

6. Install the steering frame lock.

7. Remove the front axle shafts and rear axle shafts except for stall tests.

8. Allow only authorized personnel on the machine. Keep unauthorized personnel off the machine and in clear sight of the operator.

Note: All tests and all adjustments must be made while the transmission oil is at normal operating temperature.

NOTICE

Do not connect or disconnect hose fittings to or from the quick disconnect nipples when there is pressure in the system. This will prevent damage to the seals that are in the fitting.

⚠ WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death.

The rotating shaft is located under the implement and steering pumps. Do not allow personnel into the pump bay area behind the cab when the engine is running.

Table 42

Required Tools		
Part Number	**Description**	**Quantity**
1U-5481[1]	Pressure Gauge Group	1
1U-5482	Pressure Adapter Group	1

[1] The 198-4240 Pressure Indicator Tool Gp is also available.

Test Procedures

Use the following procedure in order to check the pressure of the direction clutch oil, the speed clutch oil, and the oil pump output.

Table 43

Transmission Speed Selection	Engaged Clutches
Third Speed Forward	Number 2 and Number 3
Second Speed Forward	Number 2 and Number 4
First Speed Forward	Number 2 and Number 5
Neutral	Number 3

(continued)

(Table 43, contd)

First Speed Reverse	Number 1 and Number 5
Second Speed Reverse	Number 1 and Number 4
Third Speed Reverse	Number 1 and Number 3

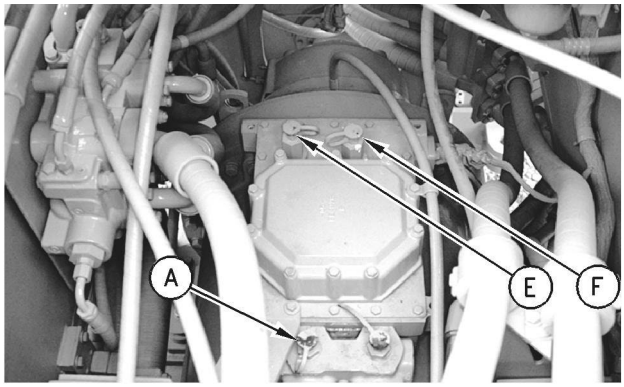


Illustration 130 g00396037

Transmission

(A) Oil pump output pressure tap
(E) Speed clutch pressure tap P1
(F) Direction clutch pressure tap P2

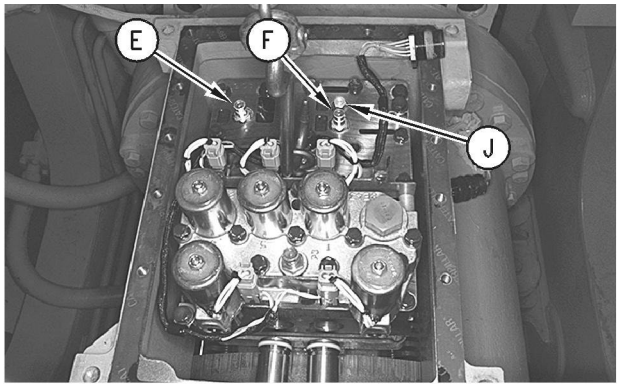


Illustration 131 g00396221

Transmission Control Valve

(E) Speed clutch pressure tap P1
(F) Direction clutch pressure tap P2
(J) Plug for the load piston LP

1. Install the correct hose assembly from 1U-5482 Pressure Adapter Group on the following pressure taps: (A), (E) and (F). Attach the opposite end of the hose assembly to the 0 to 3400 kPa (0 to 580 psi) pressure gauge in the 1U-5481 Pressure Gauge Group.

2. Engage the parking brake. Shift the transmission direction control switch to the NEUTRAL position. Shift the transmission upshift switch to the FIRST SPEED position. Start the engine and operate the engine at low idle.

3. Depress the right service brake pedal and hold the right service brake pedal. Release the parking brake. Watch the pressure gauges. Shift the transmission direction control switch from the NEUTRAL position to the FORWARD position. Increase the engine speed to high idle. Make sure that the transmission oil is at normal operating temperature. The needle on the pressure gauge for the Number 2 clutch should rise. The needle on the pressure gauge for the Number 5 clutch should rise. The pressure readings must match the values that are found in Table 44 .

With the transmission in the FORWARD position, shift through the remaining forward speeds and return to the FIRST SPEED position. Use the transmission upshift switch and the transmission downshift switch in order to change speeds. The pressure reading for each energized clutch must match the values that are found in Table 44 . This checks the pressure of all the speed clutches.

4. Perform Step 3 for all reverse speeds. The same pressure levels should be noted in all reverse speeds.

Lubrication Oil Pressure Test

Use the following procedure to check the pressure of the transmission lubrication oil.

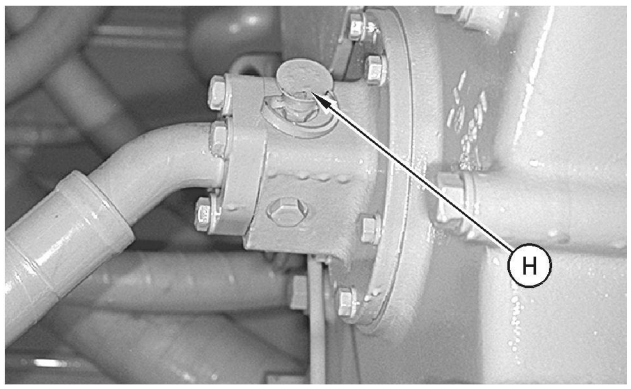


Illustration 132 g00396223

Transmission Cover

(H) Transmission lubrication pressure tap

1. Install the correct hose assembly from 1U-5482 Pressure Adapter Group on pressure tap (H). Attach the opposite end of the hose assembly to the 0 to 400 kPa (0 to 58 psi) pressure gauge in the 1U-5481 Pressure Gauge Group.

2. Start the engine and operate the engine at high idle. The oil must be at normal operating temperature. Observe the pressure gauge. The pressure reading for the lubrication oil must match the values that are found in Table 44 .

Transmission Pressures

Table 44

Transmission Pressure				
Pressure	Pressure Tap	Position of Governor Control Lever		Adjustment
		Pressure at Low Idle	Pressure at High Idle	
Oil Pump	(A)	This pressure is identical to speed clutch pressure P1.	This pressure is identical to speed clutch pressure P1.	-
Speed Clutch P1 (Initial Pressure)	(E)	The pressure is 530 ± 35 kPa (77 ± 5 psi) when the direction switch is in the NEUTRAL position and plug (J) for the load piston is removed.	-	Add spacers (30) or remove spacers (30).
Speed Clutch P1	(E)	This pressure must be more than 2000 kPa (290 psi). Plug (J) for the load piston is installed.	This pressure is 2550 ± 140 kPa (370 ± 20 psi) when the direction switch is in FORWARD or in REVERSE and any speed is selected. Plug (J) for the load piston is installed.	-
Direction Clutch P2	(F)	This pressure is 380 ± 35 kPa (55 ± 5 psi) lower than the speed clutch pressure at pressure tap (E). Plug (J) for the load piston is installed.	This pressure is 380 ± 35 kPa (55 ± 5 psi) lower than the speed clutch pressure at pressure tap (E). Plug (J) for the load piston is installed.	-
Transmission Lubrication Oil	(H)	-	This pressure is approximately 138 ± 35 kPa (20 ± 5 psi).	-

Transmission Pressures Adjustments

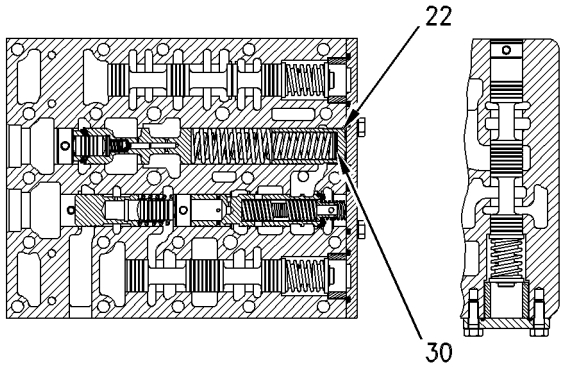


Illustration 133 g00396224

Transmission Selector and Pressure Control Valve

(22) Load piston
(30) Spacers

Table 45

Pressure Change for the Valve(1)			
Description	Thickness	Pressure Change	Location of Spacers
5M-9622 Spacer (30)	1.58 mm (.062 inch)	98 kPa (14.2 psi)	Load Piston (22)

(continued)

(Table 45, contd)

5M-9623 Spacer (30)	0.91 mm (.036 inch)	57 kPa (8.20 psi)	
5M-9624 Spacer (30)	0.25 mm (.010 inch)	16 kPa (2.29 psi)	

(1) Result of the addition of one spacer or the removal of one spacer to the valve.

i00832267

Input Transfer Gears - Adjust

SMCS Code: 3159-025-EP; 3159-025-BD

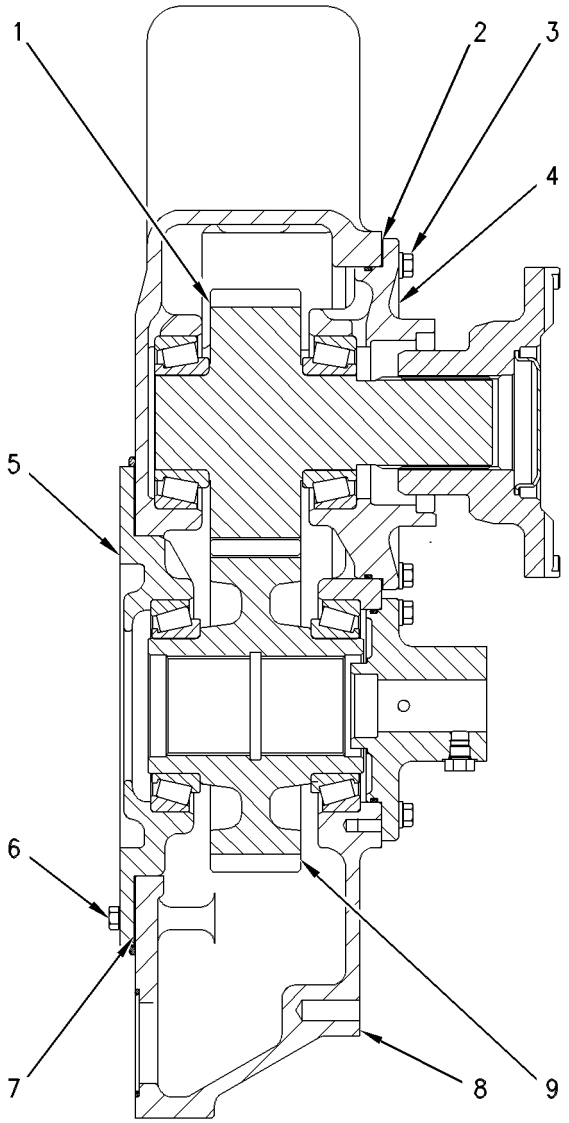


Illustration 134 g00404226

Input Transfer Gears

(1) Input gear. (2) Gap. (3) Bolt. (4) Bearing cage. (5) Bearing cage. (6) Bolt. (7) Gap. (8) Housing. (9) Output gear.

Adjustment Procedure for Bearing End Play

Note: Before you assemble the components, make sure that the bearing cups are seated in the housing and in the bearing cage. Also, make sure that the bearing cones are seated against the gear shoulders. Use a 0.038 mm (.0015 inch) shim or a feeler gauge.

Note: End play for input gear (1) and output gear (9) is 0.15 mm (.006 inch) to a maximum of 0.20 mm (.008 inch).

Adjustment Procedure for the Input Gear

1. Position housing (8) horizontally with the opening for bearing cage (4) at the top. Place input gear (1) in housing (8). Place bearing cage (4) on the housing. Do not use shims or seals.
2. Install two bearing cage bolts (3) in bearing cage (4) at an 180 degree interval. Tighten the two bearing cage bolts finger tight. Alternately tighten each bolt by one-fourth of a turn to an equal torque. Torque for the bearing cage bolts 9 N·m (7 lb ft).
3. Rotate input gear (1) at least three turns or rotate input gear (1) until the input gear turns freely.
4. Again, alternately tighten each bearing cage bolt to a torque of 9 N·m (7 lb ft).
5. Repeat Step 3 and Step 4 until the bearing cage bolts do not move at a torque of 9 N·m (7 lb ft) and until the input gear does not turn freely after three turns.
6. Loosen the bearing cage bolts evenly. Tighten the bearing cage bolts finger tight. Do not move any other parts.
7. With a tapered feeler gauge, measure gap (2) that is between housing (8) and bearing cage (4) in four places. Measure the gap at each bearing cage bolt and at 90 degrees from each bearing cage bolt.
8. Add 0.15 mm (.006 inch) to a maximum of 0.20 mm (.008 inch) to the average of the four measurements in Step 7. This is the total thickness of shims that are needed.
9. Remove bearing cage (4).
10. Install the shims and the O-ring. Install the bearing cage. Torque the bearing cage bolts to the proper specification.
11. To make sure that input gear (1) turns freely, rotate input gear (1).

Adjustment Procedure for the Output Gear

1. Position housing (8) horizontally with the opening for bearing cage (5) at the top. Place output gear (9) in housing (8). Place the bearing cage on the housing. Do not use shims or seals.

2. Install two bearing cage bolts (6) in bearing cage (5) at a 180 degree interval. Tighten the two bearing cage bolts finger tight. Alternately tighten each bolt by one-fourth of a turn to an equal torque. Torque for the bearing cage bolts 9 N·m (7 lb ft).

3. Rotate output gear (9) by at least three turns or rotate output gear (9) until the output gear turns freely.

4. Again, alternately tighten each bearing cage bolt to a torque of 9 N·m (7 lb ft).

5. Repeat Step 3 and Step 4 until the bearing cage bolts do not move at a torque of 9 N·m (7 lb ft) and until the output gear does not turn freely after three turns.

6. Loosen the bearing cage bolts evenly. Tighten the bearing cage bolts finger tight. Do not move any other parts.

7. With a tapered feeler gauge, measure gap (7) that is between housing (8) and bearing cage (5) in four places. Measure the gap at each bearing cage bolt and at 90 degrees from each bearing cage bolt.

8. Add 0.15 mm (.006 inch) to a maximum of 0.20 mm (.008 inch) to the average of the four measurements in Step 7. This is the total thickness of shims that are needed.

9. Remove bearing cage (5).

10. Install the shims and the seal. Install the bearing cage. Torque the bearing cage bolts to the proper specification.

11. To make sure that output gear (9) turns freely, rotate output gear (9).

i01239083

Output Transfer Gears - Adjust

SMCS Code: 3159-025-EP; 3159-025-BD

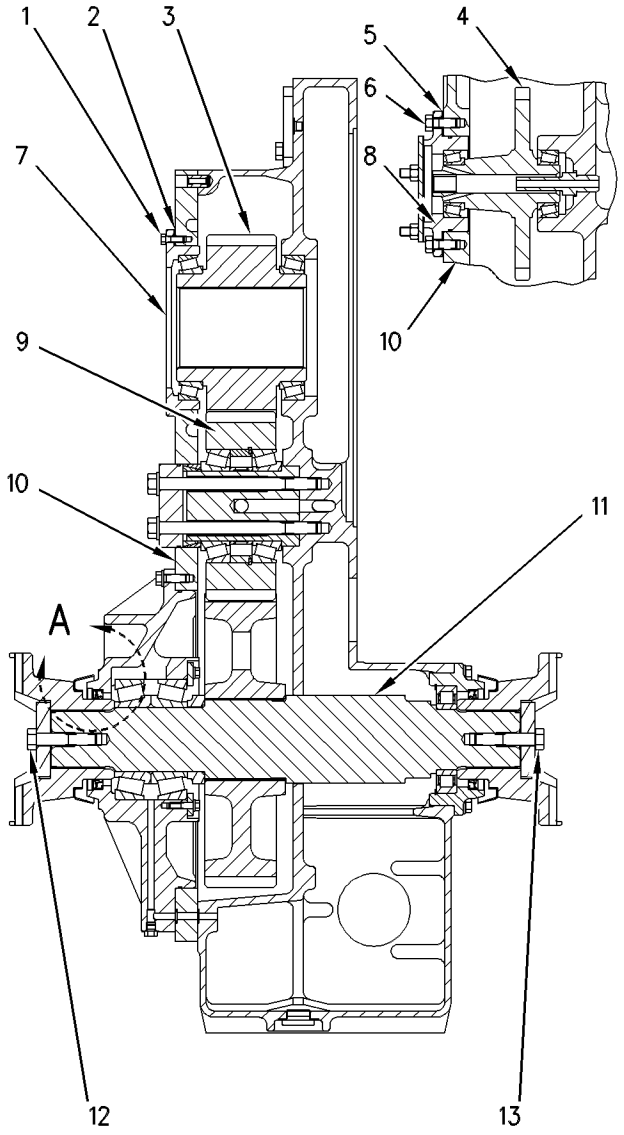


Illustration 135 g00103406

Output Transfer Gears

(1) Bolt. (2) Gap. (3) Input gear. (4) Pump gear. (5) Gap. (6) Bolt. (7) Bearing cage. (8) Bearing cage. (9) Idler gear. (10) Housing. (11) Output shaft. (12) Bolt. (13) Bolt.

Adjustment Procedure for Bearing End Play

Note: Before you assemble the components, make sure that the bearing cups are seated in the housing and in the bearing cage. Also, make sure that the bearing cones are seated against the gear shoulders. Use a 0.038 mm (.0015 inch) shim or a feeler gauge.

Note: End play for input gear (3) and pump gear (4) is 0.03 to 0.08 mm (.001 to .003 inch).

Output Shaft

Note: End play for output shaft (11) is not adjustable. The output gear must turn freely after installation.

Idler Gear

Note: End play for idler gear (9) is not adjustable. The idler gear must turn freely after installation.

Adjustment for the Input Gear

1. Position housing (10) horizontally with the opening for bearing cage (7) at the top. Place input gear (3) in housing (10). Place bearing cage (7) on the housing. Do not use shims or seals.

2. Install two bearing cage bolts (1) in bearing cage (7) at an 180 degree interval. Tighten the two bearing cage bolts finger tight. Alternately tighten each bearing cage bolt by one-fourth of a turn to an equal torque. Torque for the bearing cage bolts 28 N·m (20 lb ft).

3. Rotate input gear (3) at least three turns or rotate input gear (3) until the input gear turns freely.

4. Again, alternately tighten each bearing cage bolt to a torque of 28 N·m (20 lb ft).

5. Repeat Step 3 and Step 4 until the bearing cage bolts do not move at a torque of 28 N·m (20 lb ft) and until the input gear does not turn freely after three turns.

6. Loosen the bearing cage bolts evenly. Tighten the bearing cage bolts finger tight. Do not move any other parts.

7. With a tapered feeler gauge, measure gap (2) that is between housing (10) and bearing cage (7) in four places. Measure the gap at each bearing cage bolt and at 90 degrees from each bearing cage bolt.

8. To find the total thickness of shims that are needed, add 0.03 to 0.08 mm (.001 to .003 inch) to the average of the four measurements in Step 7.

9. Remove bearing cage (7).

10. Install the shims and the O-ring. Install the bearing cage. Torque the bearing cage bolts to the proper specification.

11. To make sure that input gear (3) turns freely, rotate input gear (3).

Adjustment for the Secondary Steering Pump (if equipped)

1. Position housing (10) horizontally with the opening for bearing cage (8) at the top. Place pump gear (4) in housing (10). Place bearing cage (8) on the housing. Do not use shims or seals.

2. Install two bearing cage bolts (6) in bearing cage (8) at a 180 degree interval. Tighten the two bearing cage bolts finger tight. Alternately tighten each bearing cage bolt by one-fourth of a turn to an equal torque. Torque for the bearing cage bolts 14 N·m (10 lb ft).

3. Rotate pump gear (4) at least three turns or rotate pump gear (4) until the pump gear turns freely.

4. Again, alternately tighten each bearing cage bolt to a torque of 14 N·m (10 lb ft).

5. Repeat Step 3 and Step 4 until the bearing cage bolts do not move at a torque of 14 N·m (10 lb ft) and until the pump gear does not turn freely after three turns.

6. Loosen the bearing cage bolts evenly. Tighten the bearing cage bolts finger tight. Do not move any other parts.

7. With a tapered feeler gauge, measure gap (5) that is between housing (10) and bearing cage (8) in four places. Measure the gap at each bearing cage bolt and at 90 degrees from each bearing cage bolt.

8. To find the total thickness of shims that are needed, add 0.03 to 0.08 mm (.001 to .003 inch) to the average of the four measurements in Step 7.

9. Remove bearing cage (8).

10. Install the shims and the O-ring. Install the bearing cage. Torque the bearing cage bolts to the proper specification.

11. To make sure that pump gear (4) turns freely, rotate pump gear (4).

(12) (13) Torque for the bolts . . . . . 475 ± 50 N·m ((350 ± 37 lb ft))

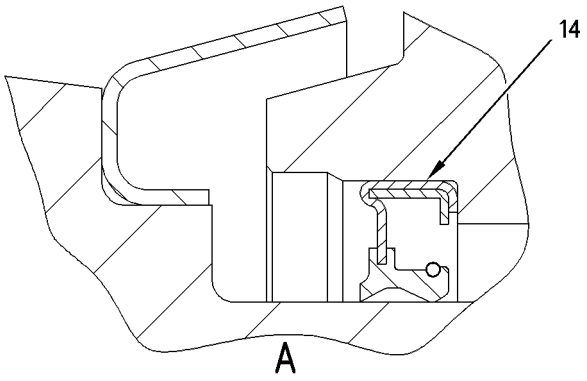


Illustration 136 g00103407

View A

(14) Seal.

(14) Apply 6V-6640 RTV Silicone Sealant to the seal bore surface of the bearing cage.

i06103568

Axle Oil Cooler Solenoid (Activation, Deactivation - Test

SMCS Code: 1365-081-JV; 5479-081-AOC

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide”for tools and supplies to collect and contain fluids in Caterpillar machines.

Dispose of all fluids according to local regulations.

The axle cooling system is a “On/Off” system. The steering pilot pump supplies the axle oil cooling system. When the system is activated, the oil for the steering pilot pump is diverted to the axle oil system in order to drive the axle oil cooling motor before going to the steering pilot system. The activation and the deactivation of the axle oil cooling system is controlled by the solenoid valve in the axle cooling system control valve. Without a properly operating solenoid valve, the axle oil cooling system will not properly cool the axles on the machine. The axle oil cooling system control valve is located above the torque converter housing.

Use the following procedure in order to verify the correct pressures for the system.

1. Park the machine on a smooth, level surface. Allow the axles to cool below 30 °C (86 °F).

2. Connect the steering frame lock link.

3. Engage the parking brake.

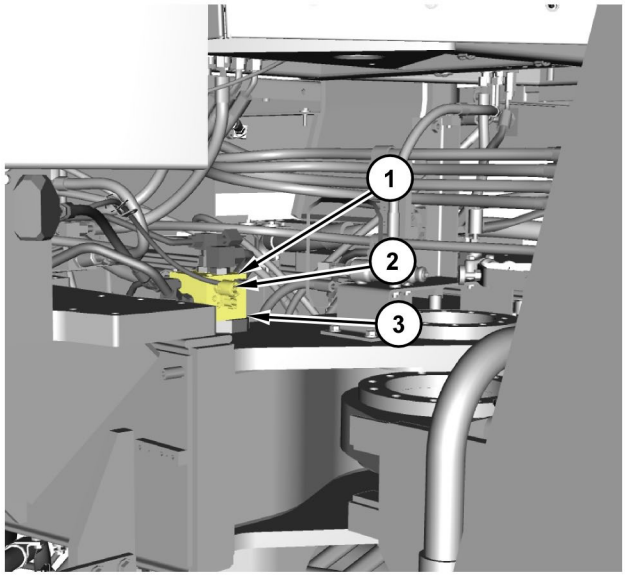


Illustration 137 g03810789

Right side of the machine under the platform

(1) Harness connector
(2) Solenoid valve
(3) Axle oil cooling control valve

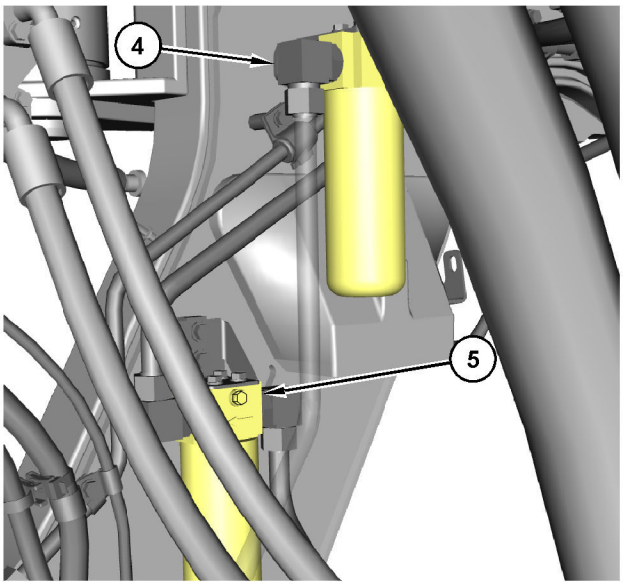


Illustration 138 g03810787

Power train filter locations

(4) 9/16 port on filter base
(5) 9/16 port on filter base

4. Install a fitting to hook up pressure gauge in ports (4) and (5) on the filter bases.

Note: Port (4) faces outward towards the frame and port (5) faces inward away from the frame.

5. Attach a 3500 kPa (500 psi) pressure gauge to pressure tap (4) and pressure tap (5) on the diagnostic plate.

6. Shift the transmission to neutral.

7. Disconnect the solenoid valve at the harness connector (1). The axle oil cooling system will activate when the solenoid is disconnected.

8. Start the engine. Warm the hydraulic oil to the normal operating temperature of 49° to 65 °C (120° to 150 °F).

9. Run the engine at high idle. Record the readings from both of the gauges. The pressure should be above 200 kPa (30 psi).

If the pressure does not rise above 200 kPa (30 psi) on both gauges:

- Verify that the lines are routed properly
- Verify that the diverter valve in the axle oil cooling valve is not filled with debris
- Verify that there are no leaks in the axle oil cooling control valve
- Verify that the thermal bypass relief valves (front and rear) are not stuck open
- Perform a performance bench test of the axle oil cooler unit

10. After verifying the above conditions in Step 9, perform the procedure again in order to verify that the correct pressures have been reached.

11. Reconnect the solenoid valve at harness connector (1). The axle cooling system will be deactivated when the solenoid is connected and the front and the rear axle temperatures are both below 30 °C (86 °F).

12. Run the engine at high idle. Record the readings on both gauges. The pressure should be below 50 kPa (7 psi).

If the pressure does not drop below 50 kPa (7 psi) on both gauges:

- Verify that the solenoid is working properly
- Ensure that the are no issues with the harness
- Ensure that there is current being applied to the solenoid
- Ensure that the solenoid is not damaged
- Verify that the diverter valve in the axle oil cooling control valve is not filled with debris

- Verify that there are not any leaks in the axle cooling control valve

13. After verifying the above conditions in Step 12, perform the procedure again in order to verify that the correct pressures have been reached.

i00831198

Differential Pinion Preload - Adjust

SMCS Code: 3254-025-ZP

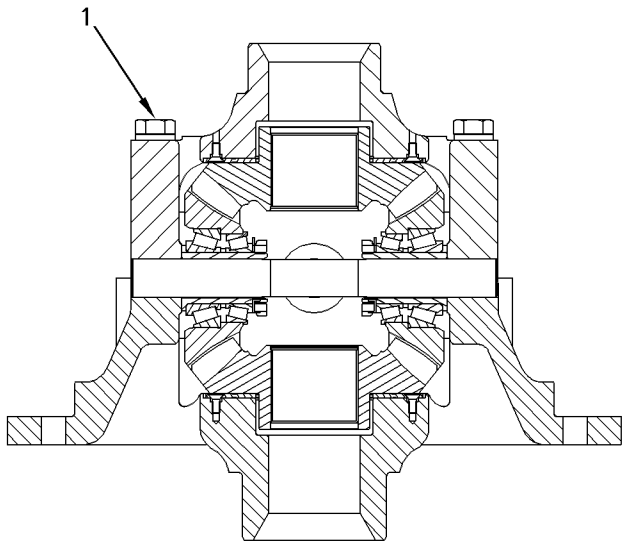


Illustration 139 g00103436

(1) Housing Bolts

Torque for the eight bolts that fasten the housings together . . . . . 460 ± 70 N·m ((340 ± 50 lb ft))
Torque-turn after reaching the specified torque . . . . . 180 ± 10°

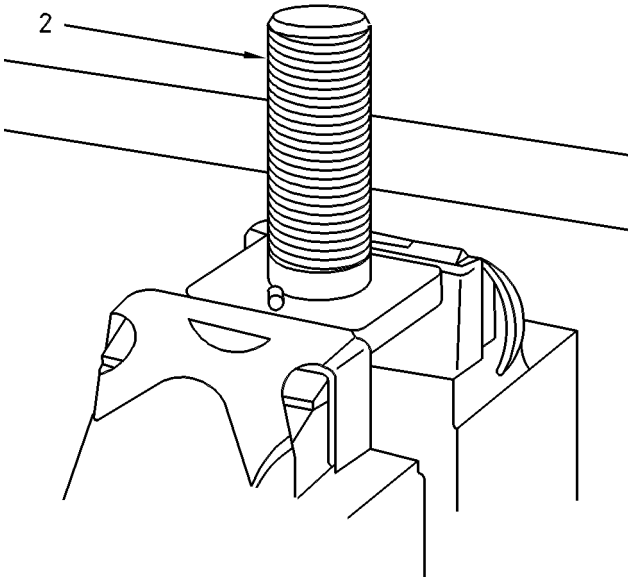


Illustration 140 g00103711

1. Put 5P-1730 Holding Fixture (2) in a vise and tighten the vise.

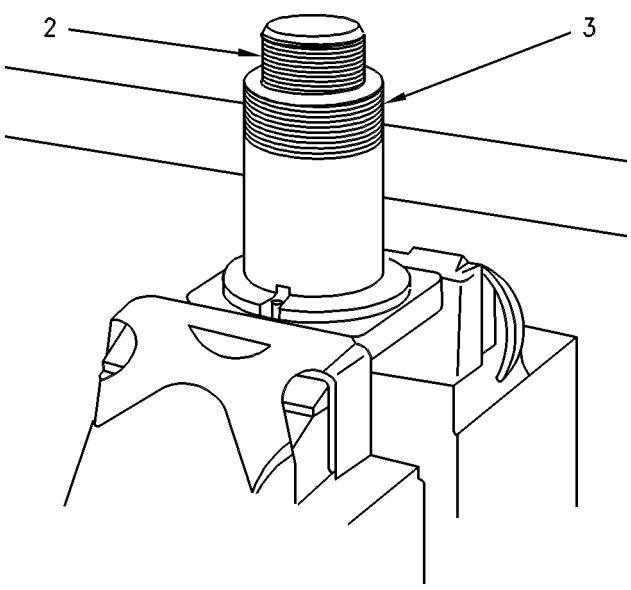


Illustration 141 g00103714

2. Install retainer (3) on the 5P-1730 Holding Fixture so that the notch in the retainer is aligned with the dowel on the holding fixture.

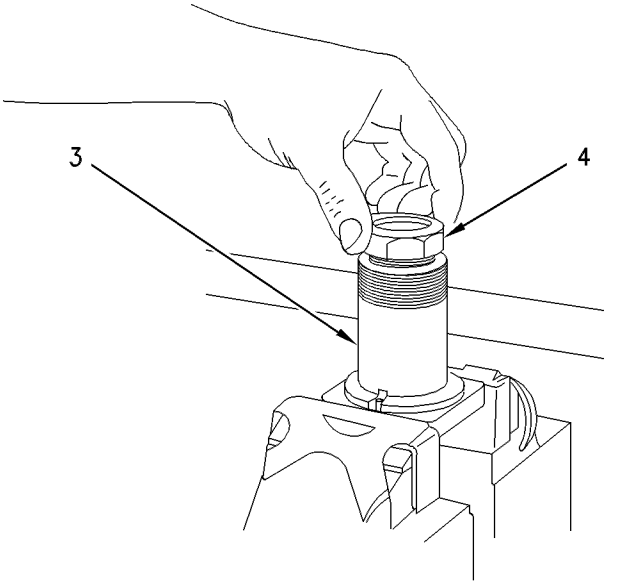


Illustration 142 g00103716

3. Install nut (4) (part of 5P-1730 Holding Fixture) on the threaded end of holding fixture (2). Tighten the nut against retainer (3) by hand.

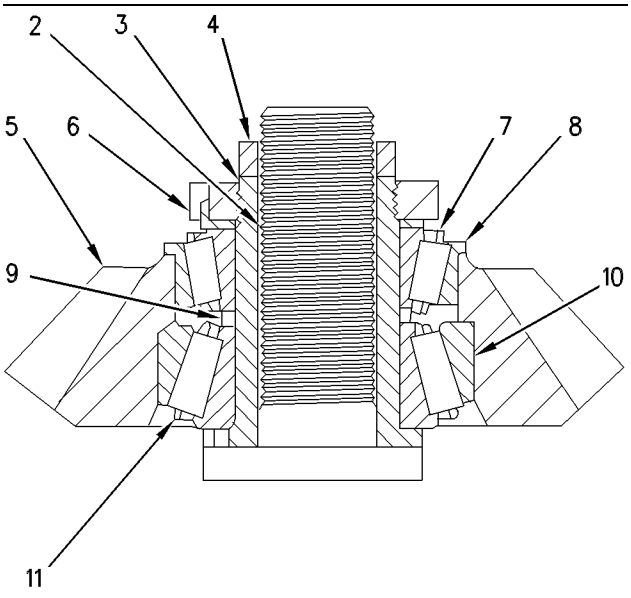


Illustration 143 g00103717

4. Install bearing cup (8) and bearing cup (10) in pinion (5).

5. Install bearing cone (11) and spacer (9) on retainer (3).

6. Install pinion (5) on the retainer.

7. Install bearing cone (7) on the retainer.

8. Put the lock (13) in position on the retainer.

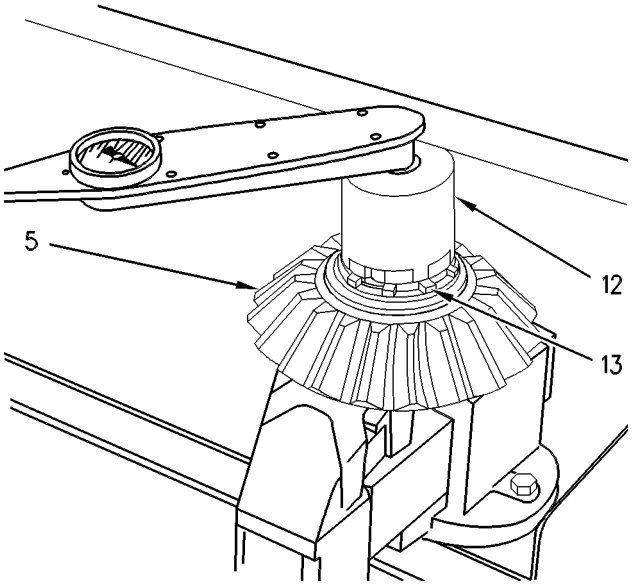


Illustration 144 g00103718

9. Install nut (6). While the pinion is turned slowly, use 5P-0964 Spanner Wrench (12) and a torque wrench to tighten the nut to a torque of 70 ± 15 N·m (52 ± 11 lb ft).

10. Bend the lock (13) so that the nut is held.

11. Remove nut (4).

12. Remove the pinion from the holding fixture.

13. Perform Step 1 through Step 12 for all four pinions before you install the pinions in the housing.

Note: After the pinions are installed in the differential case, place the differential case in a vise. Rotate one side gear clockwise for two revolutions. Then, rotate the gear counterclockwise for two revolutions. The torque that is needed to turn the assembled gears must not be more than 50 N·m (37 lb ft).

i02254116

Differential Backlash and Bearings - Adjust

SMCS Code: 3258-025-BKL

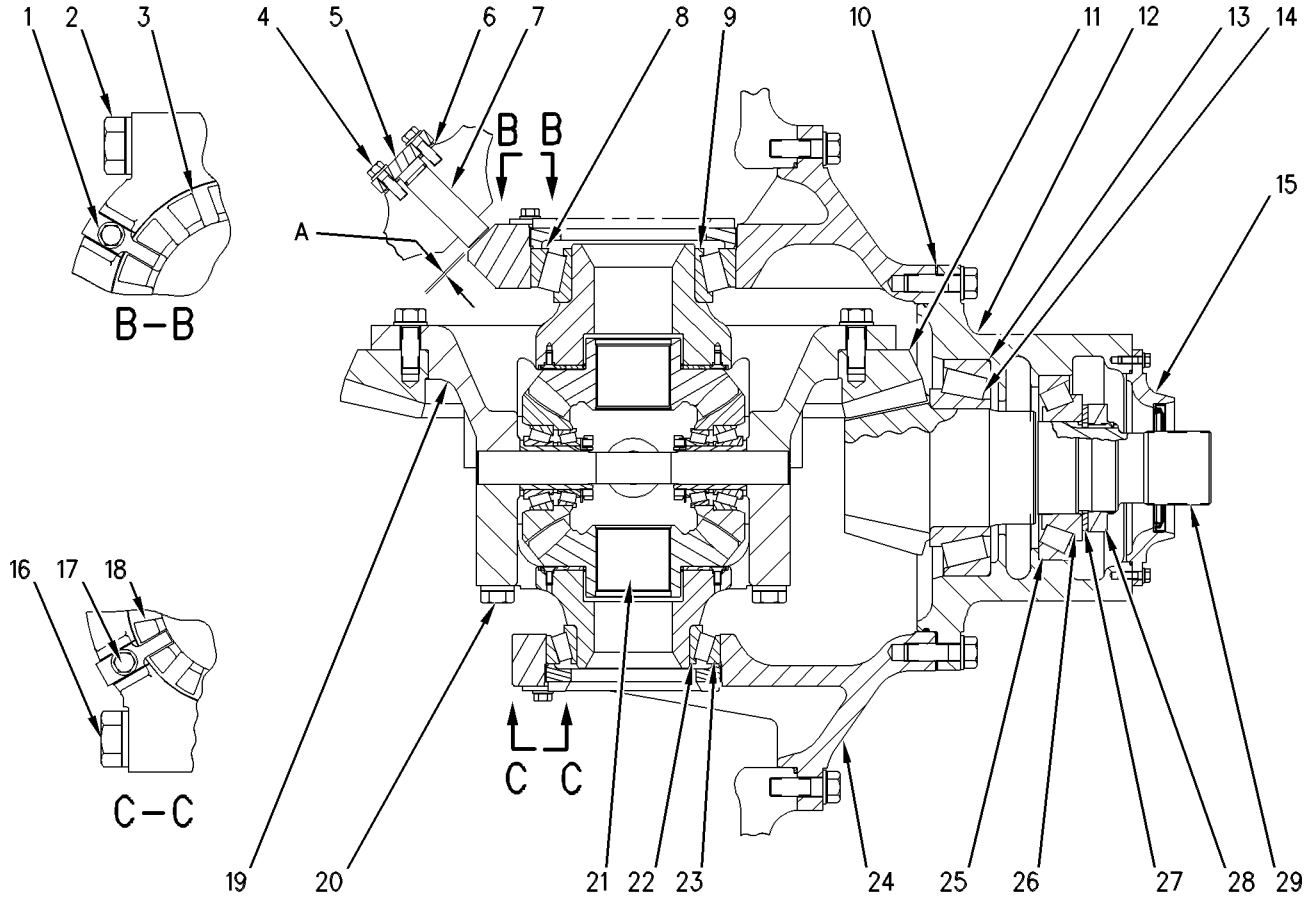


Illustration 145 g00405449

Differential and Bevel Gear

(1) Adjusting nut lock
(2) Bolts
(3) Adjusting nut
(4) Bolts
(5) Cover
(6) Shims
(7) Pin
(8) Bearing cup
(9) Bearing cone
(10) Shims
(11) Bevel gear
(12) Housing
(13) Bearing cup
(14) Bearing cone
(15) Retainer
(16) Bolts
(17) Adjusting nut lock
(18) Adjusting nut
(19) Differential case
(20) Bolts
(21) Differential
(22) Bearing cone
(23) Bearing cup
(24) Carrier assembly
(25) Bearing cup
(26) Bearing cone
(27) Washer
(28) Nut
(29) Bevel pinion

Note: The following procedure controls bearing preload. The procedure provides the same results for new bearings and for used bearings.

1. Install bevel gear (11) onto differential case (19). Torque for the 36 bolts is 750 ± 90 N·m (550 ± 65 lb ft).

2. Install bearing cone (9) and bearing cone (22) onto differential group (21). Make sure that the bearing cone is fully seated. Lubricate the bearing cone with SAE 50W differential oil.

3. Press bearing cup (13) and bearing cup (25) on pinion housing (12). Make sure that the bearing cups are fully seated.

4. Press bearing cone (14) on pinion (29). Make sure that the bearing cone is fully seated. Lubricate the bearing cone with SAE 50W differential oil.

5. Install pinion (29) in housing (12). Press bearing cone (26) onto the pinion shaft. Allow a small amount of end play to remain. Lubricate the bearing cone with SAE 50W differential oil.

Note: If you freeze the bearing cups, allow the parts to reach a uniform temperature. Then use a driver or a press to reset the bearing cups. The limit for freezing the bearing cups is −29°C (−20°F). Remove any frost and wipe the bearing cups dry. Lubricate the bearing cups with SAE 50W differential oil in order to prevent rust on the bearing cups.

Note: If you heat the bearing cones, allow the parts to reach a uniform temperature. Then use a driver or a press to reset the bearing cones. The limit for heating the bearing cones is a maximum of 135°C (275°F) for a maximum of four hours. Lubricate the bearing cones with SAE 50W differential oil after the bearing cones have cooled in order to prevent rust on the bearing cones.

6. Secure the assembled pinion housing (12) in a holding fixture. Install washer (27) and nut (28).

Table 46

Required Tools		
Part Number	**Description**	**Quantity**
1U-6691	Socket Wrench Assembly	1

7. While you rotate pinion shaft (29), tighten nut (28) in order to achieve a preload rolling torque of 2.2 to 5.1 N·m (20 to 45 lb in). This is the torque that is needed in order to rotate pinion (29). Make sure that there is zero end play of pinion shaft (29).

Note: Reduce preload rolling torque to 1.1 to 2.55 N·m (10 to 23 lb in) for used roller bearings with more than 100 hours of operation.

8. If the preload rolling torque for the pinion exceeds the specifications, back off nut (28) by 1/8 turn and reseat bearing cone (26) and washer (27) against nut (28). Perform Step 7 again.

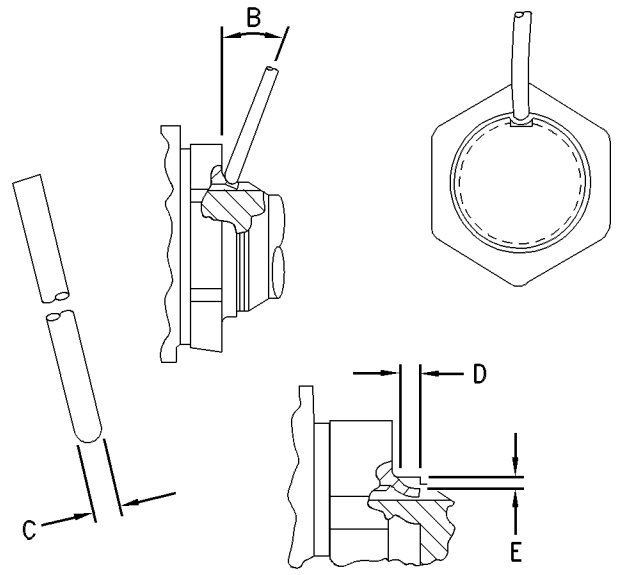


Illustration 146 g00103469

Stake Nut and Tooling

9. When the torque for rotating pinion (29) is correct, stake nut (28) by peening the collar into the slot in the pinion shaft. Proper peening requires the use of a punch with a spherical nose. The punch should have a nose that is (C) diameter. The punch should be held at an angle (B). The desired result is a stake of minimum length (D) and minimum depth (E). See Illustration 146 for a view of a completed staked nut.

List of dimensions for a staked nut

Dimension (B) . . . . . 10 to 30°
Dimension (C) . . . . . 7.5 to 8.0 mm ((0.30 to 0.32 inch))
Dimension (D) . . . . . .4.7 mm ((0.19 inch))
Dimension (E) . . . . . .2.5 mm ((0.10 inch))

Note: The nut may be reused if the collar is not cracked during removal or during restaking.

10. Secure carrier assembly (24) in a holding fixture.

11. Install the pinion subassembly in carrier assembly (24) with 80 percent of a new shim pack (10). Make sure that the axle centerline is vertical and that the teeth of bevel gear (11) are facing upward, as shown.

12. Tighten bolts (2) and (16) in each bearing cap to a torque of 25 N·m (18 lb ft).

13. Move adjusting nut (3) and adjusting nut (18) to a position that maintains the gear backlash and a slight bearing end play, but not a tight gear mesh.

14. Reposition the differential assembly so that the pinion shaft is vertical and the gear end is downward.

15. Measure the torque for rotating pinion (29) and record the measured torque.

16. Move adjusting nut (3) to the zero backlash position. Back off adjusting nut (3) by one-half turn.

17. Move adjusting nut (18) while you rotate bevel gear (11). Monitor the torque that is required to rotate pinion (29).

18. Continue to move adjusting nut (18) until a torque is registered over the torque that was measured in Step 15. This is the seated position.

19. Move adjusting nut (18) while rotating the bevel gear set until the overall rolling torque is 4 N·m to 15 N·m (35 lb in to 130 lb in).

20. Measure the backlash between bevel gear (11) and pinion gear (29). Measure the backlash at three equally spaced positions around the bevel gear. The backlash must be 0.40 ± 0.12 mm (0.016 ± 0.005 inch).

21. If the backlash does not meet the specification at any one of the three positions, back off one adjusting nut and move the other adjusting nut forward by the same amount. This will maintain the bearing preload.

22. Measure the torque for rotating pinion (29). The torque must be 4 N·m to 15 N·m (35 lb in to 130 lb in).

23. When proper backlash has been obtained tighten bolts (2) and (16) in each bearing cap to a torque of 1800 ± 200 N·m (1330 ± 150 lb ft).

24. Install adjusting nut locks (1) and (17).

Tooth Contact Pattern Adjustment (Pinion and Bevel Gear)

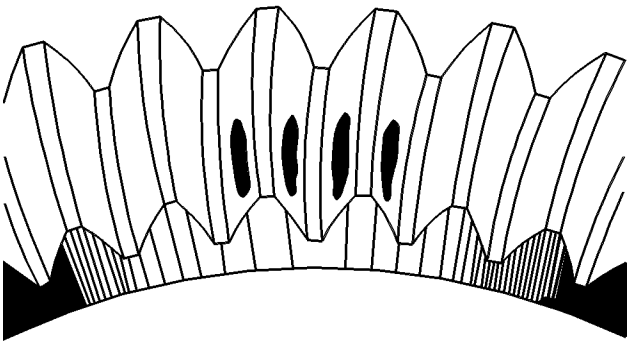


Illustration 147 g00103470

1. After the backlash adjustment and the preload adjustment have been made, check the tooth contact between pinion (29) and bevel gear (11) by using the following procedure:

a. Put a small amount of Prussian blue, of red lead, or of paint on the teeth of bevel gear (11).

b. Turn pinion (29) in both directions.

c. The end of the correct area of tooth contact is near the inside end of the teeth of the bevel gear (11). The contact area should extend halfway across the length of the teeth. See Illustration 147 for the correct area of tooth contact.

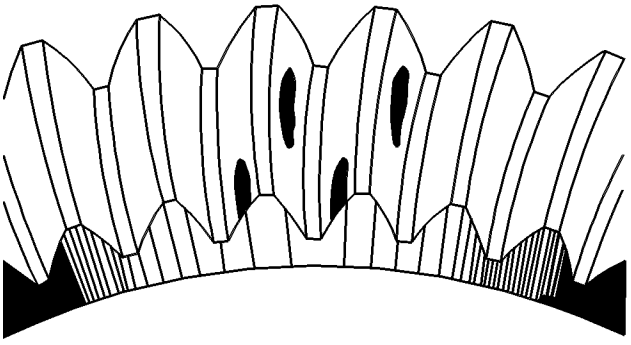


Illustration 148 g00103471

2. If the area of tooth contact looks like Illustration 148 , use the following procedure:

a. Remove some of the shims (10).

b. Perform Step 14 through Step 24 again.

c. Perform Step 2 and Step 3 again in order to check the area of tooth contact.

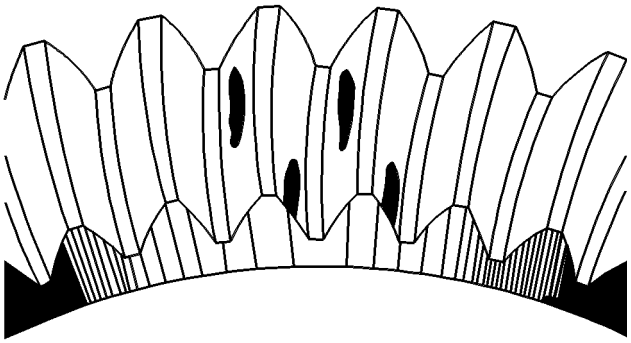


Illustration 149 g00103472

3. If the area of tooth contact looks like Illustration 149 , use the following procedure:

a. Add some of the shims (10).

b. Perform Step 14 through Step 24 again.

c. Perform Step 2 and Step 3 again in order to check the area of tooth contact.

Note: Always make sure that the backlash adjustment is correct before an adjustment is made to the area of tooth contact. Several adjustments to the backlash and to the tooth contact may be necessary in order to achieve the correct adjustments.

4. Install pin (7) and cover (5) without shims (6). Tighten bolts (4) enough in order to remove any clearance between the pin and the cover.

5. Measure the distance between the face of the cover (5) and the face of the axle housing. Install the shims (6) so that the pin is under a preload of −0.03 mm (−.001 inch) or an end play of 0.03 mm (.001 inch).

6. Install retainer (15).

i04786529

Wheel Bearings - Adjust

SMCS Code: 4051-025-BD

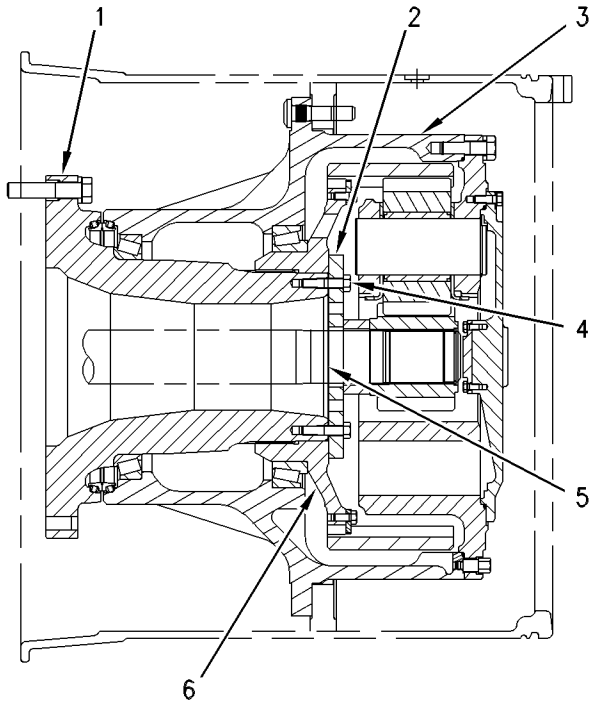


Illustration 150 g00401740

Final Drive and Wheel

(1) Spindle
(2) Retainer
(3) Wheel
(4) Bolt
(5) Shim
(6) Hub

Note: The following procedure should be performed with the spindle off the machine in a vertical position for best results. The following procedure can be performed on the machine with the spindle in a horizontal position. Make sure that no end play in the wheel bearing exists after adjusting. The tire and rim must be removed for either method. The same adjustment procedure can be used for both positions of the spindle.

This procedure requires a 0 to 25 mm (0 to 1 inch) outside micrometer and a depth micrometer that has 32 mm (1.25 inch) of travel.

1. Measure the thickness of retainer (2) with the outside micrometer. Measure the retainer at three places near the small gauge holes. Record the average of these three measurements.

2. Assemble the seal group in spindle (1) and in wheel (3). Apply oil on the wheel bearings. Install the wheel bearings and the wheel on the spindle.

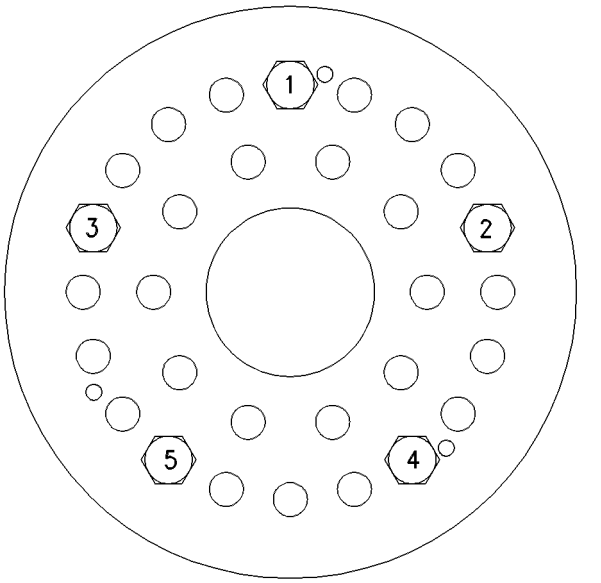


Illustration 151 g00103636
Bolt Tightening Sequence

3. Install hub (6) on the spindle. Apply oil to the threads of five bolts (4) and use the bolts to install retainer (2) without shims. Install five bolts (4) finger tight in the locations that are shown in Illustration 151 .

4. Tighten bolts (4) in the retainer to a torque of 90 ± 14 N·m (65 ± 7 lb ft). Tighten the bolts in the sequence that is shown in Illustration 151 .

5. Rotate the wheel for one revolution and tighten bolts (4) again to a torque of 90 ± 14 N·m (65 ± 7 lb ft).

6. Loosen bolts (4) so that the wheel can slide a slight amount downward on the wheel bearings.

7. Tighten bolts (4) to a torque of 40 ± 7 N·m (30 ± 5 lb ft). Tighten bolts (4) in the sequence that is shown in Illustration 151 .

8. Rotate the wheel for one revolution and tighten bolts (4) again to a torque of 40 ± 7 N·m (30 ± 5 lb ft).

9. To measure the distance from the retainer to the end of the spindle, use the depth micrometer. Measure the distance through the three small holes in the retainer.

10. Record the average of the three depth measurements. Calculate the difference between the average thickness that was measured in Step 1 and the average depth that was measured in Step 9. The difference is the gap that is between the retainer and the end of the spindle.

11. Add 0.1 mm (.004 inch) to the gap that was determined in Step 10. This measurement is the thickness of shims (5) that must be installed.

Note: The shims must be within 0.025 mm (.001 inch) of the thickness in Step 11.

12. Remove retainer (2). Install the necessary number of shims (5).

13. Install retainer (2) and 20 bolts (4). Start at the top of the retainer. If the machine has high lift capabilities, torque the bolts evenly to 475 ± 60 N·m (350 ± 45 lb ft). If the machine has standard lift capabilities, torque the bolts evenly to 270 ± 40 N·m (200 ± 30 lb ft).

Note: In Step 13, 5/8 inch bolts will use the lower torque value and 3/4 inch bolts will use the higher torque value.

i01649266

Glossary of Electrical Terms

SMCS Code: 1400; 4800

Active – This pertains to the status of a fault or to the status of a service code. When the fault is active, the fault is currently present.

+Battery – This pertains to any of the harness wiring which is part of the circuit that connects to the positive battery post.

+V – +V is a constant voltage that is supplied to a component. This voltage provides electrical power for the component's operation. +V is provided by an electronic control module or the battery.

Calibrate – The calibration procedure is performed in order to calculate the operating range of the left pedal position sensor. The calibration information is used by the control. The calibration information is used in order to determine the modulation curve of the pedal for the impeller clutch. The calibration information is used in order to determine the limits of the diagnostics for the position sensor on the left brake pedal.

Caterpillar Electronic Technician (ET) – This is a diagnostic service tool for a personal computer (PC).

Clear – This pertains to removing diagnostic information from the memory of the ECM. Before clearing a fault, a fault must be on hold and a fault must not be present.

Component Identifier (CID) – A CID is a code that is used to identify a particular component. The CID is a four digit code that is shown on the ECM display when the ECM is in service mode or normal mode.

Connector Contact – A connector contact is the component that actually makes the electrical connection between the harness connector and another connector plug. Connector contacts are either pins or sockets.

Detected Fault – This is a fault that has been found by the ECM. The fault is recorded and diagnostic information is available in the service mode.

Diagnostic – Diagnostic information is available when the ECM is in service mode. This helps a technician with troubleshooting.

Display – Display refers to the readout and indicators that are visible through the window of the control.

Electronic Control Analyzer Programmer (ECAP) – This is a service tool which helps diagnose electronic control systems.

Fault – A fault is a failure of a component in an ECM system. The ECM detects a fault when a signal at the ECM connector is outside a valid range. An FMI and a CID identify the type of fault.

Failure Mode Identifier (FMI) – An FMI is a diagnostic code that identifies the type of failure that has occurred. The FMI consists of a two digit code that is preceded by the letter F. This code is shown on the control display area when you are in service mode or normal mode.

Harness Code – The harness code provides the characteristics of the machine such as the size of the engine, idle speed, tire size and attachments. The Caterpillar Monitoring System uses the data link to provide the harness code to the ECM. The ECM operates on different machines, but the ECM must know the characteristics of the machine.

Hold – This pertains to the holding of diagnostic information that is shown in the display area when the ECM is in the service mode. It is necessary to hold the set of diagnostic information before troubleshooting or clearing.

Jumper – A jumper is a piece of wire that is used to make an electrical connection during troubleshooting.

Machine Code – The machine code is a number that consists of two digits. The machine code is assigned to a particular harness code for a particular machine by the ECM. The machine code is shown on the message display when the machine is in the Self Test Mode. Each sales model has a specific harness code. Therefore, each sales model also has a specific machine code.

Module Identifier (MID) – A MID is a diagnostic code that identifies the ECM which diagnosed the fault. The three-digit code is displayed in the display area of the Caterpillar Monitoring System when the machine is in the service mode. The MID for the transmission control on machines that are not equipped with an electronically controlled engine is 27. The MID for the transmission control on machines with an electronically controlled engine is 81.

Present – This pertains to the status of a fault or the status of a service code. The fault is currently active when the fault is present.

Scroll – When you scroll through information in the display area, all available sets of diagnostic information are shown by one set at a time. A set of diagnostic information is shown briefly. Then, the display automatically advances to the next set. After all sets have been shown, the display shows “END” . Then, the sets are repeated.

Service Code – A service code describes a condition in an electrical system. This code is stored in the ECM for the service technician.

Show – This pertains to information that is shown on the ECM display that is viewed by the operator or a service person.

Signal – The signal pertains to the condition of the ECM inputs. A ground signal has continuity with the frame ground. An open signal is not connected to the frame ground and the voltage is approximately 5 DCV. A +battery signal is at the same voltage as the battery (25 to 30 DCV).

Signal Wire – The signal wire is the harness wire that connects the sensor or the switch to the ECM.

Switch Input – The switch input is any ECM input which is expecting a ground signal, an open signal or a +battery signal.

System Voltage – System voltage is the actual voltage that exists between the positive battery post and the frame ground. System voltage is also known as +battery voltage.

Undetected Fault – This is a fault that is not detected by the ECM, but the fault is found by the operator or by a service technician.

i02443349

System Schematic

SMCS Code: 7566

These simplified schematics of the Power Train electronic control module (ECM). The schematic is electrically correct but the schematic does not show all possible harness connectors.

Refer to Electrical System Schematic for the complete schematic of a particular machine.

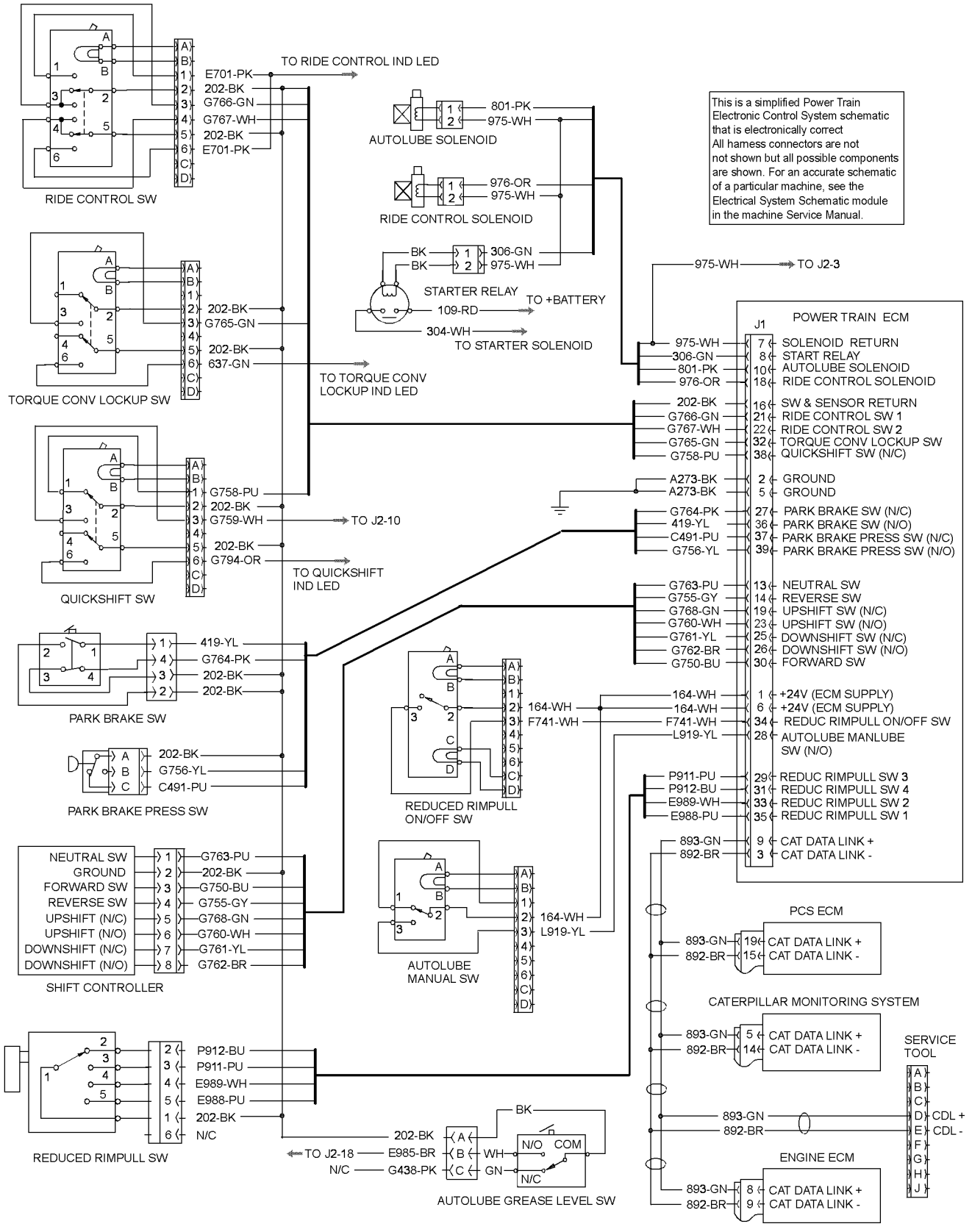


Illustration 152 g01220849

Connector J1 connections of the Power Train Electronic Control Module

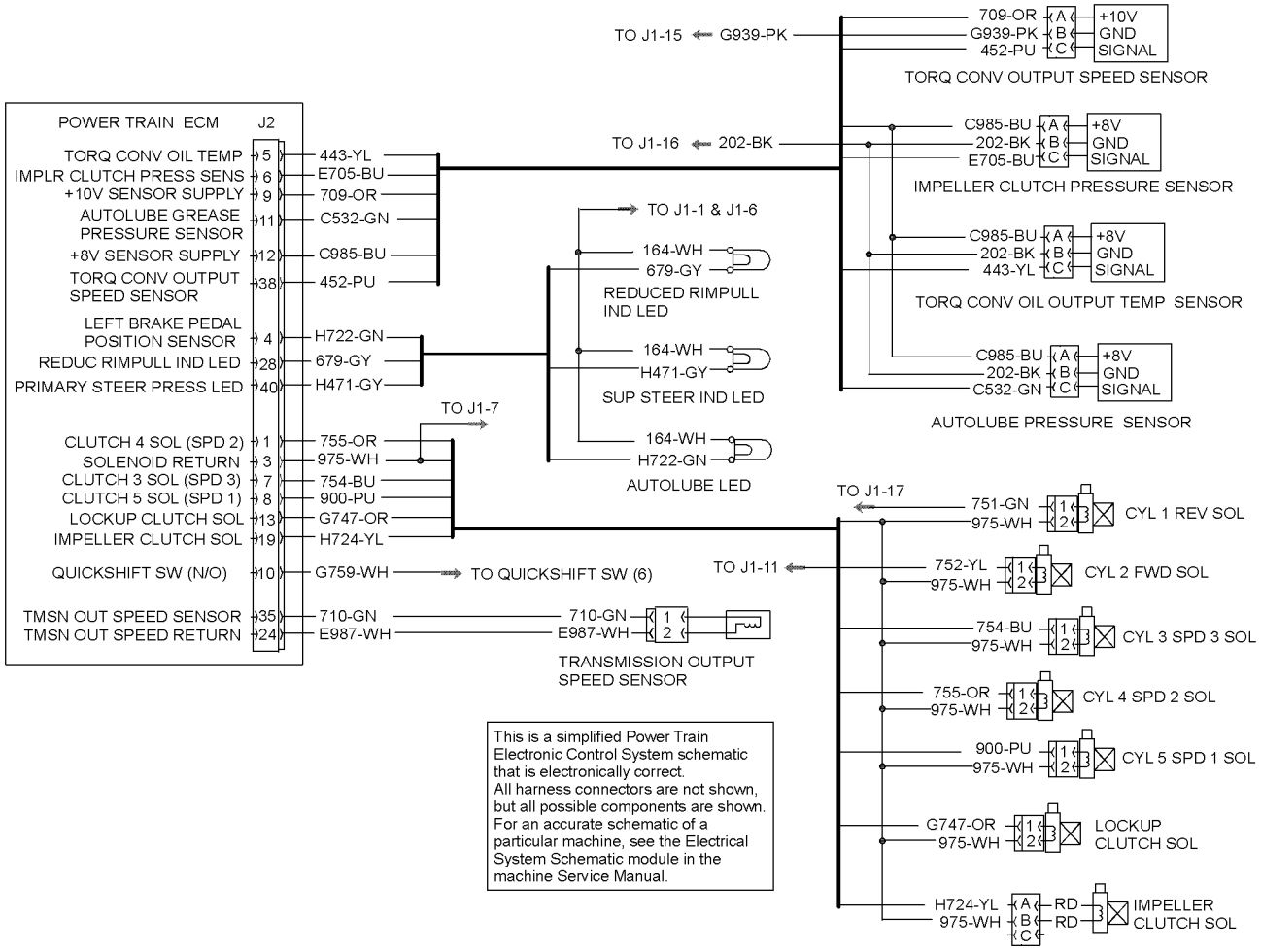


Illustration 153 g01220972

Connector J2 connections of the Power Train Electronic Control Module

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RENR8812-02 (en-us)
August 2018

Disassembly and Assembly

844H Wheel Dozer and , 990H Wheel Loader
Power Train

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

Disassembly and Assembly Section

i02468992

Steering Frame Lock - Separate and Connect

SMCS Code: 7506-029

Connection Procedure

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine. Secure clevis pin with locking pin.

Before operating the machine, fasten the steering frame lock link into the stored position and secure the clevis pin with locking pin.

Failure to lock into the stored position before operating can result in loss of steering.

1. Move the machine to a hard, level surface. Park the machine in the straight ahead position and engage the parking brake.

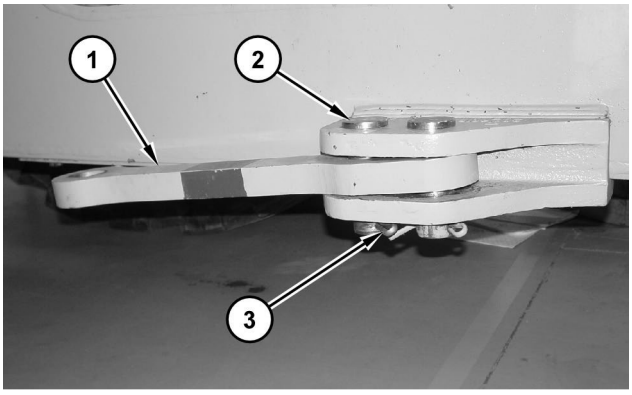


Illustration 1 g01231240

2. Remove cotter pin (3) from pin (2).

3. Remove pin (2) from the rear frame.

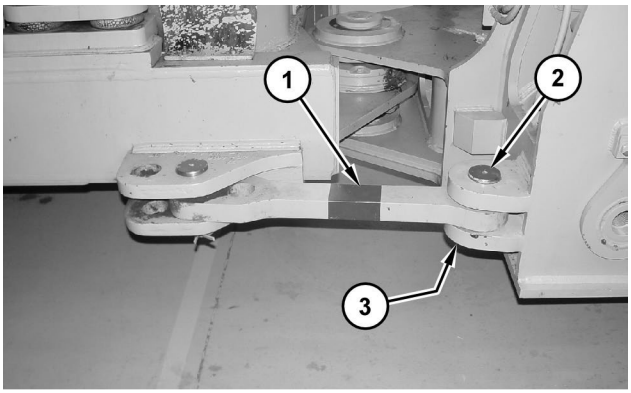


Illustration 2 g01231236

4. Move steering frame lock (1) in position to the front frame. Install pin (2) and cotter pin (3).

Note: In order to align the pin bores, steer the machine left or steer the machine right.

Separation Procedure

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine. Secure clevis pin with locking pin.

Before operating the machine, fasten the steering frame lock link into the stored position and secure the clevis pin with locking pin.

Failure to lock into the stored position before operating can result in loss of steering.

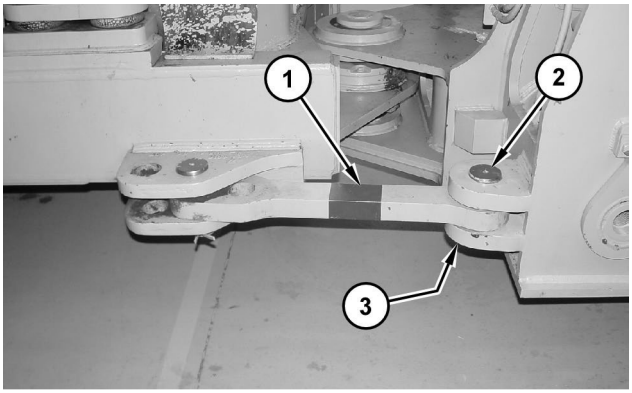


Illustration 3 g01231236

1. Remove cotter pin (3) and pin (2).

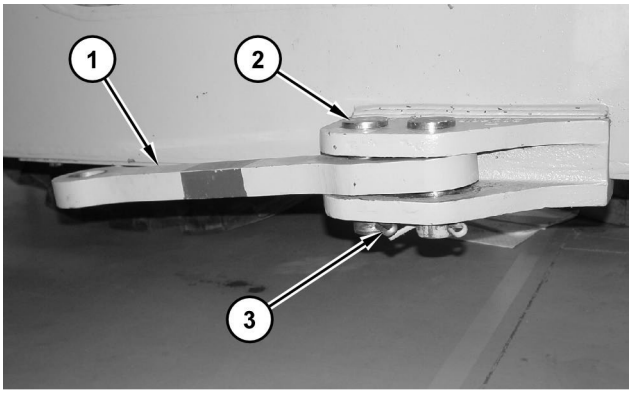


Illustration 4 g01231240

2. Move steering frame lock (1) to the storage position.

3. Install pin (2) and cotter pin (3).

i04166051

System Pressure - Release

SMCS Code: 4250-553-PX; 4300-553-PX; 5050-553-PX

Release Procedure (Implement System)

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

1. If the machine is equipped with a ride control system, move the ride control switch to the ON position.

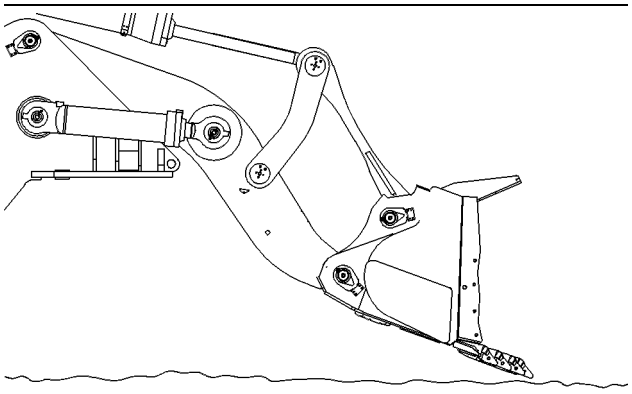


Illustration 5 g02009358

2. Position the bucket or the work tool just above the ground at a slight downward angle in order to ensure that the head end of the lift cylinders is pressurized.

3. Turn the engine start switch to the OFF position.

4. When the engine has stopped, turn the engine start switch back to the ON position so the pilot oil can reach the main valve.

5. Move the implement lockout switch to the UNLOCKED position.

6. Move the lift control lever to the FLOAT position and the tilt control lever to the TILT BACK position at the same time. This action allows the bucket or the work tool to tilt back while the boom is lowered.

The bottom of the bucket or the work tool should rest flat on the ground and the weight of the linkage should be supported by the ground. The pressure from the head end of the lift cylinders and from the ride control accumulator is now vented to the hydraulic tank.

7. When the bucket or the work tool has settled to the ground, move both control levers to the HOLD position. Then, cycle the control levers through all positions in order to purge any remaining pressure from the implement hydraulic system.

8. Turn the engine start switch to the OFF position.

9. Slowly loosen the hydraulic tank filler cap in order to release the pressure from the hydraulic tank.

10. After all of the pressure has been released, tighten the hydraulic tank filler cap. The hydraulic system pressure has now been released. Hydraulic lines and components can now be removed.

Release Procedure (Steering System and Braking System)

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

Note: Make sure that the parking brake is engaged.

1. Straighten the machine and install the steering link.

2. Lower the bucket to the ground and stop the engine.

3. Move the STIC steering and transmission lock control to the LOCKED position.

4. In order to release the pressure from steering cylinders, the machine must not be operated for a minimum of 1 hour. This will allow sufficient time for the pressure in the steering system to dissipate.

5. Depress the brake pedal repeatedly in order to release any pressure in the braking system.

6. Slowly loosen the hydraulic tank filler cap in order to release the pressure from the hydraulic tank.

7. After all of the pressure has been released, tighten the hydraulic tank filler cap. The hydraulic system pressure has now been released. Hydraulic lines and components can now be removed.

Dead Electronics

1. If the electronics fail, it may not be possible to relieve all stored hydraulic oil pressure. The following precautions should be taken.

2. Turn the engine OFF.

3. The machine should be secured with a lockout.

4. Use the appropriate stand or blocks to prevent undesired drift of implements.

5. Barriers should be used in order to prevent personnel from entering areas that implement drift or movement could be hazardous.

6. To lower lift arms and the ripper onto the ground or onto the appropriate supports, open the 112-1817 Manual Valve Gp.

7. Do not open or disassemble any hydraulic circuits until the electronic controls are required to relieve stored hydraulic pressure.

i07118096

Crankcase Guard - Remove and Install

SMCS Code: 7151-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Quantity**
A	463-3380	Lift As	1

Start By:

a. Connect the steering frame lock.

Note: The crankcase guard consists of three separate guards. Each guard can be removed independently.

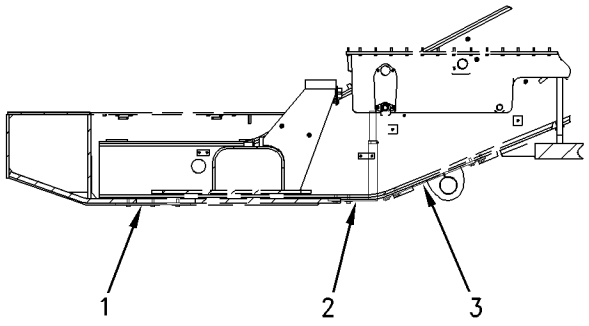


Illustration 6 g00866852

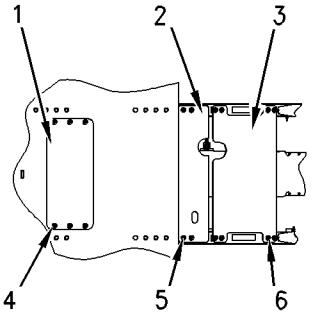


Illustration 7 g00866862

1. Use Tooling (A) to remove crankcase guard (3). The weight of crankcase guard (3) is approximately 59 kg (130 lb). Remove bolts (6) and crankcase guard (3).

2. Use Tooling (A) to remove crankcase guard (2). The weight of crankcase guard (2) is approximately 27 kg (60 lb). Remove bolts (5) and crankcase guard (2).

3. Use Tooling (A) to remove crankcase guard (1). The weight of crankcase guard (1) is approximately 39 kg (85 lb). Remove bolts (4) and crankcase guard (1).

Installation Procedure

1. Install all the crankcase guards in the reverse order of removal.

i07113176

Power Train Guard (Transmission) - Remove and Install

SMCS Code: 7153-010; 7153-010-T3

Removal Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	463-3380	Lift As	1

Start By:

a. Connect the steering frame lock.

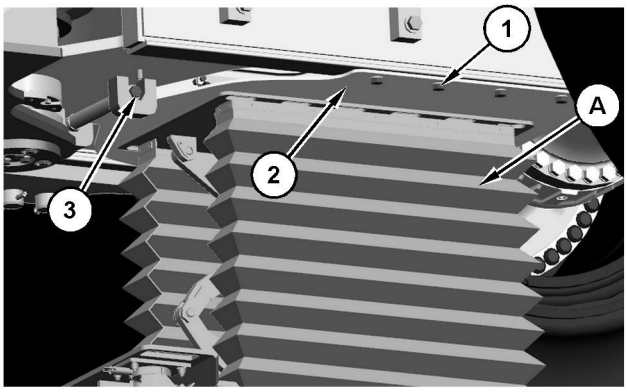


Illustration 8 g06228973

1. Use Tooling (A) to remove power train guard (2). The weight of power train guard (2) is approximately 110 kg (243 lb). Remove bolts (1), bolts (3), and use Tooling (A) to lower power train guard (2) to the ground.

Installation Procedure

1. Install the power train guard in the reverse order of removal.

i02496891

STIC Control - Remove

SMCS Code: 3033-011

Removal Procedure

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

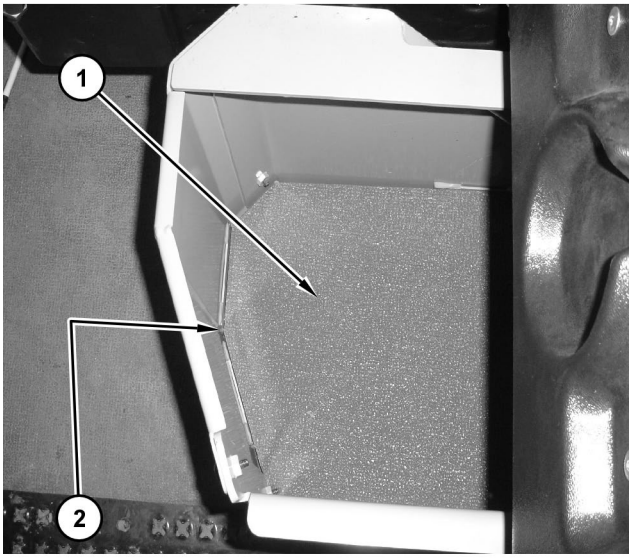


Illustration 9 g01248640

1. Remove mat (1). Remove plate (2).

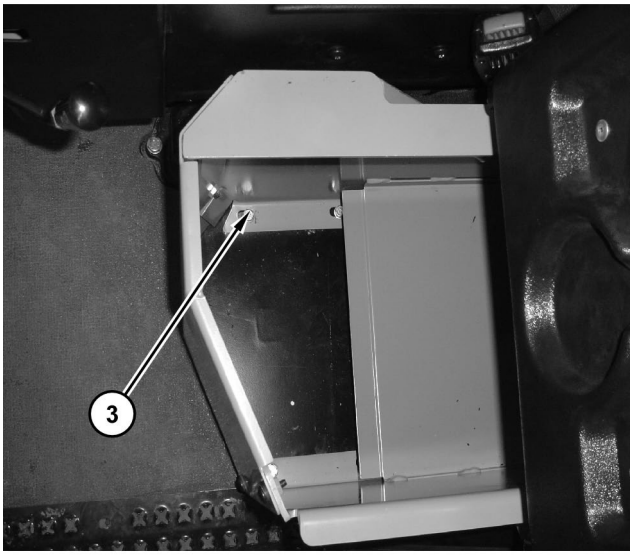


Illustration 10 g01248642

2. Remove bolts (3).

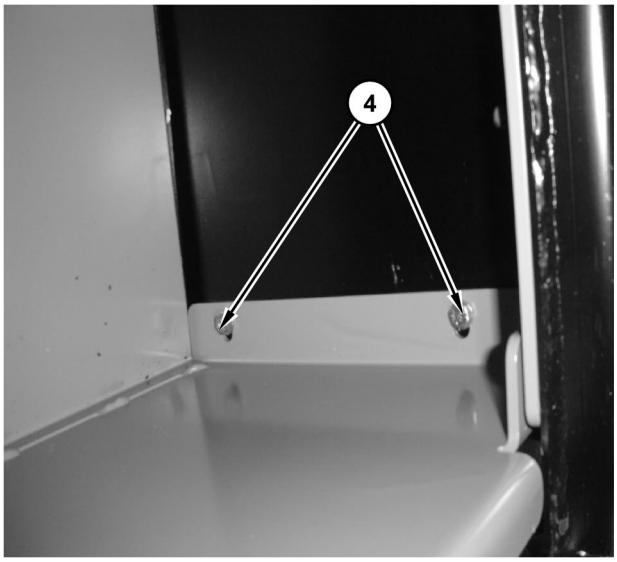


Illustration 11 g01248639

3. Remove bolts (4).

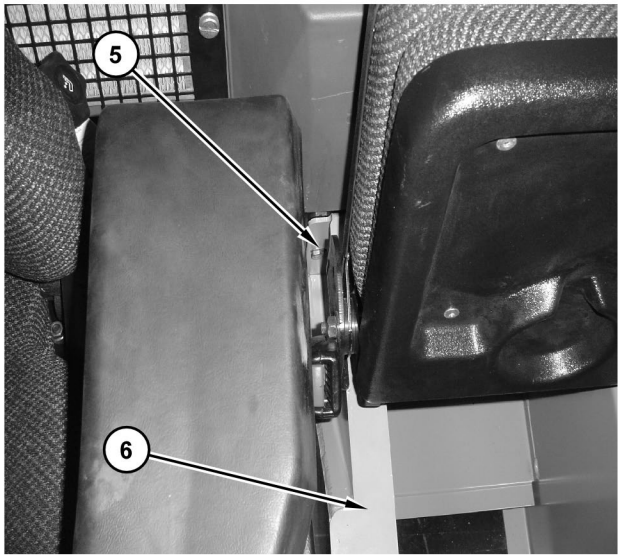


Illustration 12 g01248641

4. Remove bolts (5). Remove storage box assembly (6).

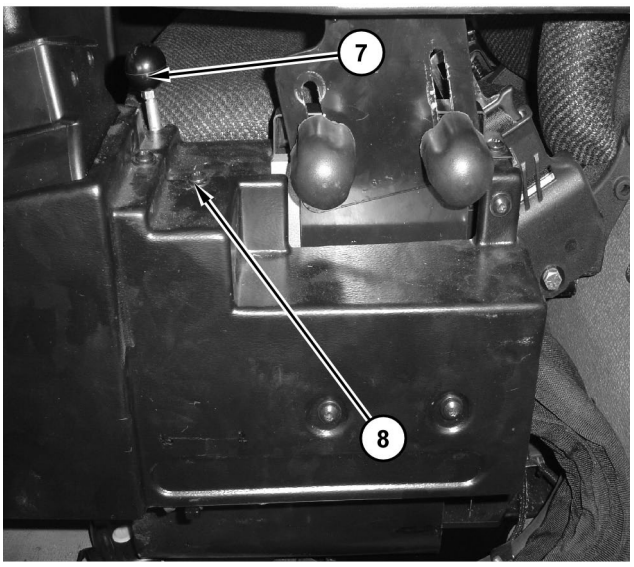


Illustration 13 g01248635

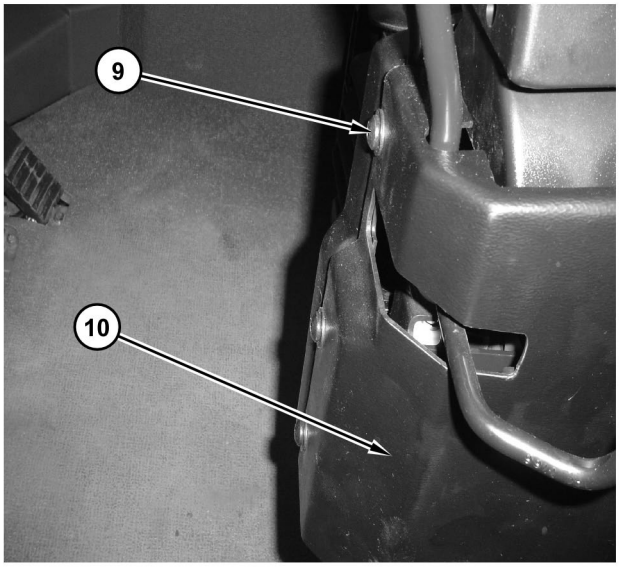


Illustration 14 g01248637

5. Remove knob (7). Remove bolts (8) and (9). Remove covers (10).

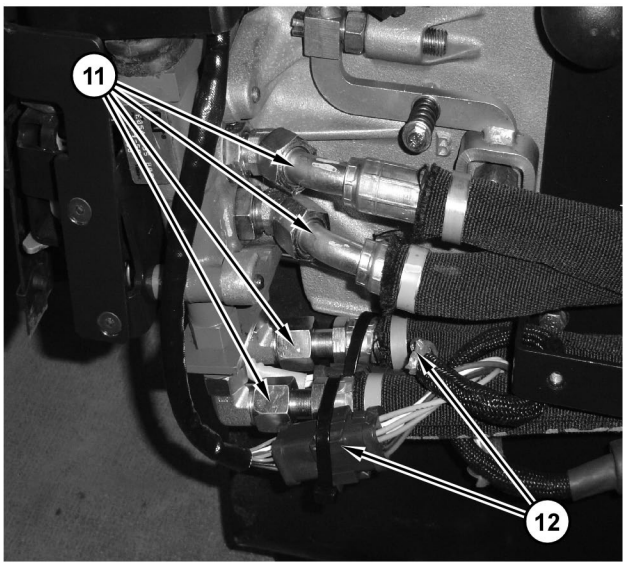


Illustration 15 g01248636

6. Disconnect hose assemblies (11). Disconnect harness assemblies (12).

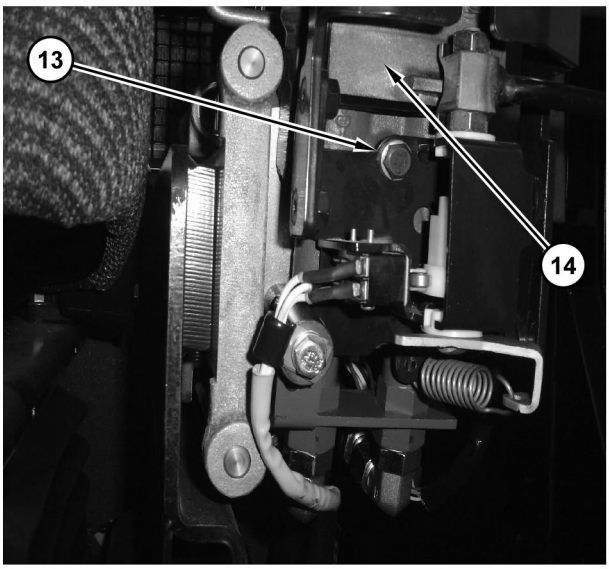


Illustration 16 g01248638

7. Remove bolts (13). Remove the STIC steering control lever and steering pilot valve (14) as a unit.

i02496813

STIC Control - Install

SMCS Code: 3033-012

Installation Procedure

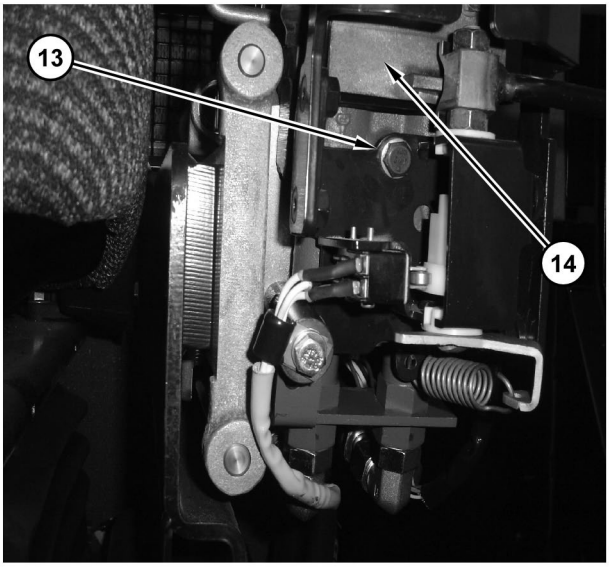


Illustration 17 g01248540

1. Install the STIC steering control lever and steering pilot valve (14) as a unit. Install bolts (13).

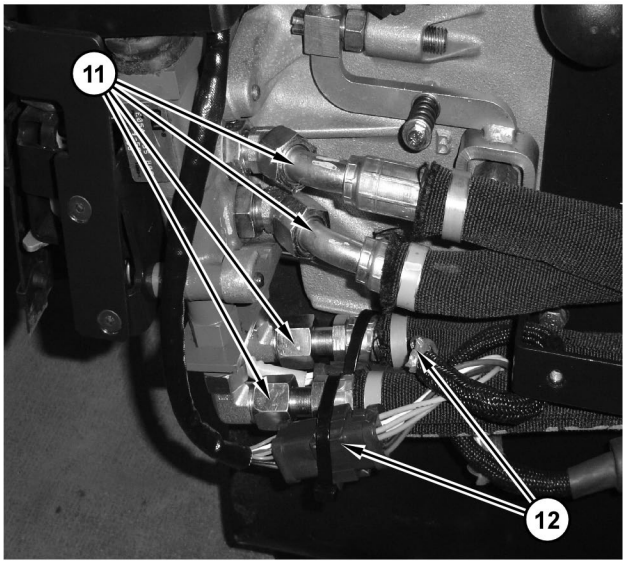


Illustration 18 g01248537

2. Connect hose assemblies (11). Connect harness assemblies (12).

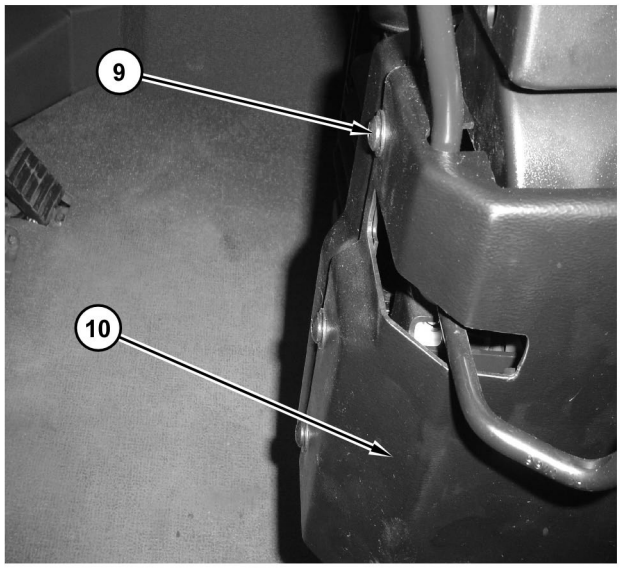


Illustration 19 g01248538

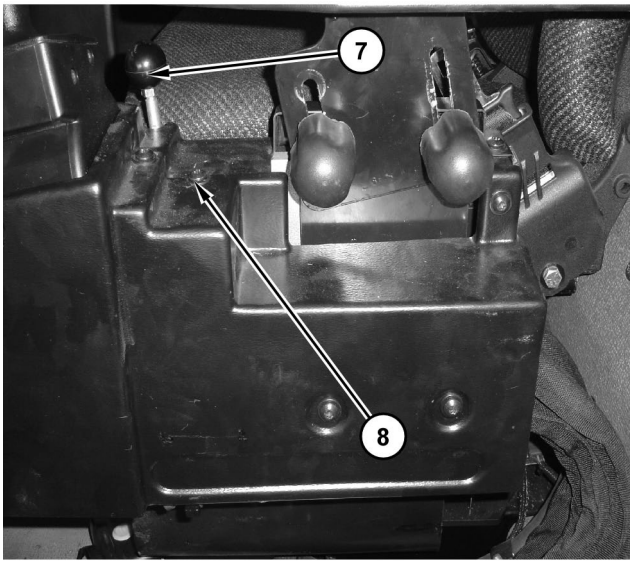


Illustration 20 g01248536

3. Install covers (10). Install bolts (8) and (9). Install knob (7).

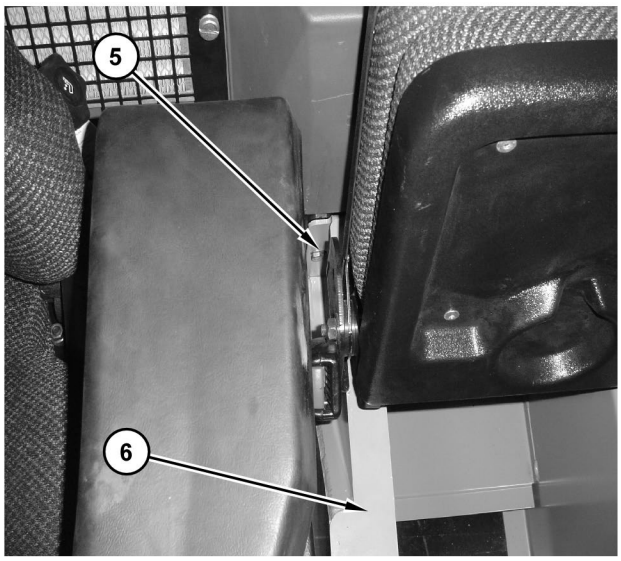


Illustration 21 g01248544

4. Install storage box assembly (6). Install bolts (5).

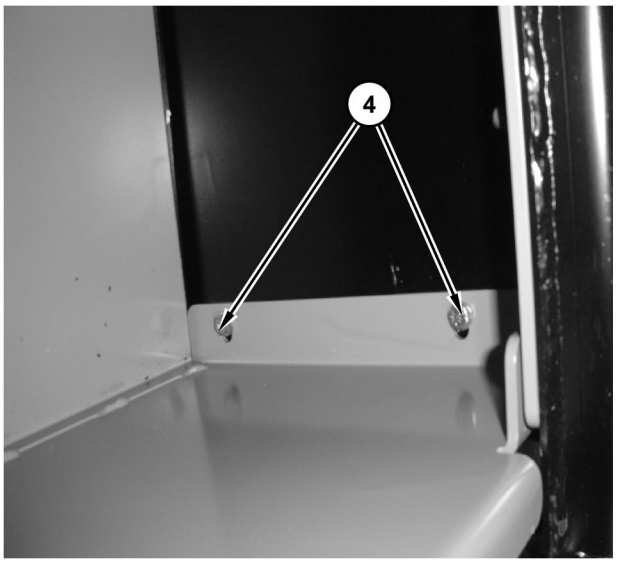


Illustration 22 g01248541

5. Install bolts (4).

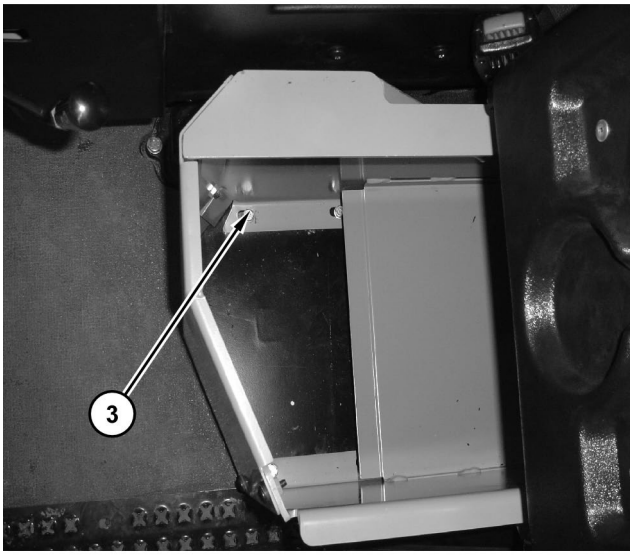


Illustration 23 g01248545

6. Install bolts (3).

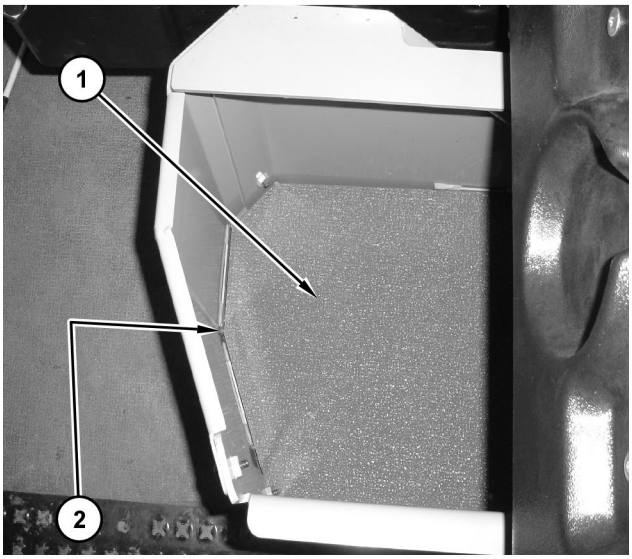


Illustration 24 g01248542

7. Install plate (2). Install mat (1).

i02480891

Torque Converter (Lockup) - Remove

SMCS Code: 3101-011-L7

Removal Procedure

Table 3

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	1U-9200	Lever Puller Hoist	1
C	138-7575	Link Bracket	3

Start By:

a. Remove the steering pump. Refer to Disassembly and Assembly, “Piston Pump (Steering) - Remove”.

b. Remove the implement hydraulic pump. Refer to Disassembly and Assembly, “Piston Pump (Tandem, Implement) - Remove”.

c. Remove the input drive shaft. Refer to Disassembly and Assembly, “Input Drive Shaft - Remove and Install” for the machine that is being serviced.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

WARNING

Personal injury can result from hot oil or hot components.

At operating temperature, oil is hot and under pressure. Hot oil can cause burns.

Remove the fill cap only when the engine is stopped, and the fill cap is cool enough to touch with your bare hand.

Do not allow hot oil or components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help prevent fluid loss and this will help to prevent contaminants from entering the system.

1. Close the heater hose valves.

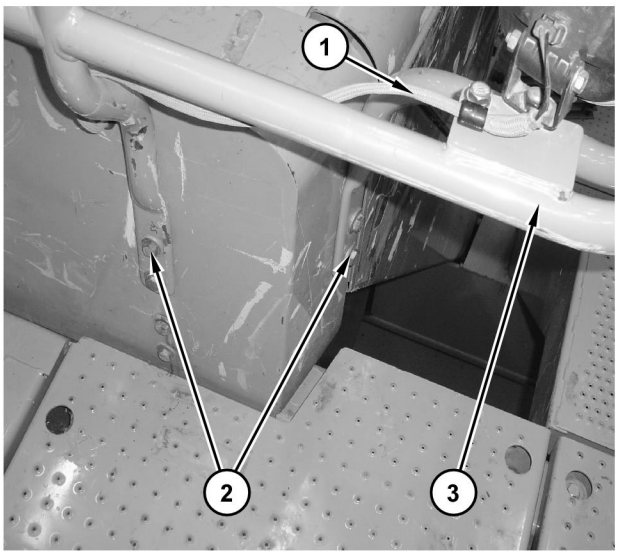


Illustration 25 g01252702

2. Disconnect harness assembly (1). Remove bolts (2). Use two people in order to remove handrail assembly (3). Repeat for the opposite side.

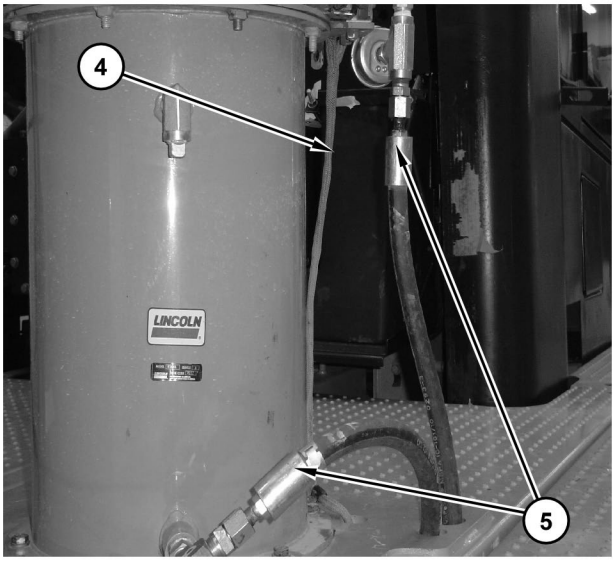


Illustration 26 g01252739

3. Disconnect harness assembly (4) and the mounting hardware. Disconnect hose assemblies (5).

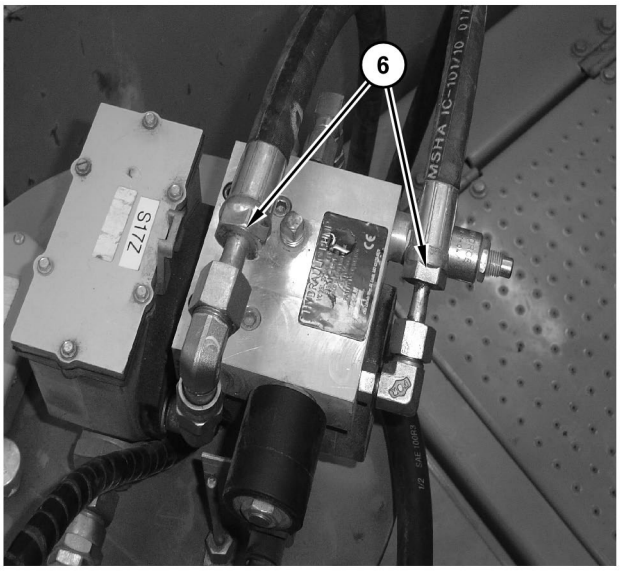


Illustration 27 g01252754

4. Disconnect hose assemblies (6).

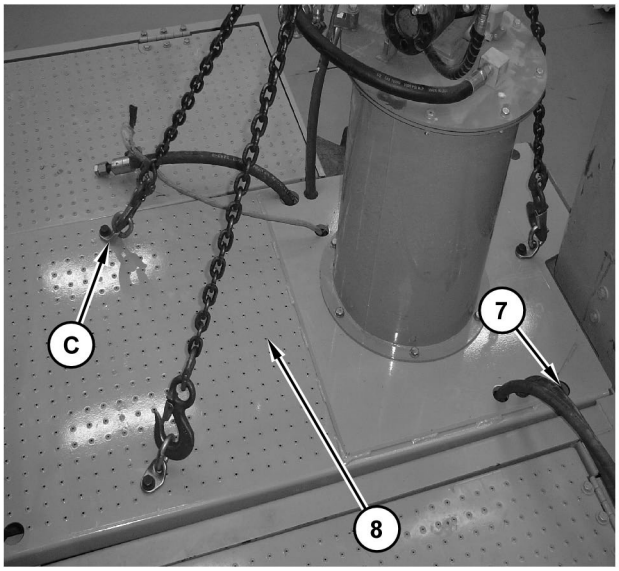


Illustration 28 g01253114

5. Remove bolts (7). Attach Tooling (C) and a suitable lifting device to cover assembly (8). The weight of cover assembly (8) is approximately 159 kg (350 lb). Remove cover assembly (8).

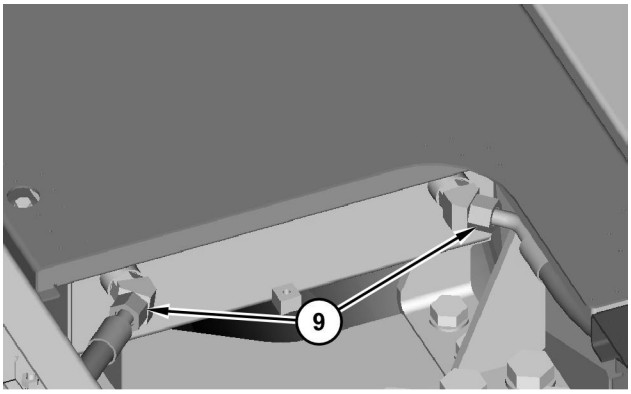


Illustration 29 g01253162

6. Disconnect hose assemblies (9).

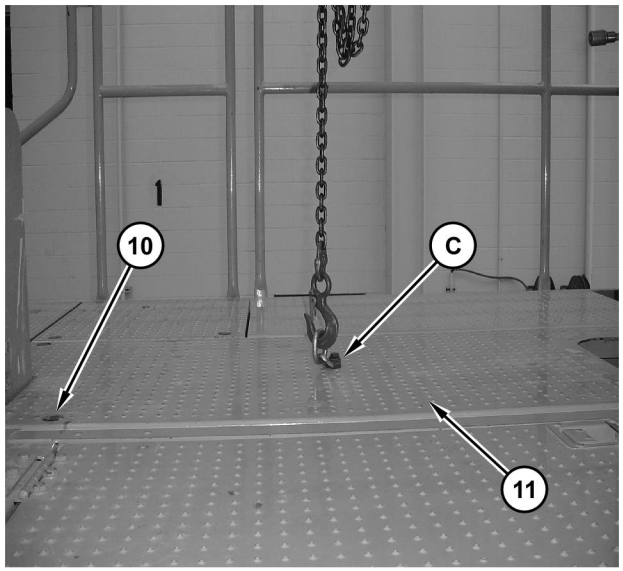


Illustration 30 g01253170

7. Remove bolts (10). Attach Tooling (C) and a suitable lifting device to cover assembly (11). The weight of cover assembly (11) is approximately 118 kg (260 lb). Remove cover assembly (11).

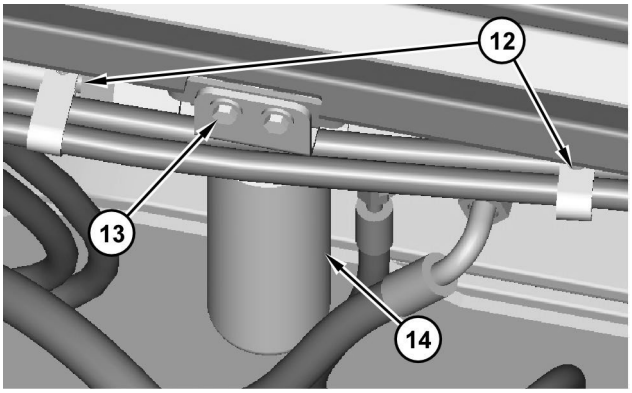


Illustration 31 g01239011

8. Remove clips (12).

9. Remove bolts (13) and position hydraulic oil filter base (14) out of the way.

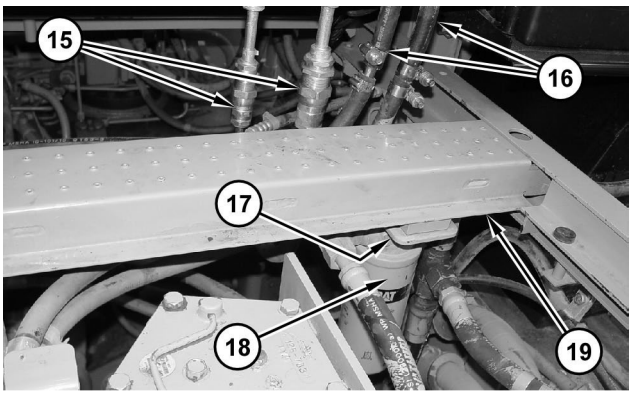


Illustration 32 g01239015

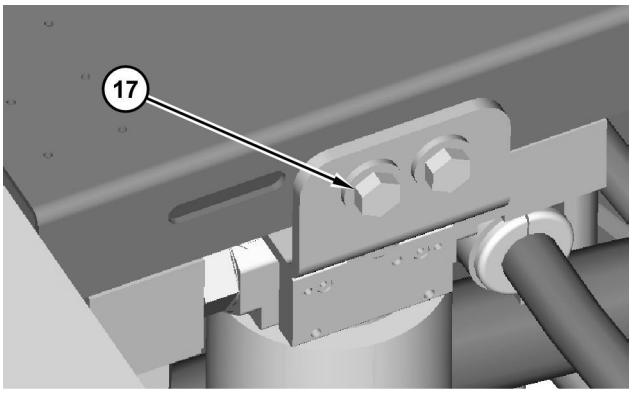


Illustration 33 g01253231

10. Disconnect hose assemblies (15).

11. Disconnect hose assemblies (16).

12. Remove bolts (17) and position hydraulic oil filter base (18) out of the way.

13. Remove brace (19).

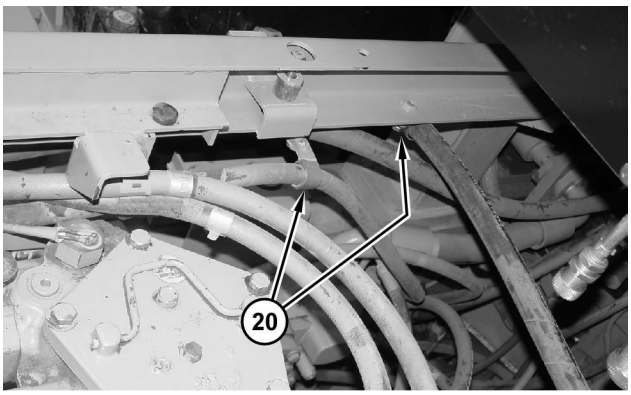


Illustration 34 g01239016

14. Remove clips (20).

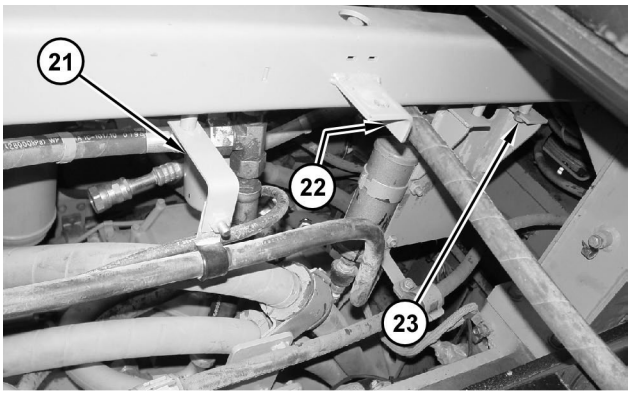


Illustration 35 g01239018

15. Remove bracket (21). Remove clip (22).

16. Remove bolts (23).

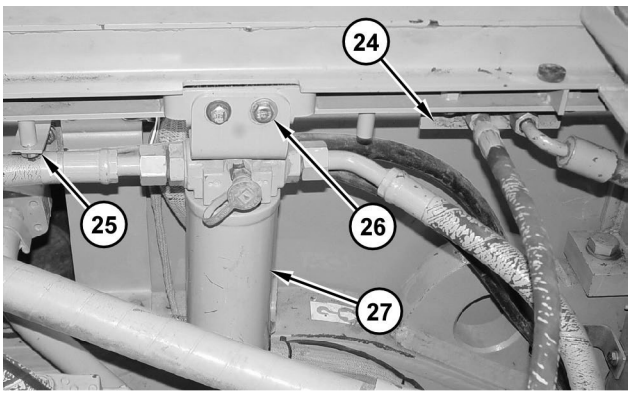


Illustration 36 g01239611

17. Remove bracket (24). Remove bracket (25).

18. Remove bolts (26) and position hydraulic oil filter base (27) out of the way.

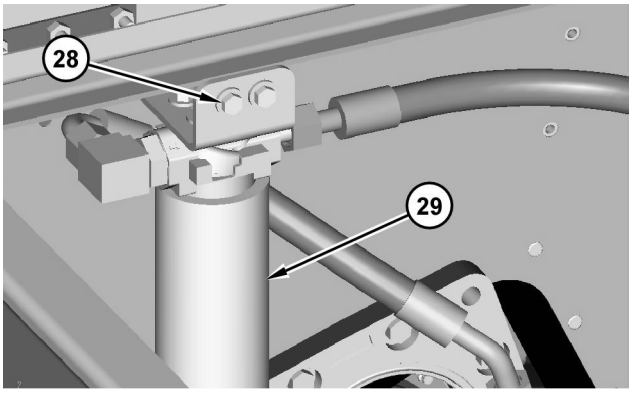


Illustration 37 g01240058

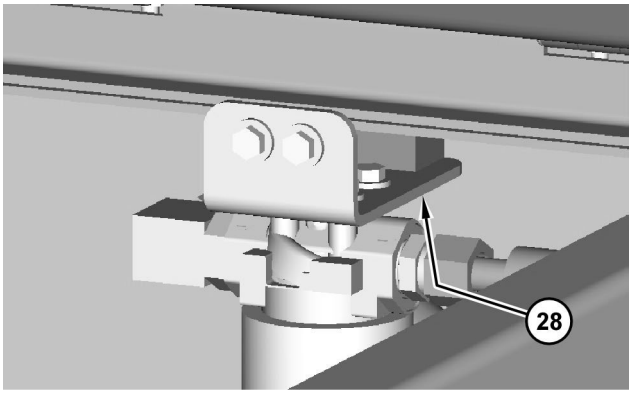


Illustration 38 g01253247

19. Remove bolts (28) and position hydraulic oil filter base (29) out of the way.

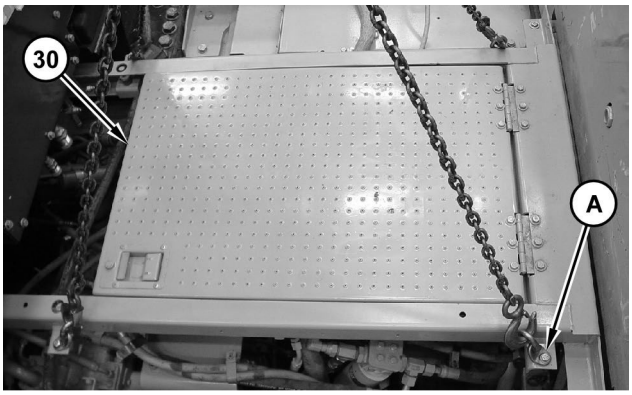


Illustration 39 g01240076

20. Attach Tooling (A) and a suitable lifting device onto panel assembly (30). The weight of panel assembly (30) is approximately 82 kg (180 lb).

Note: Adjust the length of the chains that are nearest to the cab by approximately 305 mm (12.0 inch).

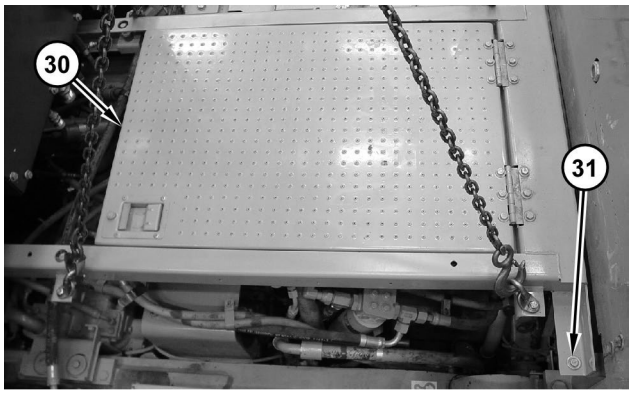


Illustration 40 g01240082

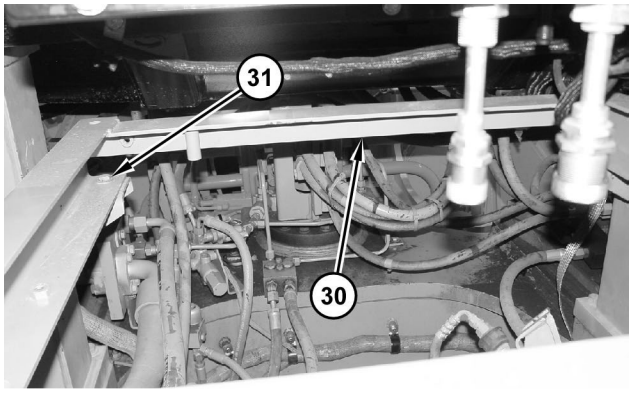


Illustration 41 g01240083

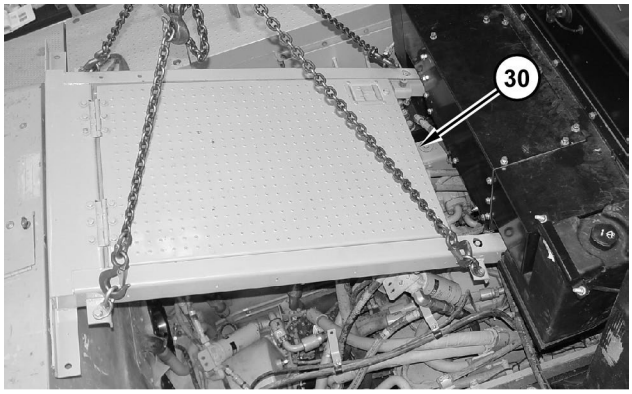


Illustration 42 g01240090

21. Remove bolts (31) and remove panel assembly (30).

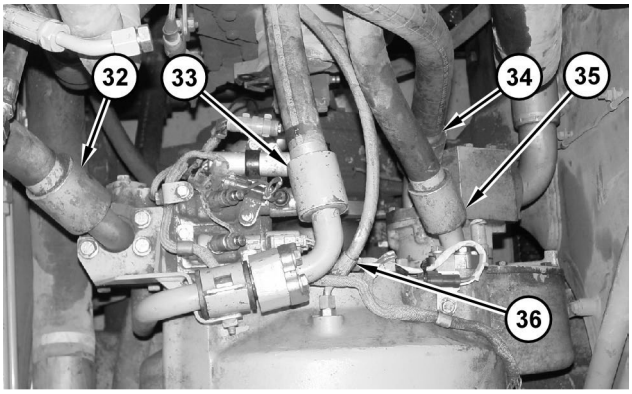


Illustration 43 g01240094

22. Disconnect hose assembly (32), hose assembly (33), hose assembly (34), hose assembly (35), and hose assembly (36).

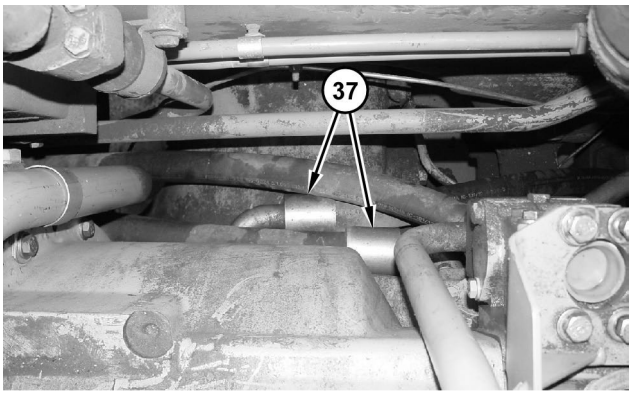


Illustration 44 g01240099

23. Disconnect hose assemblies (37).

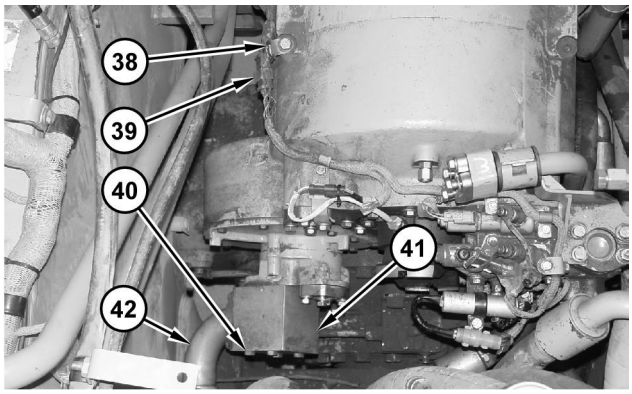


Illustration 45 g01240104

24. Remove clip (38). Disconnect harness assembly (39).

25. Remove bolts (40) in order to disconnect adapter block (41) and hose assembly (42).

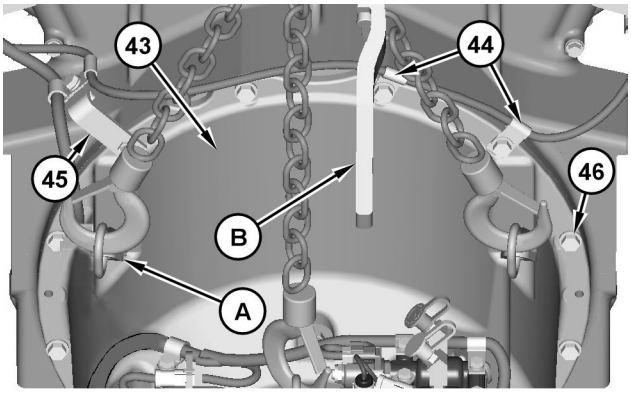


Illustration 46 g01240256

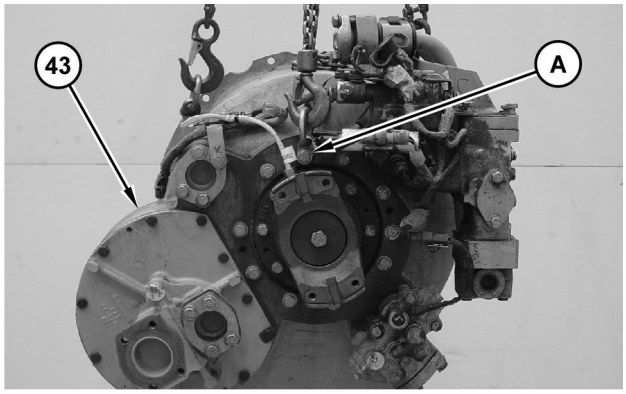


Illustration 47 g01240113

26. Attach Tooling (A), Tooling (B), and a suitable lifting device onto torque converter (43). The weight of torque converter (43) is approximately 476 kg (1050 lb).

27. Remove clips (44). Remove bracket (45).

28. Remove bolts (46) and remove torque converter (43).

i05323748

Torque Converter (Lockup) - Disassemble

SMCS Code: 3101-015-L7

Disassembly Procedure

Table 4

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	3E-3879	Eyebolt	1
B	138-7573	Link Bracket	2
C	1H-3110	Bearing Puller Attachment	1
D	154-6182	Forcing Bolt	2

Start By:

a. Remove the torque converter. Refer to Disassembly and Assembly, "Torque Converter - Remove".

1. Use a suitable lifting device in order to place the torque converter on suitable blocking. The weight of the torque converter is 363 kg (800 lb).

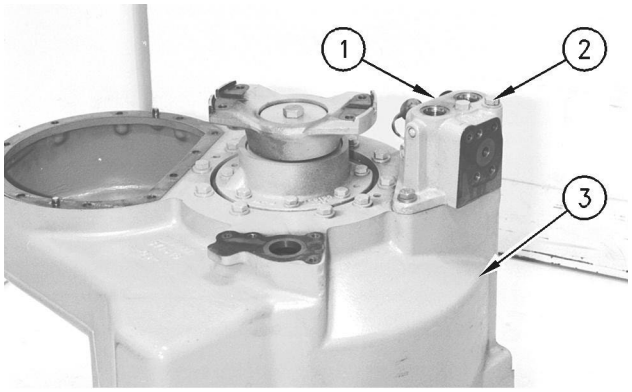


Illustration 48 g00859460

2. Remove bolts (2).

3. Remove housing (1) from housing assembly (3).

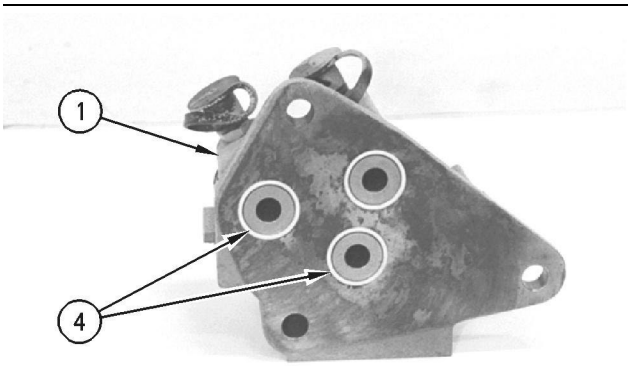


Illustration 49 g00859461

4. Remove O-ring seals (4) from housing (1).

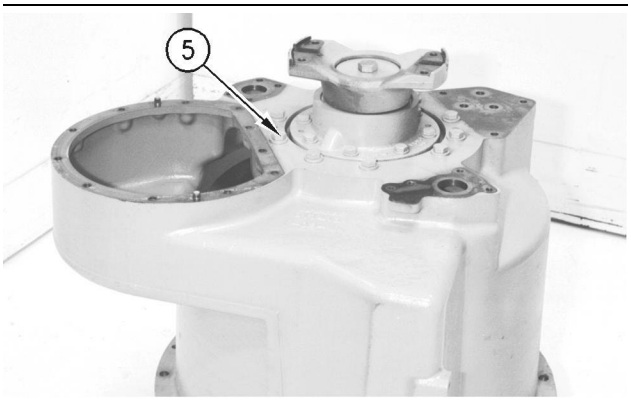


Illustration 50 g00859462

5. Remove bolts (5).

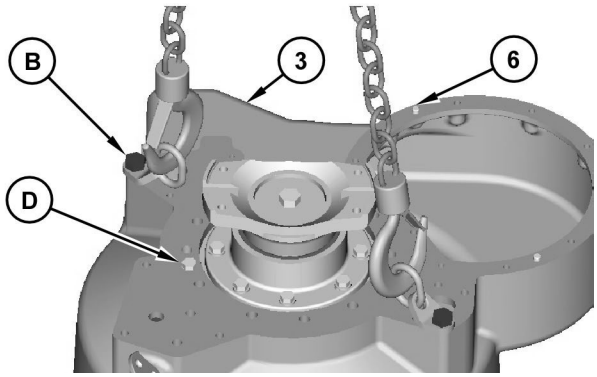


Illustration 51 g01249520

6. Use Tooling (D) in order to separate housing assembly (3).

7. Use Tooling (B) and a suitable lifting device in order to remove housing assembly (3) from the torque converter. The weight of housing assembly (3) is approximately 127 kg (280 lb).

8. Remove dowel pins (6).

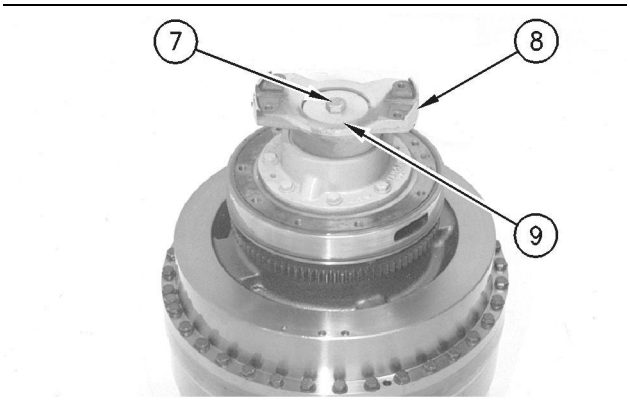


Illustration 52 g00859465

9. Remove bolt (7), retainer (9), and yoke (8).

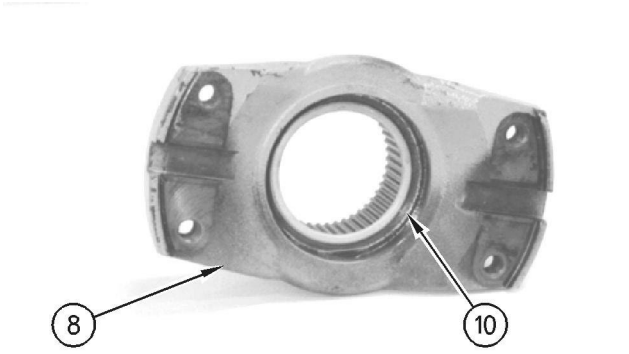


Illustration 53 g00859466

10. Remove O-ring seal (10) from yoke (8).

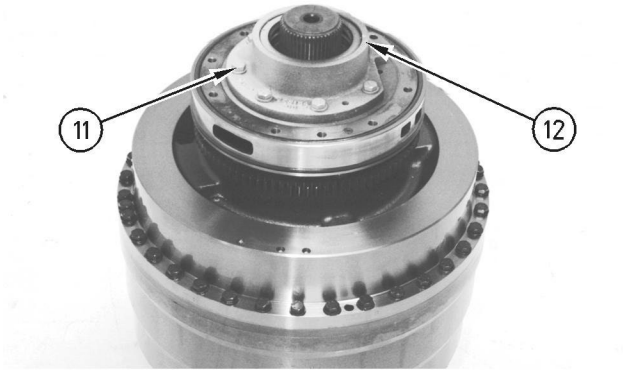


Illustration 54 g00859467

11. Remove bolts (11).

12. Remove the gasket and retainer (12).

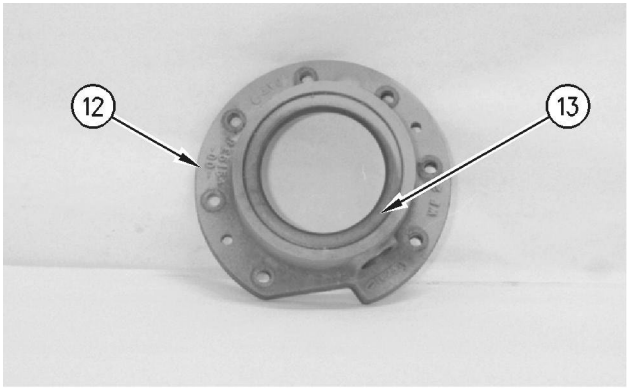


Illustration 55 g00859468

13. Remove lip seal (13) from retainer (12).

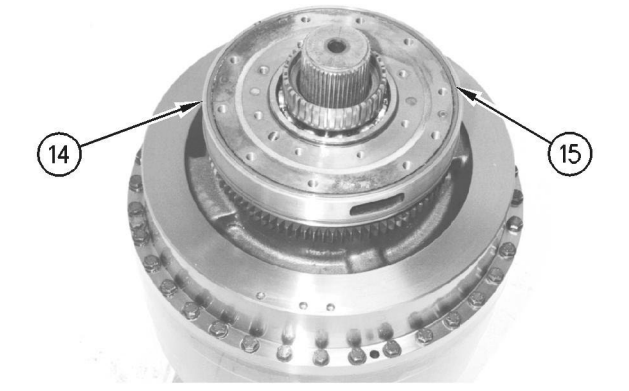


Illustration 56 g00859470

14. Remove O-ring seal (15) from stator carrier (14).

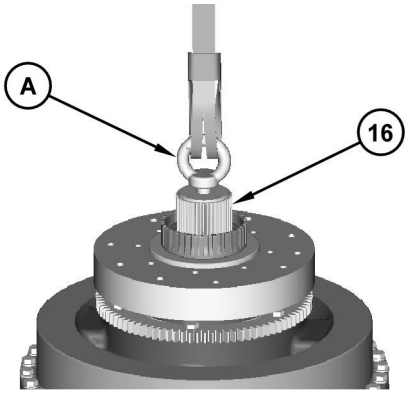


Illustration 57 g01249548

15. Use Tooling (A) and a suitable lifting device in order to remove shaft (16) from the torque converter. The weight of shaft (16) is approximately 15 kg (33 lb).



Illustration 58 g01252331

16. Remove rotor (17) from shaft (16).

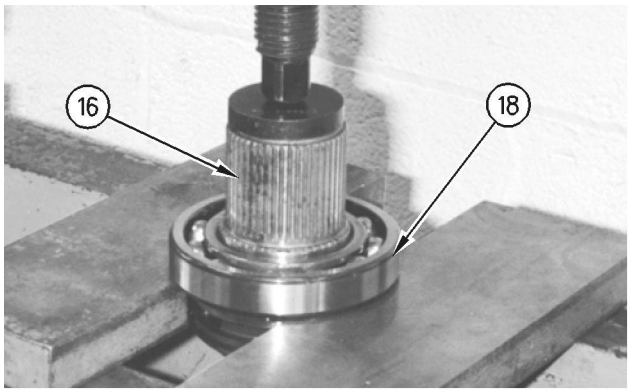


Illustration 59 g00859475

17. Use a suitable press in order to push shaft (16) out of bearing (18).

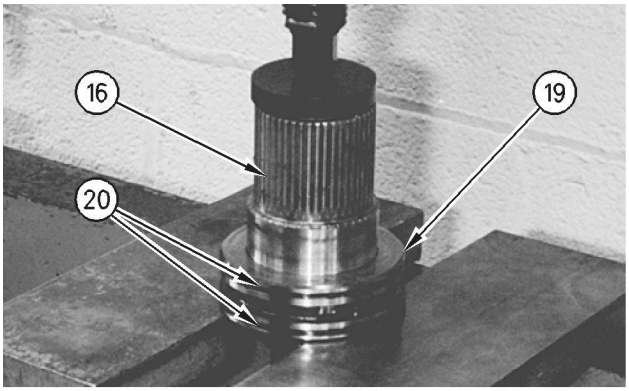


Illustration 60 g00859479

18. Remove rings (20) from carrier (19).

19. Use a suitable press in order to push shaft (16) out of carrier (19).

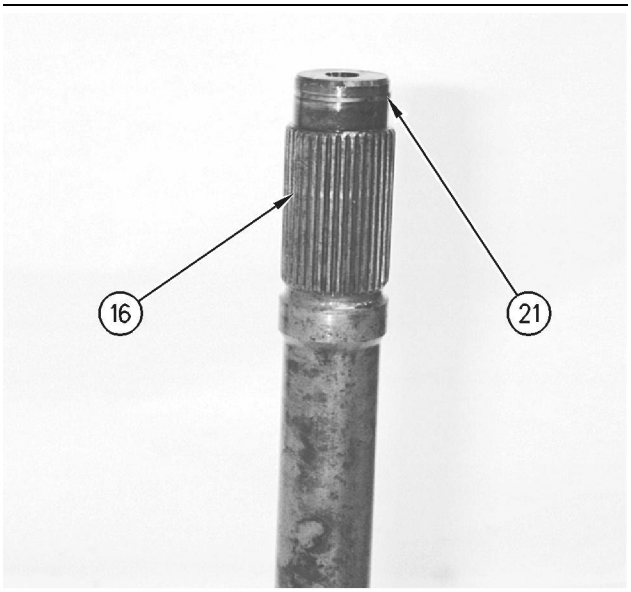


Illustration 61 g00859486

20. Remove ring (21) from shaft (16).



Illustration 62 g00859488

21. Remove bolts (22) from the housing assembly.

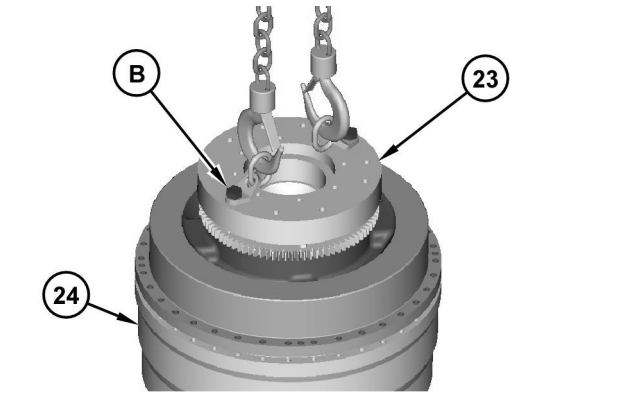


Illustration 63 g01249553

22. Use Tooling (B) and a suitable lifting device in order to separate housing (23) from housing assembly (24). The weight of housing (23) and the components is 133 kg (295 lb). The weight of housing assembly (24) and the components is approximately 68 kg (150 lb).

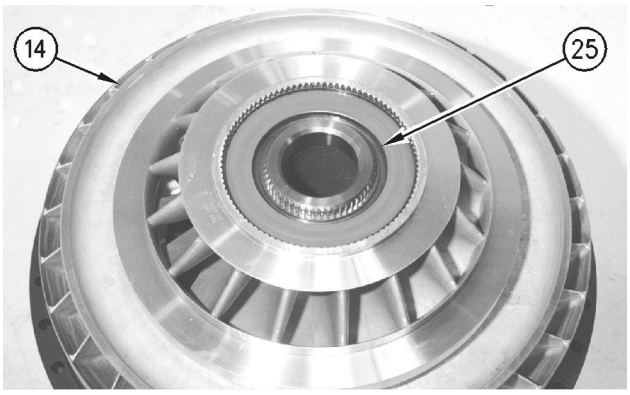


Illustration 64 g00859498

23. Turn over the housing.

24. Remove retaining ring (25) from stator carrier (14).



Illustration 65 g00859505

25. Remove stator (26).

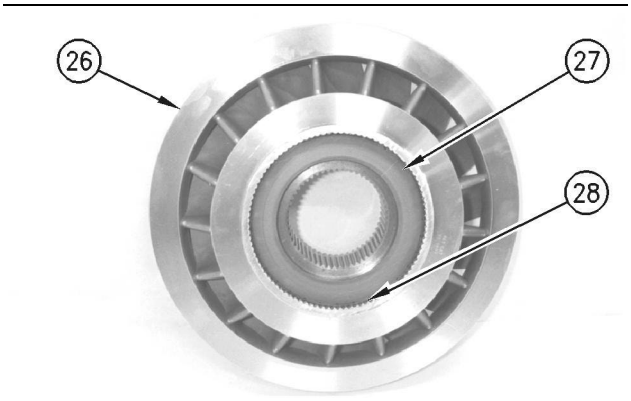


Illustration 66 g00859506

26. Remove retaining ring (28) from stator (26).

27. Remove splined adapter (27).

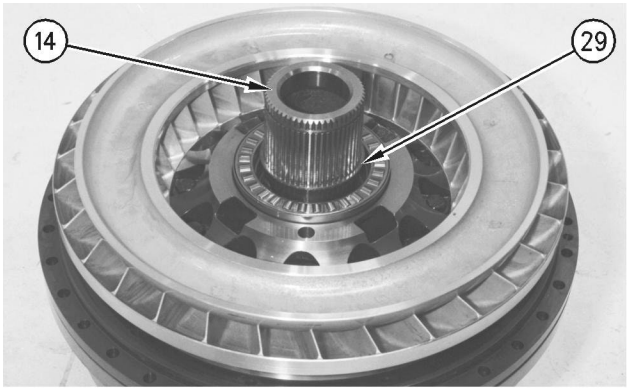


Illustration 67 g00859508

28. Remove retaining ring (29) from stator carrier (14).

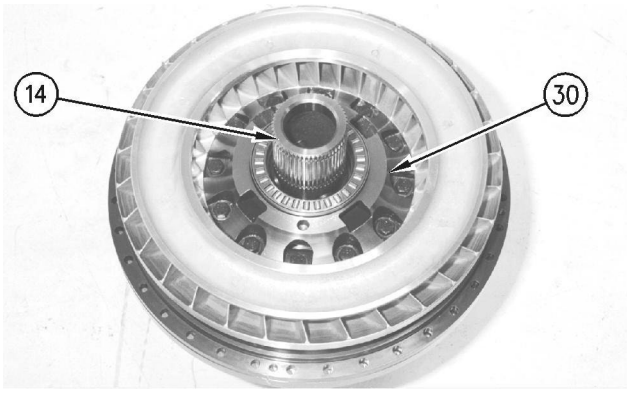


Illustration 68 g00859509

29. Remove impeller hub (30) and the adapter assembly as a unit.

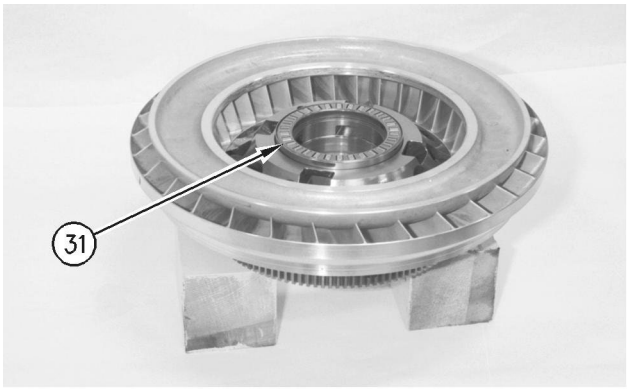


Illustration 69 g00859511

30. Remove the bearing, the race, and retainer (31).

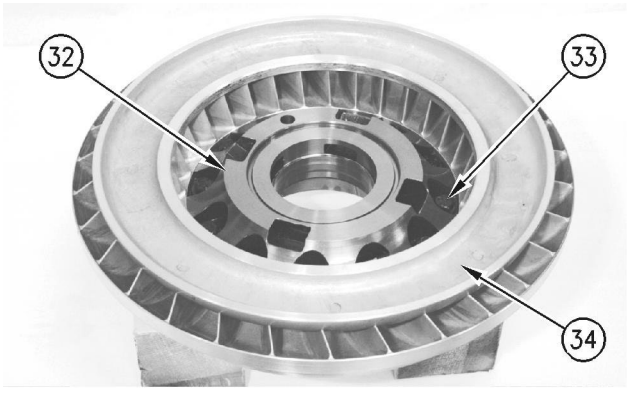


Illustration 70 g00859514

31. Remove bolts (33).

32. Remove hub (32) from impeller (34).

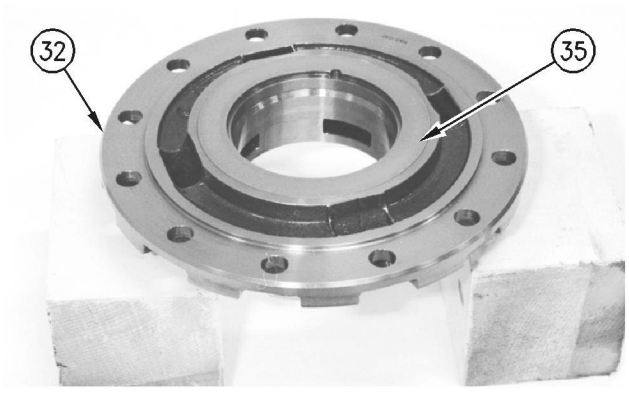


Illustration 71 g00859515

33. Remove race (35) from the back of hub (32).

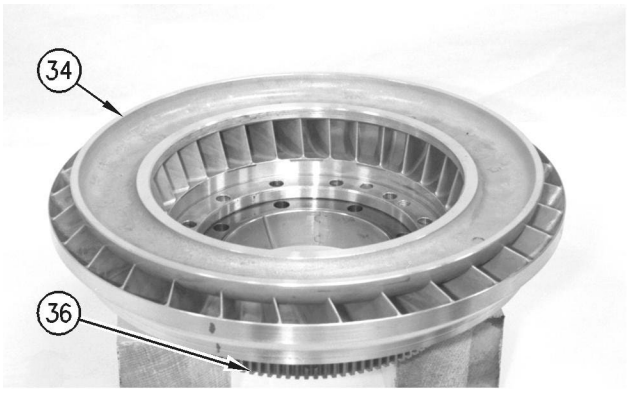


Illustration 72 g00859517

34. Lift impeller (34) from clutch adapter assembly (36).

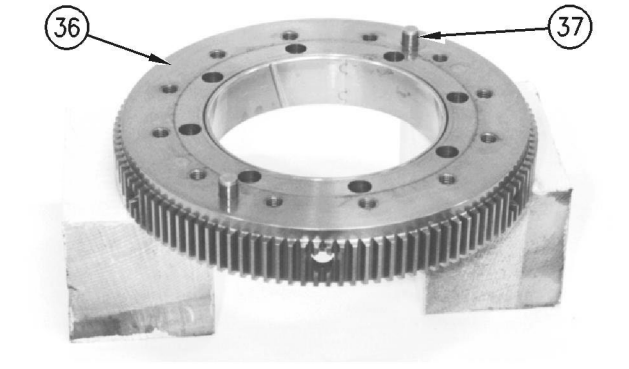


Illustration 73 g00859642

35. Remove dowel pins (37) from clutch adapter assembly (36).

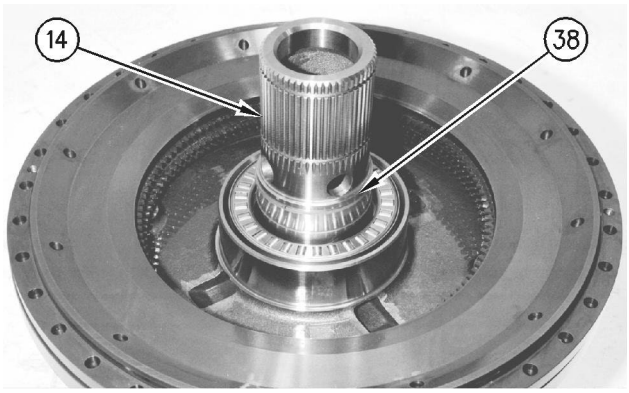


Illustration 74 g00859648

36. Remove seal ring (38) from stator carrier (14).

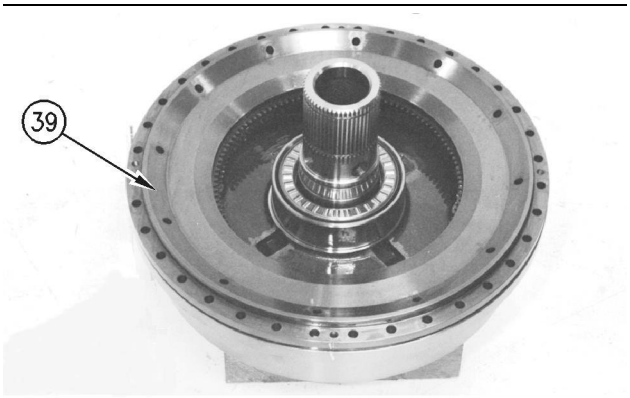


Illustration 75 g00859649

37. Remove clutch plate (39).

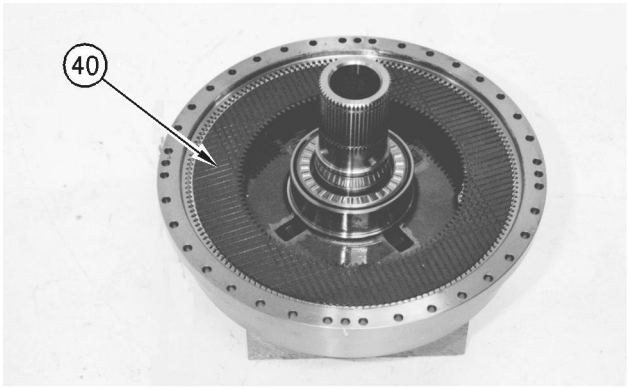


Illustration 76 g00859650

38. Remove clutch discs and clutch plates (40).

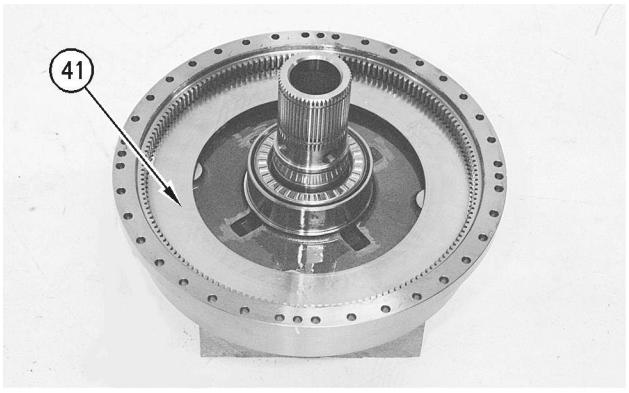


Illustration 77 g00859651

39. Remove lockup clutch piston (41).

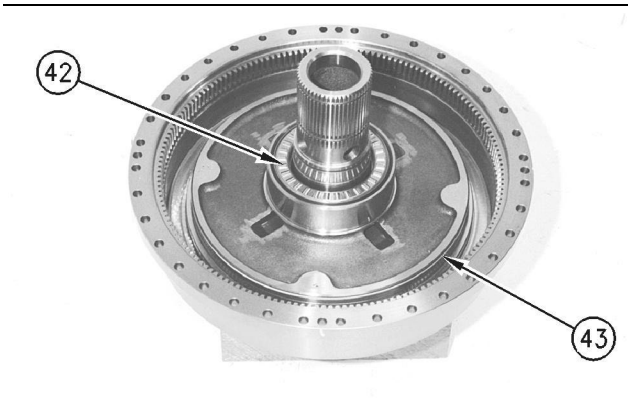


Illustration 78 g00859652

40. Remove the bearing, the race, and retainer (42).

41. Remove O-ring seals (43).

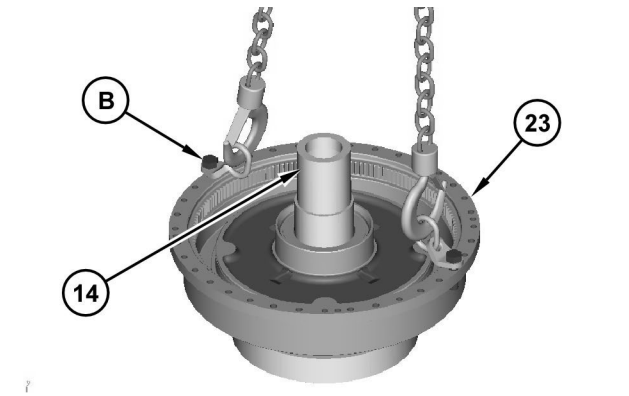


Illustration 79 g01249570

42. Use Tooling (B) and a suitable lifting device in order to remove housing (23) from stator carrier (14).

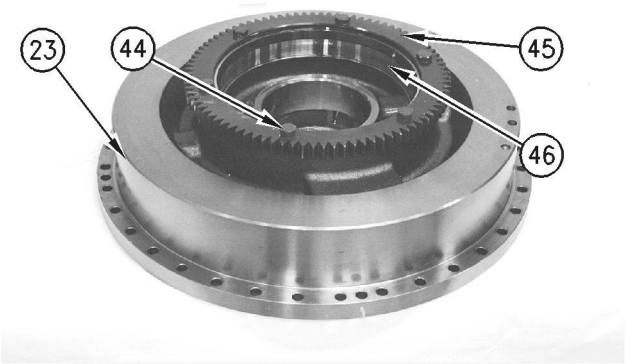


Illustration 80 g00859655

43. Remove bolts (44), drive gear (45), and race (46) from housing (23).

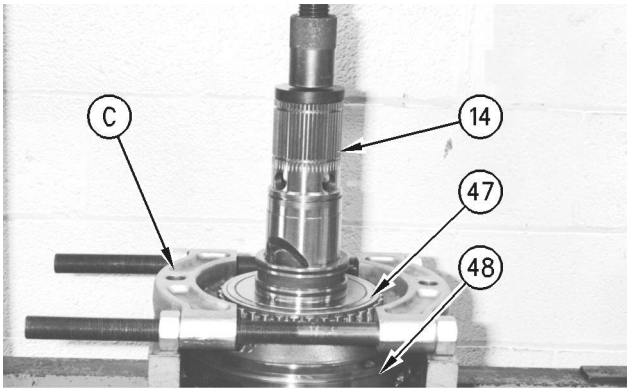


Illustration 81 g00859659

44. Use Tooling (C) and a suitable press in order to remove stator carrier (14) from inner bearing (47).

45. Remove O-ring seal (48).

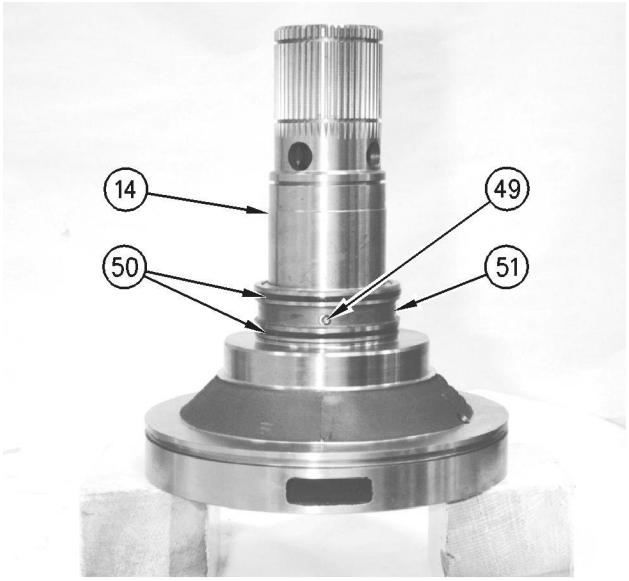


Illustration 82 g00859660

46. Remove rings (50) from seal ring carrier (51).

Note: In order to prevent damage, do not remove seal ring carrier (51) if it is not necessary.

47. Remove dowel pin (49) and seal ring carrier (51) from stator carrier (14).

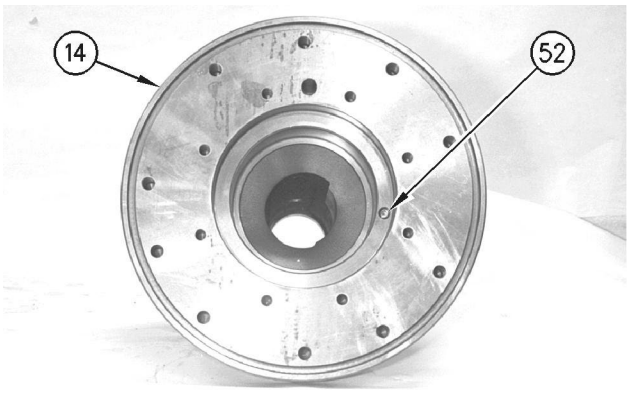


Illustration 83 g00859661

48. Remove orifice plug (52) from stator carrier (14).

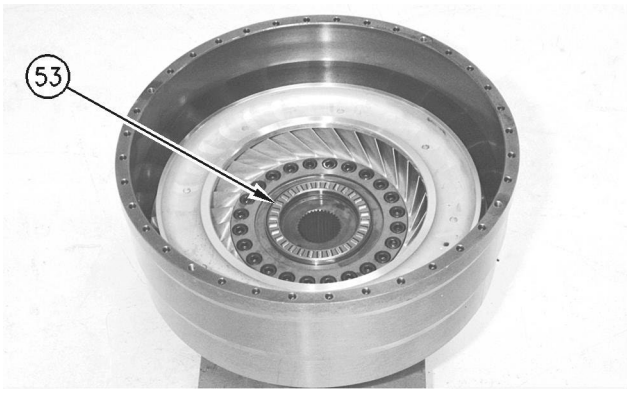


Illustration 84 g00859663

49. Remove the bearing, the race, and retainer (53) from the housing assembly.

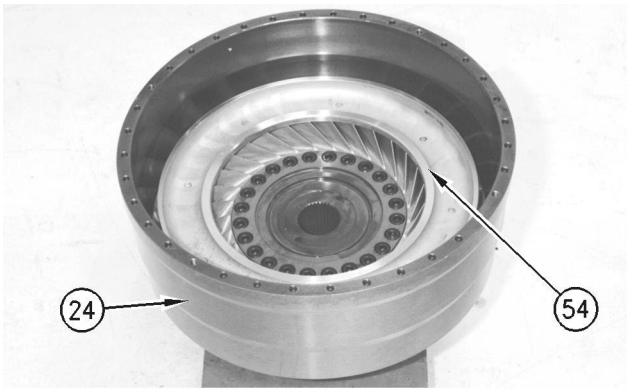


Illustration 85 g00859664

50. Remove converter turbine assembly (54) from housing assembly (24).

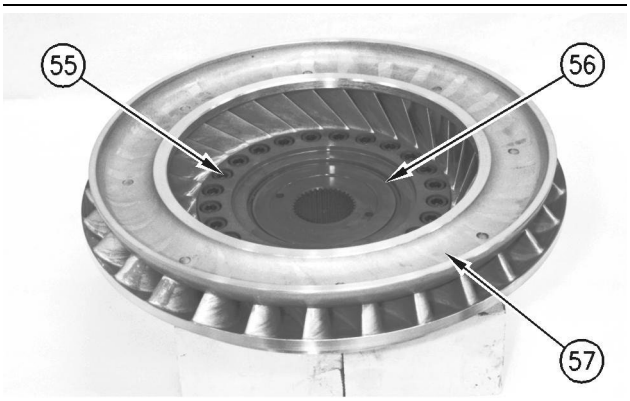


Illustration 86 g00859666

51. Remove bolts (55).

52. Remove turbine hub (56) from converter turbine (57).

53. Remove the race from the back of turbine hub (56).

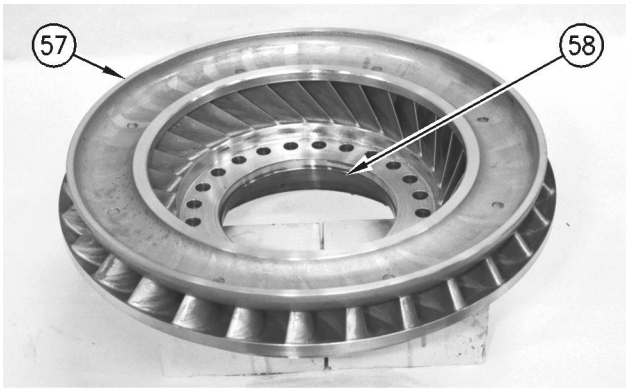


Illustration 87 g00859667

54. Remove converter turbine (57) from clutch adapter (58).

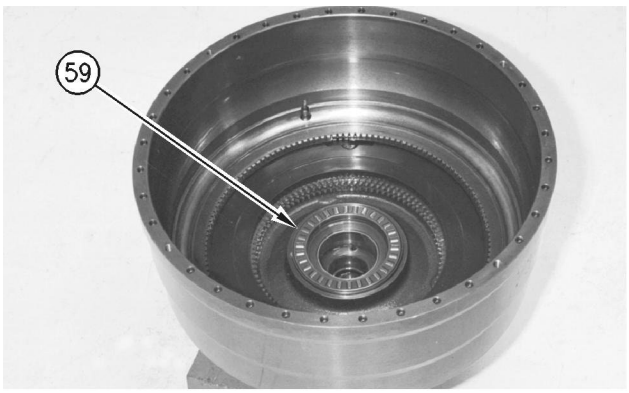


Illustration 88 g00859668

55. Remove the bearing, the race, and retainer (59) from the housing assembly.

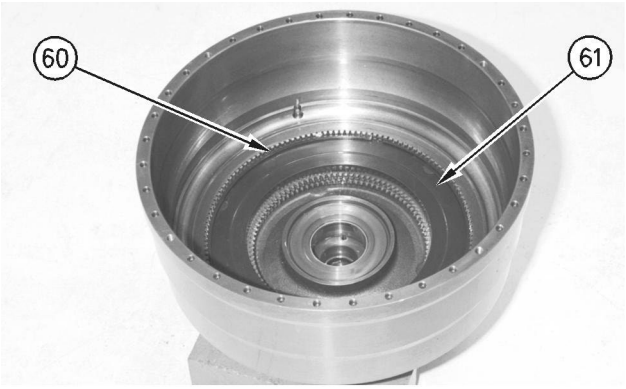


Illustration 89 g00859670

56. Remove retaining ring (60) from the housing assembly.

57. Remove clutch plate (61) from the housing assembly.

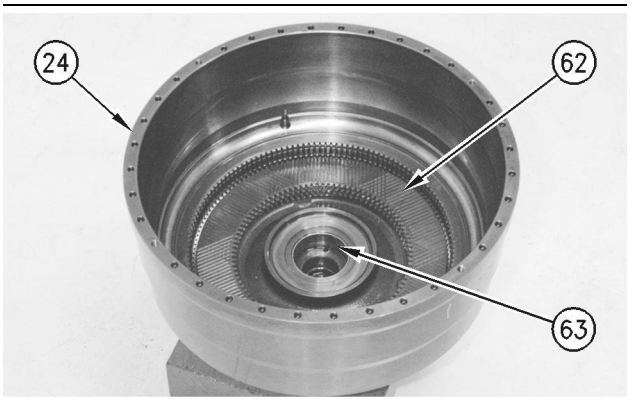


Illustration 90 g00859672

58. Remove clutch discs and clutch plates (62).

59. Remove bearing (63) from housing assembly (24).

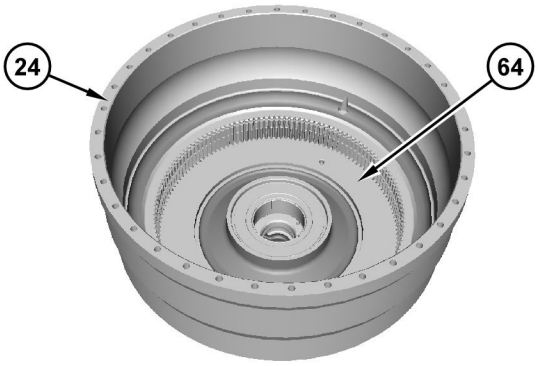


Illustration 91 g03372699

60. Remove clutch piston (64) from housing assembly (24).

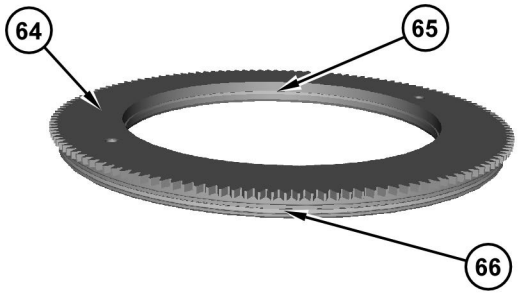


Illustration 92 g03372700

61. Remove ring seal (65) and ring seal (66) from clutch piston (64).

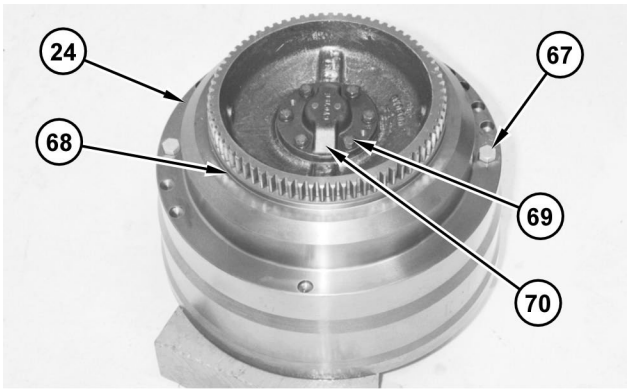


Illustration 93 g03372705

62. Turn over housing assembly (24).

63. Put the housing assembly on suitable blocking.

64. Remove plugs (67).

65. Remove O-ring seal (68).

66. Remove bolts (69).

67. Remove cover (70).

i05323771

Torque Converter (Lockup) - Assemble

SMCS Code: 3101-016-L7

Assembly Procedure

Table 5

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	3E-3879	Eyebolt	1
B	138-7573	Link Bracket	2
C	1P-0520	Driver Group	1
E	1P-0808	Multipurpose Grease	1

Note: Cleanliness is an important factor. Before assembly, thoroughly all parts in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Apply oil to all of the bearings before assembly.

1. Check the condition of the O-ring seals that are used in the torque converter and torque converter housing. If any of the seals are damaged, use new parts for replacement.

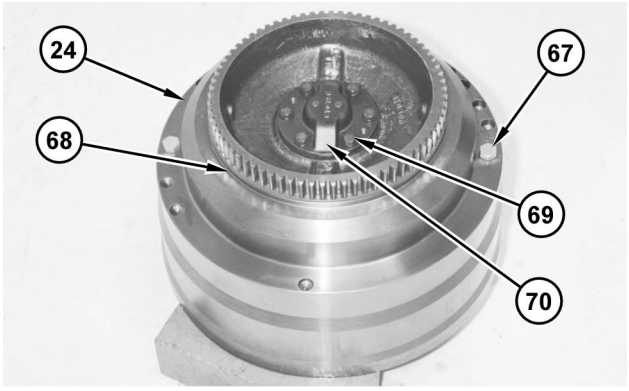


Illustration 94 g03372705

2. Install bolts (69) in cover (70). Tighten bolts (69) to a torque of 60 ± 7 N·m (45 ± 5 lb ft).

3. Install O-ring seal (68).

4. Install plugs (67) into housing assembly (24).

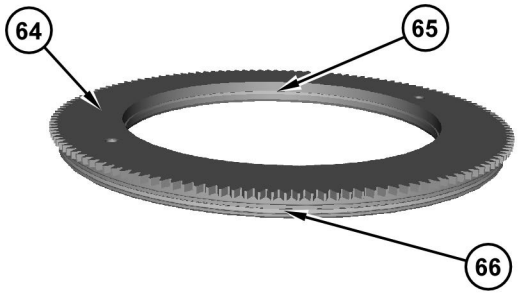


Illustration 95 g03372700

5. Install ring seal (65) and ring seal (66) to clutch piston (64).

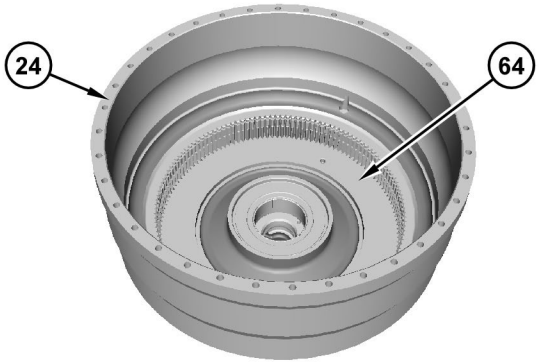


Illustration 96 g03372699

6. Turn over housing assembly (24). Place the housing assembly on suitable blocking.

7. Install clutch piston (64) to housing assembly (24).

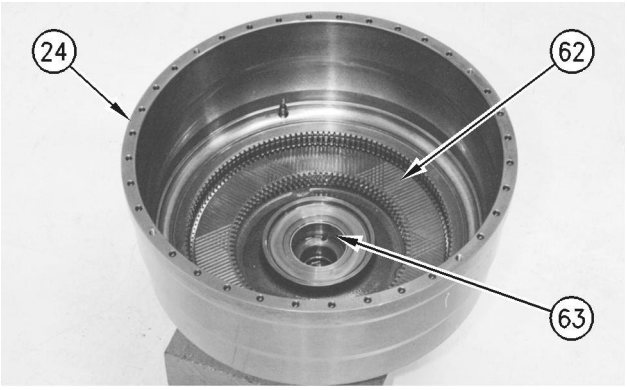


Illustration 97 g00859672

8. Install bearing (63) into housing assembly (24).

9. Install clutch discs and clutch plates (62) in an alternating order.

Note: Start with a clutch disc and end with a clutch disc.

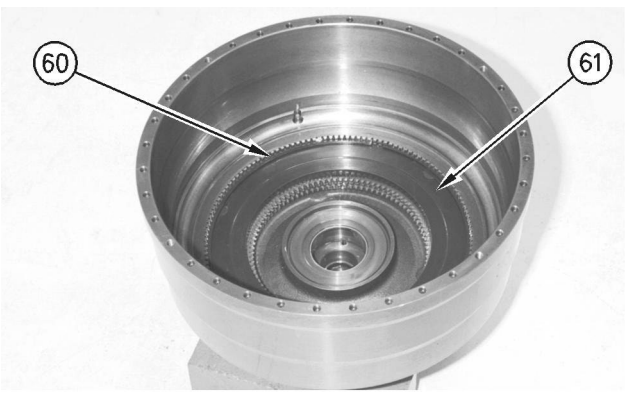


Illustration 98 g00859670

10. Install clutch plate (61) into the housing assembly.

11. Install retaining ring (60) in the housing assembly.

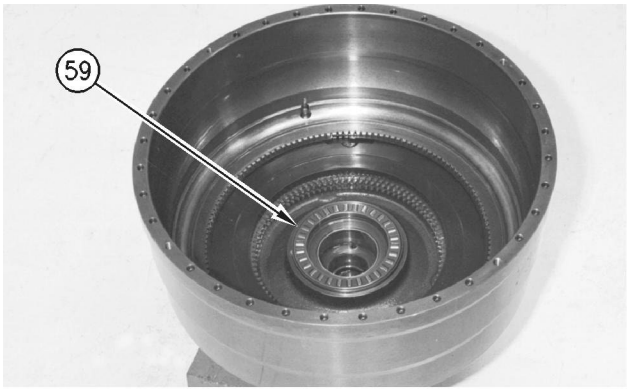


Illustration 99 g00859668

12. Install the bearing, the race, and retainer (59) in the housing assembly.

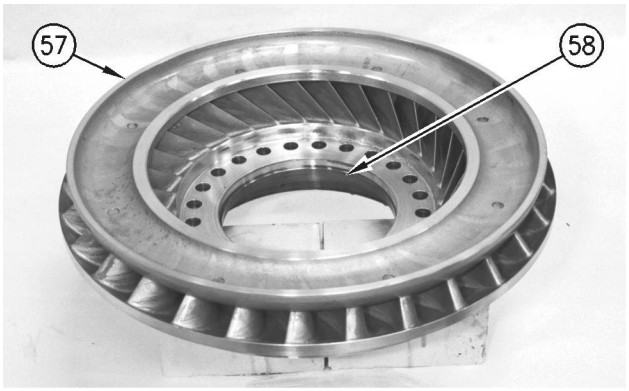


Illustration 100 g00859667

13. Install the converter turbine on clutch adapter (58).

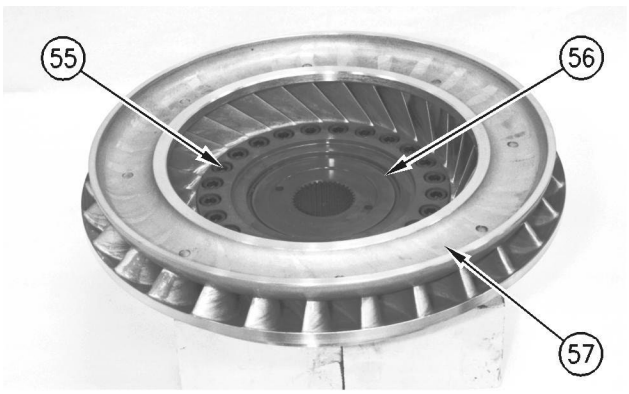


Illustration 101 g00859666

14. Install the race to the back of turbine hub (56).

15. Install bolts (55) in order to install turbine hub (56) to converter turbine (57). Tighten bolts (55) to a torque of 105 ± 15 N·m (80 ± 10 lb ft).

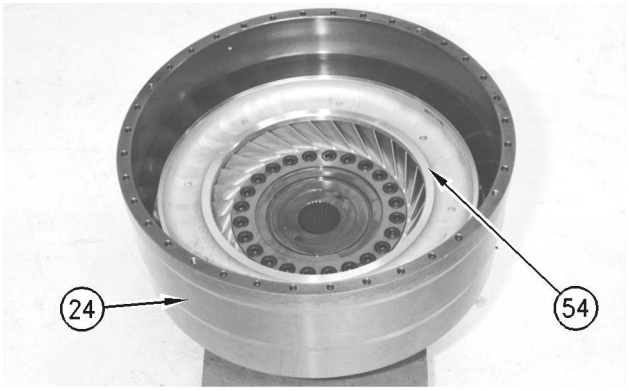


Illustration 102 g00859664

16. Install converter turbine assembly (54) into housing assembly (24).

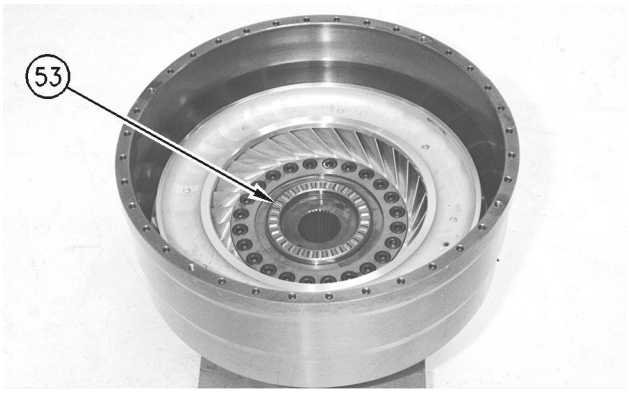


Illustration 103 g00859663

17. Install the retainer, the race, and bearing (53) in the housing assembly.

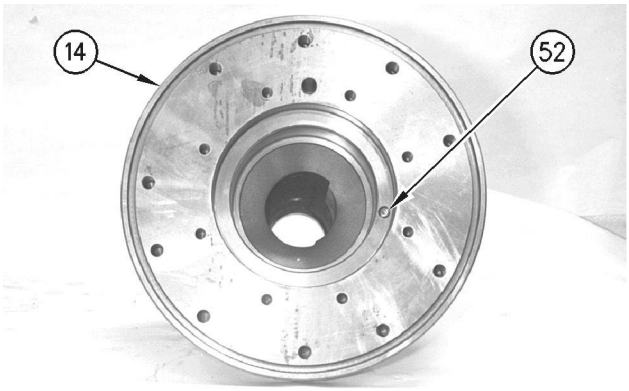


Illustration 104 g00859661

18. Install orifice plug (52) into stator carrier (14).

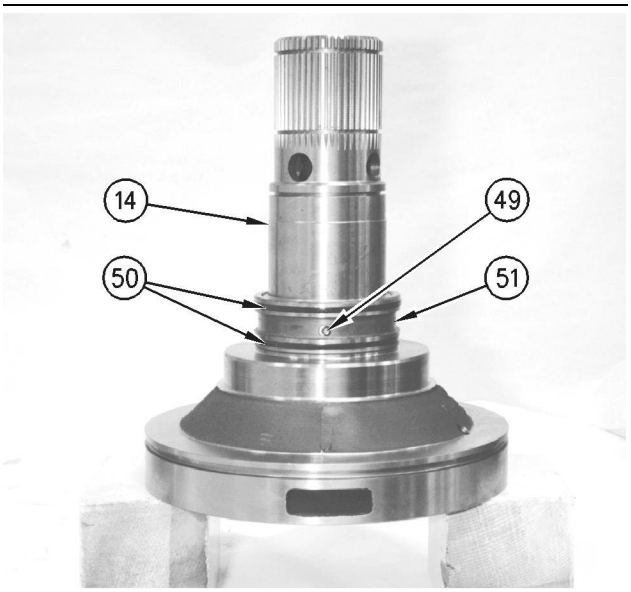


Illustration 105 g00859660

19. Raise the temperature of seal ring carrier (51) to a maximum temperature of 135 °C (275 °F).

Note: Note the location of the two holes in the side of seal ring carrier (51). Make sure that one hole is aligned with the oil passage on stator carrier (14). Make sure that the remaining hole is in alignment with the hole that is provided for the installation of dowel pin (49). Failure to align the oil passages in seal ring carrier (51) and stator carrier (14) will result in failure of the components.

20. Install seal ring carrier (51) onto stator carrier (14).

21. Install dowel pin (49) into seal ring carrier (51).

22. Install seal rings (50) to seal ring carrier (51).

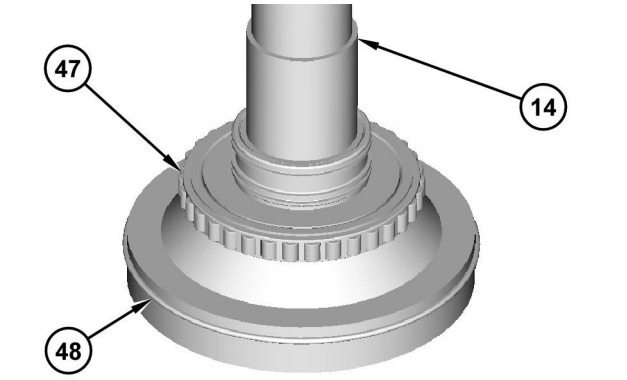


Illustration 106 g01252361

23. Raise the temperature of inner bearing (47) to a maximum temperature of 135 °C (275 °F).

24. Install inner bearing (47) onto stator carrier (14).

25. Install O-ring seal (48) on the stator carrier.

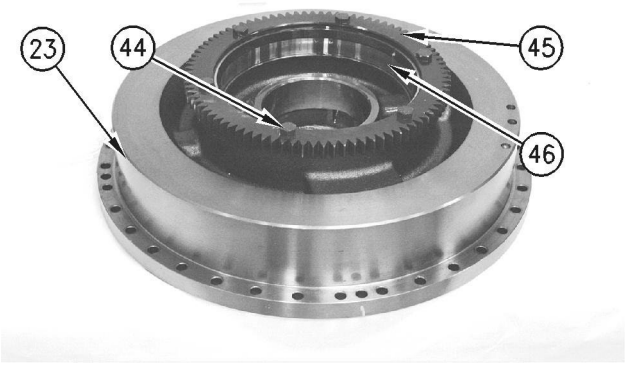


Illustration 107 g00859655

26. Lower the temperature of race (46).

27. Install race (46) into housing (23).

28. Install drive gear (45) and bolts (44) into housing (23). Tighten bolts (44) to a torque of 60 ± 7 N·m (45 ± 5 lb ft).

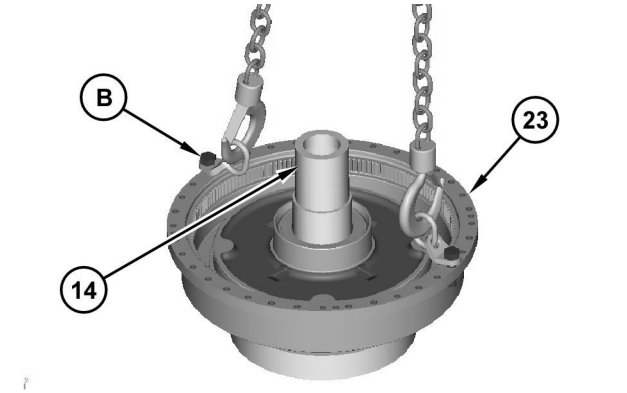


Illustration 108 g01249570

29. Use Tooling (B) and a suitable lifting device in order to install housing (23) onto stator carrier (14).

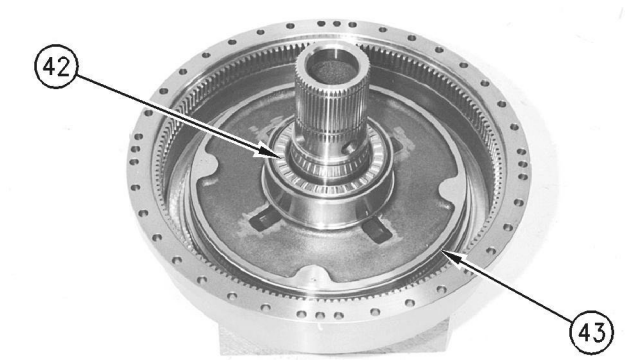


Illustration 109 g00859652

30. Install O-ring seals (43) to housing (23).

31. Install the bearing, the race, and retainer (42) onto the stator carrier.

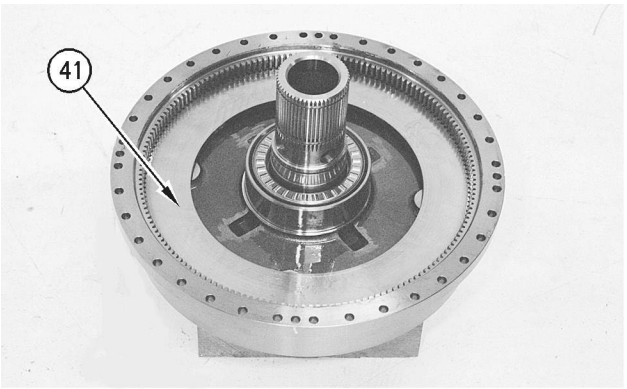


Illustration 110 g00859651

32. Install lockup clutch piston (41).

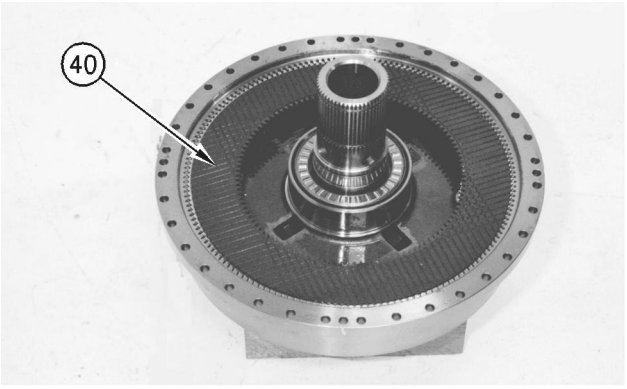


Illustration 111 g00859650

33. Install clutch discs and clutch plates (40) in an alternating order.

Note: Start with a clutch disc and end with a clutch disc.

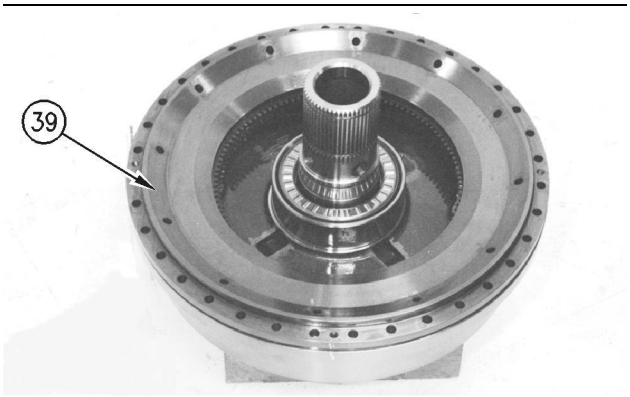


Illustration 112 g00859649

34. Install clutch plate (39).

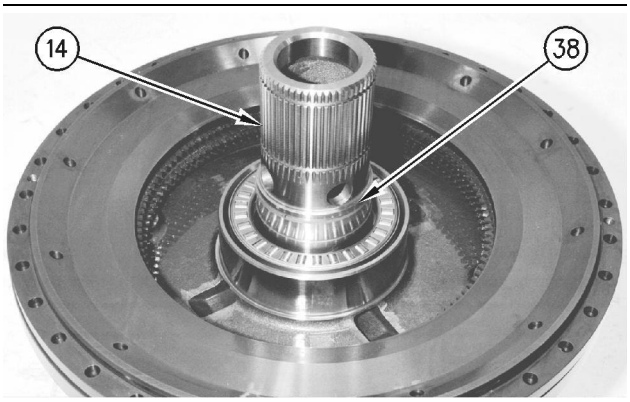


Illustration 113 g00859648

35. Install seal ring (38) onto stator carrier (14).

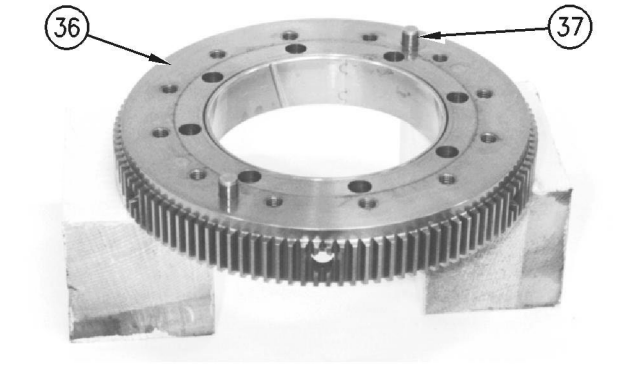


Illustration 114 g00859642

36. Install dowel pins (37) to clutch adapter assembly (36).

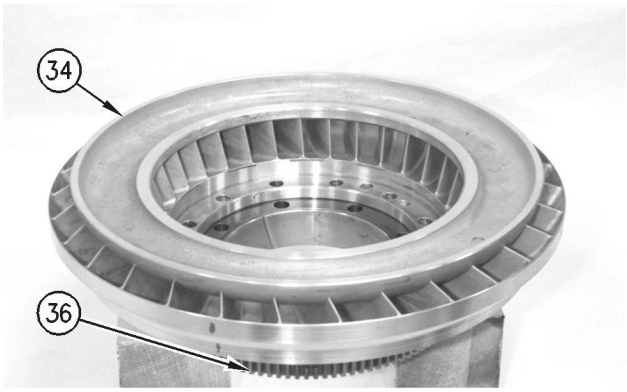


Illustration 115 g00859517

37. Install impeller (34) to clutch adapter assembly (36).

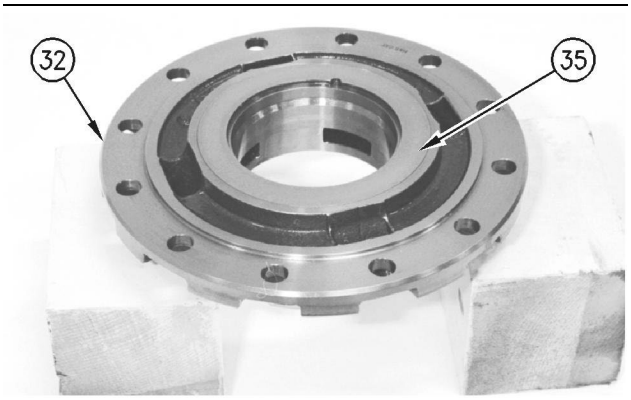


Illustration 116 g00859515

38. Install race (35) on the back of hub (32).

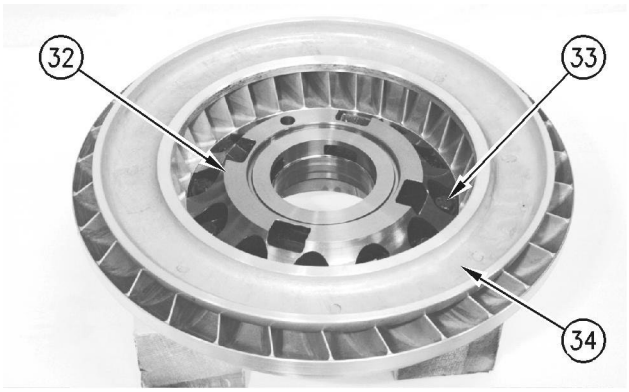


Illustration 117 g00859514

39. Install hub (32) and bolts (33) to impeller (34). Tighten bolts (33) to a torque of 105 ± 15 N·m (80 ± 10 lb ft).

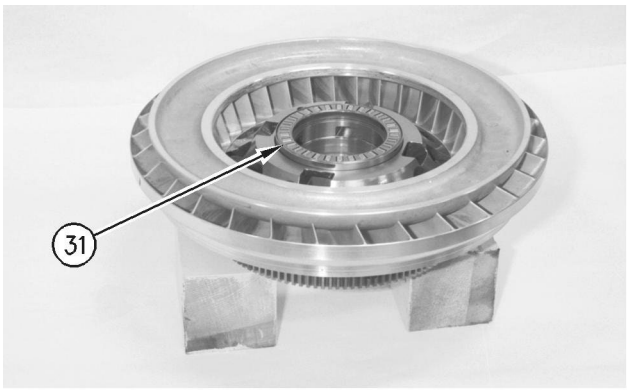


Illustration 118 g00859511

40. Install the bearing , the race, and retainer (31).

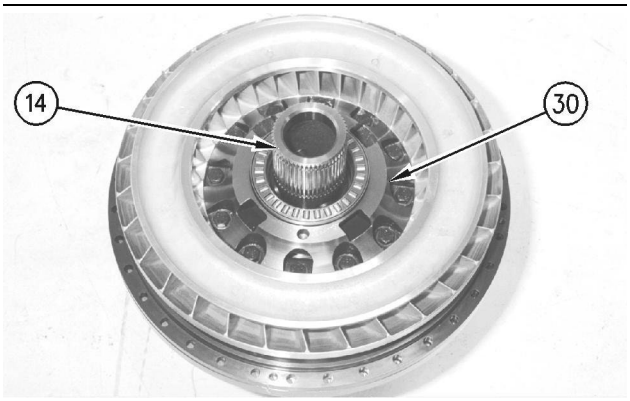


Illustration 119 g00859509

41. Install impeller hub (30) onto stator carrier (14).

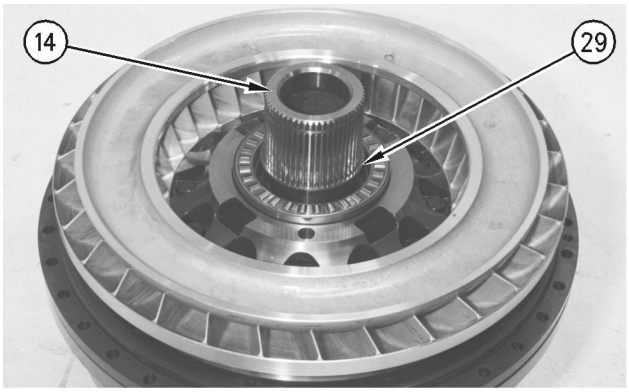


Illustration 120 g00859508

42. Install retaining ring (29) to stator carrier (14).

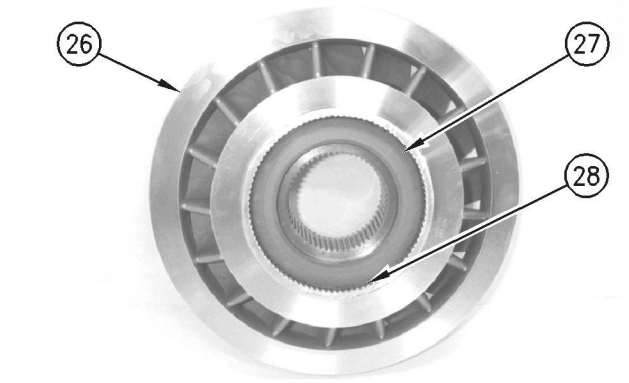


Illustration 121 g00859506

43. Install splined adapter (27) to stator (26).

44. Install the retaining ring to stator (26).

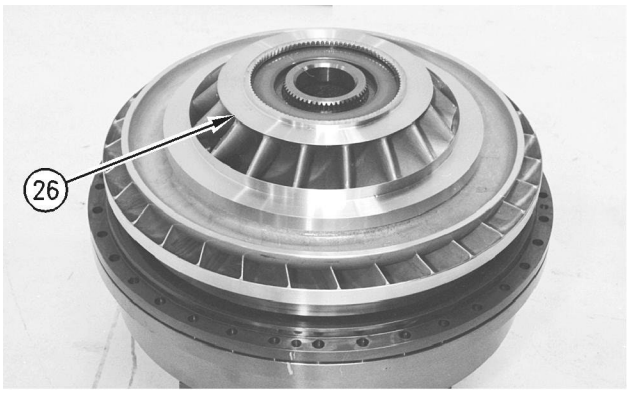


Illustration 122 g00859505

45. Install stator (26).

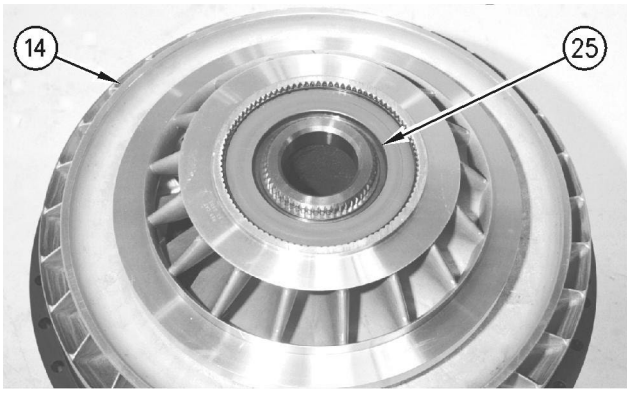


Illustration 123 g00859498

46. Install retaining ring (25) to stator carrier (14).

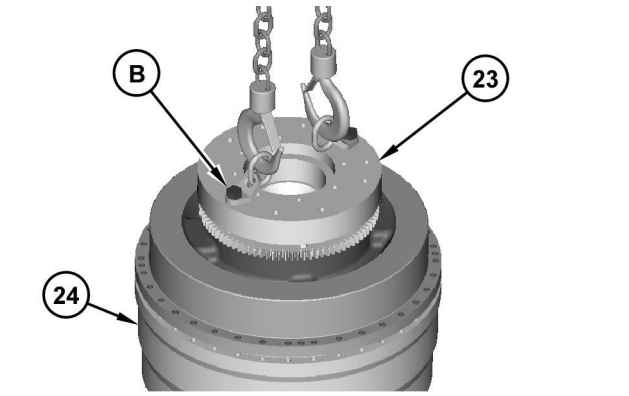


Illustration 124 g01249553

47. Turn over housing assembly (23). Place the housing onto suitable blocking.

48. Use Tooling (B) and a suitable lifting device in order to install housing assembly (23) into housing (24). The weight of housing (23) and the components is approximately 133 kg (295 lb). The weight of housing assembly (24) and the components is approximately 68 kg (150 lb).



Illustration 125 g00859488

49. Install bolts (22) into the housing assembly. Tighten bolts (22) to a torque of 60 ± 7 N·m (45 ± 5 lb ft).

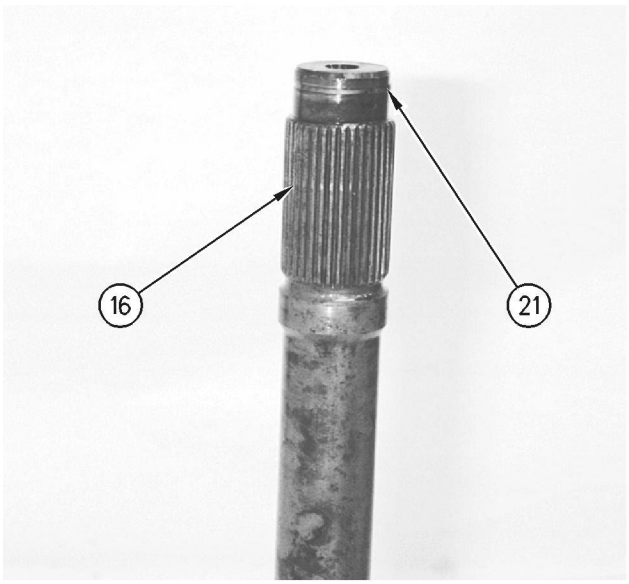


Illustration 126 g00859486

50. Install ring (21) to shaft (16).

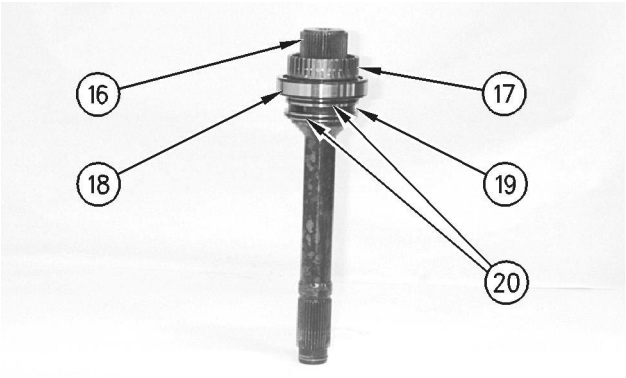


Illustration 127 g00859474

51. Raise the temperature of carrier (19) and bearing (18) to a temperature of 149 °C (300 °F).

52. Install the seal carrier and the bearing onto shaft (16).

53. Install rings (20) onto carrier (19).

54. Install rotor (17) to shaft (16).

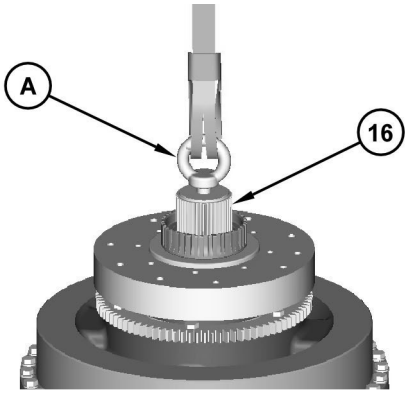


Illustration 128 g01249548

55. Use Tooling (A) and a suitable lifting device in order to install shaft (16) into the torque converter.

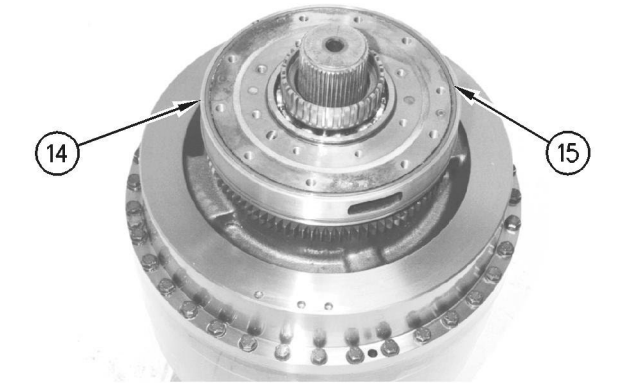


Illustration 129 g00859470

56. Install O-ring seal (15) on stator carrier (14).

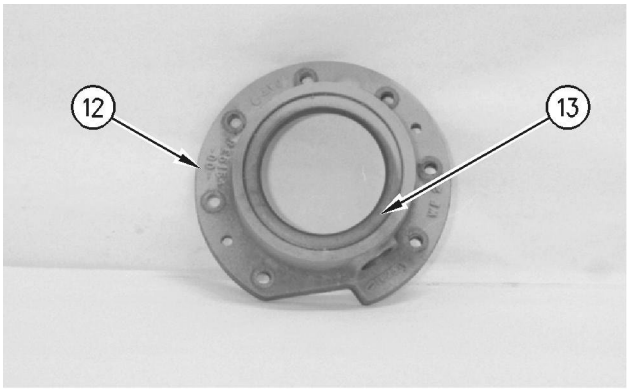


Illustration 130 g00859468

57. Install lip seal (13) in retainer (12).

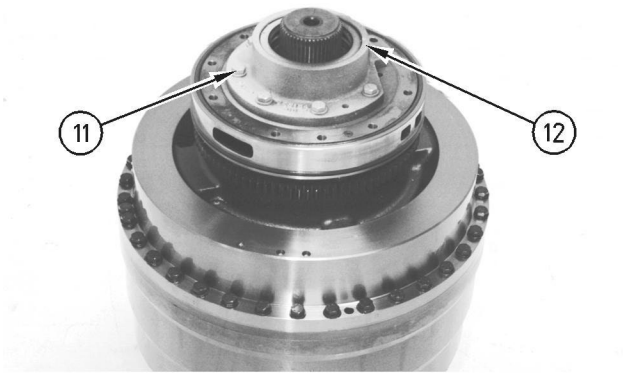


Illustration 131 g00859467

58. Install the gasket and retainer (12).

59. Install bolts (11). Tighten bolts (11) to a torque of 60 ± 7 N·m (45 ± 5 lb ft).

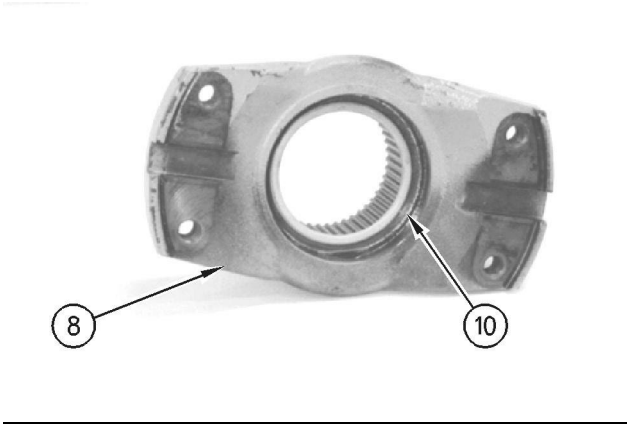


Illustration 132 g00859466

60. Install O-ring seal (10) into yoke (8).

Note: Apply Tooling (E) to the O-ring seal in order to hold the O-ring seal in place during assembly.

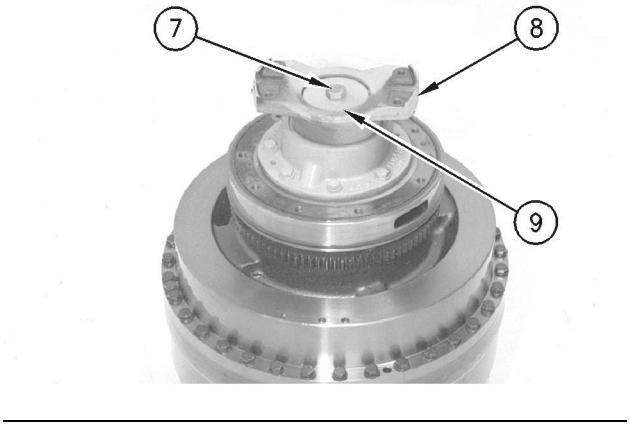


Illustration 133 g00859465

61. Install yoke (8) and retainer (9).

62. Install bolt (7) onto shaft (16). Tighten bolt (7) to a torque of 240 ± 25 N·m (175 ± 20 lb ft).

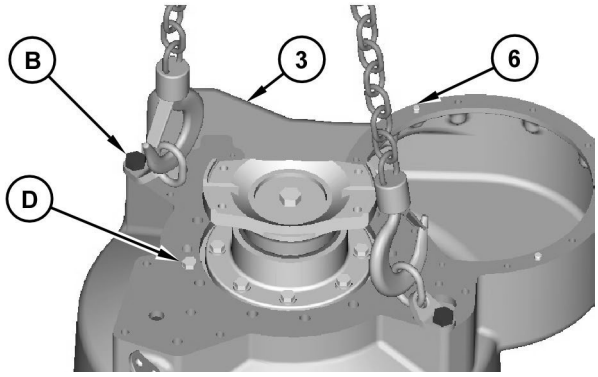


Illustration 134 g01249520

63. Install dowel pins (6) into housing assembly (3).

64. Use Tooling (B) and a suitable lifting device in order to install housing assembly (3) onto the torque converter assembly. The weight of housing assembly (3) is approximately 127 kg (280 lb).

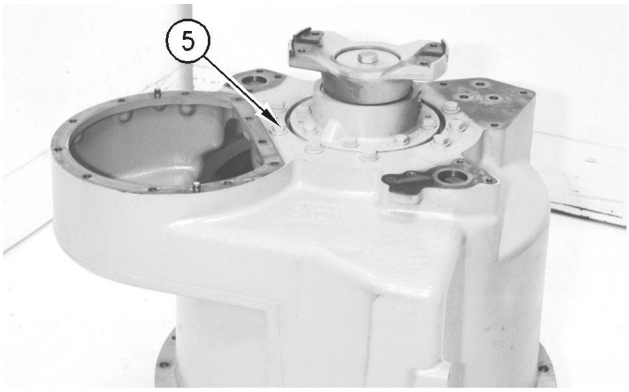


Illustration 135 g00859462

65. Install bolts (5) in the housing assembly.

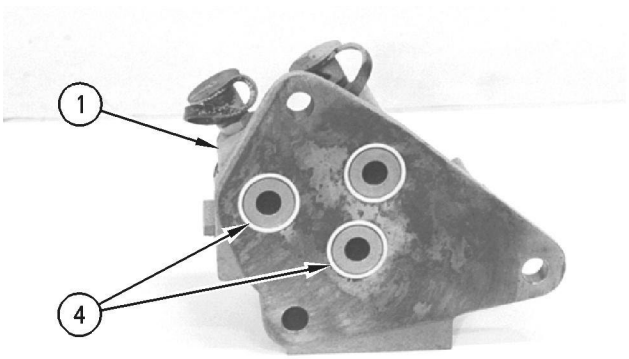


Illustration 136 g00859461

66. Install O-ring seals (4) in housing (1).

Note: Apply Tooling (E) on the O-ring seals in order to hold the O-ring seals in place during the assembly.

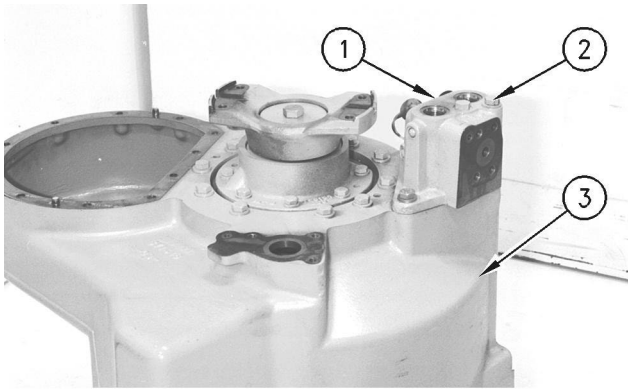


Illustration 137 g00859460

67. Install housing (1) onto housing assembly (3).

68. Install bolts (2).

End By:

a. Install the torque converter. Refer to Disassembly and Assembly, "Torque Converter - Install".

i02480892

Torque Converter (Lockup) - Install

SMCS Code: 3101-012-L7

Installation Procedure

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	1U-9200	Lever Puller Hoist	1
C	138-7575	Link Bracket	3

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Replace O-ring seals that are worn or damaged.

1. Clean the mating surfaces of the torque converter and of the engine.

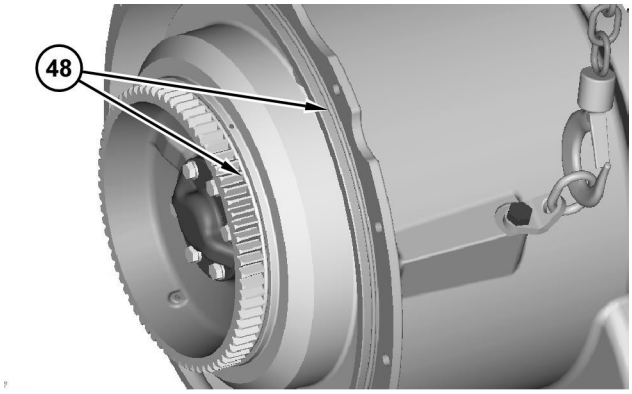


Illustration 138 g01240674

2. Lubricate the O-ring seals (48) with clean transmission oil.

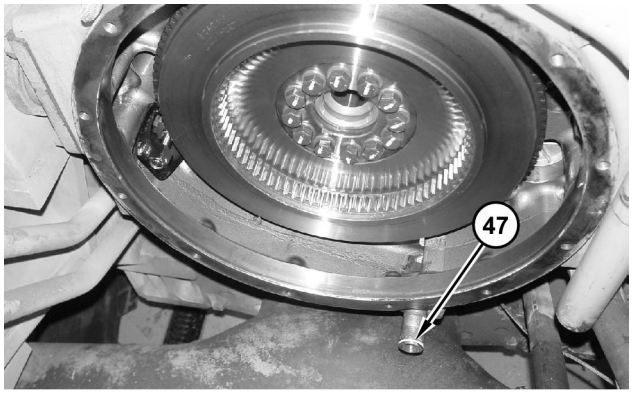


Illustration 139 g01240165

3. Lubricate O-ring seal (47) with clean transmission oil.

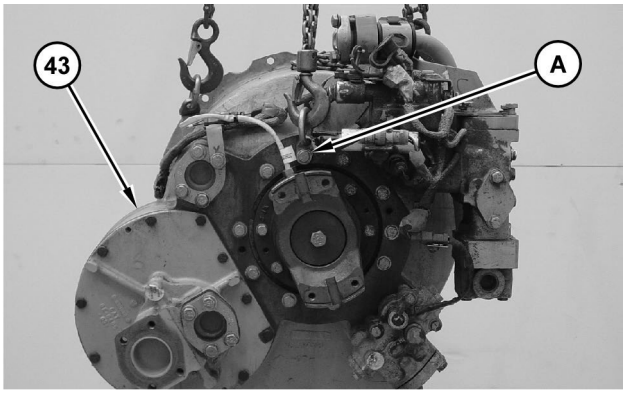


Illustration 140 g01240113

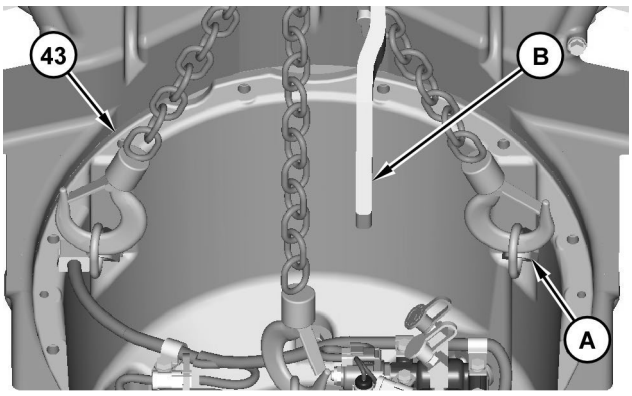


Illustration 141 g01240107

4. Use Tooling (A), Tooling (B), and a suitable lifting device in order to install torque converter (43). The weight of torque converter (43) is approximately 476 kg (1050 lb).

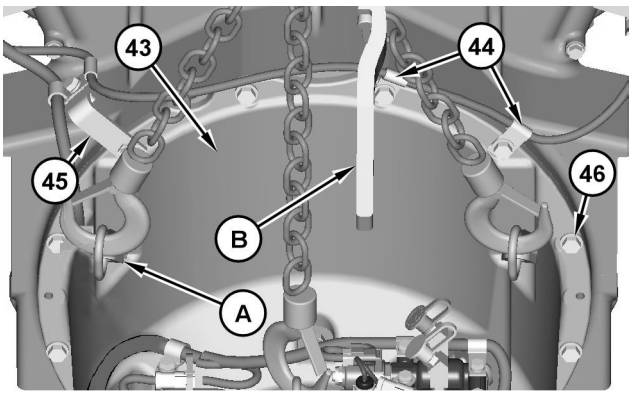


Illustration 142 g01240256

5. Position bracket (45) and clips (44) onto torque converter (43). Install bolts (46).

6. Remove Tooling (A), Tooling (B), and the suitable lifting device.

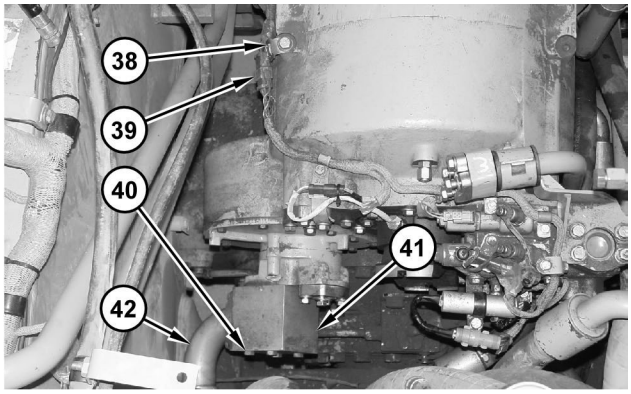


Illustration 143 g01240104

7. Position hose assembly (42) and adapter block (41). Install bolts (40).

8. Connect harness assembly (39). Install clip (38).

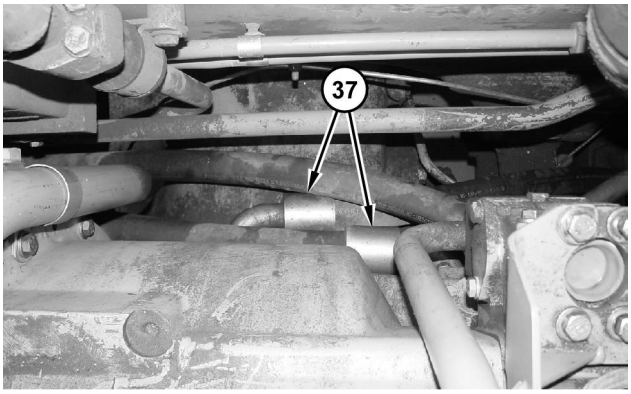


Illustration 144 g01240099

9. Connect hose assemblies (37).

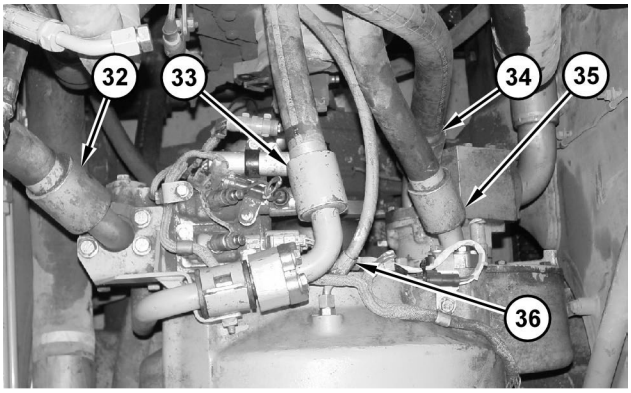


Illustration 145 g01240094

10. Connect hose assembly (36), hose assembly (35), hose assembly (34), hose assembly (33), and hose assembly (32).

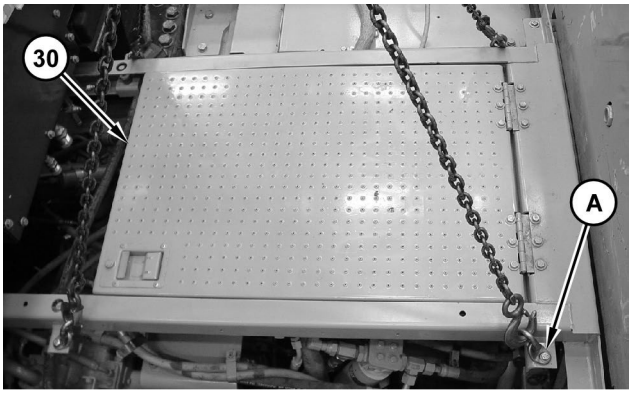


Illustration 146 g01240076

11. Use Tooling (A) and a suitable lifting device in order to position panel assembly (30). The weight of panel assembly (30) is approximately 82 kg (180 lb).

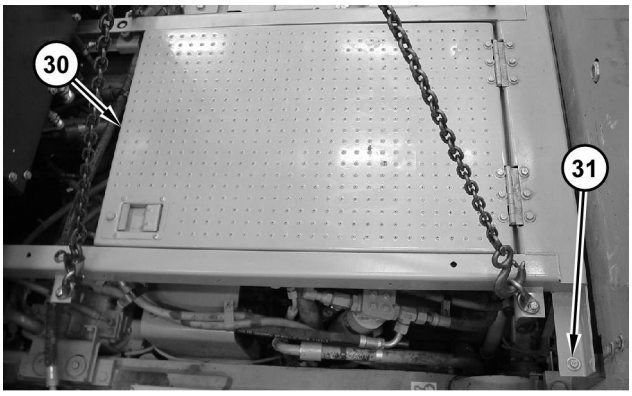


Illustration 147 g01240082

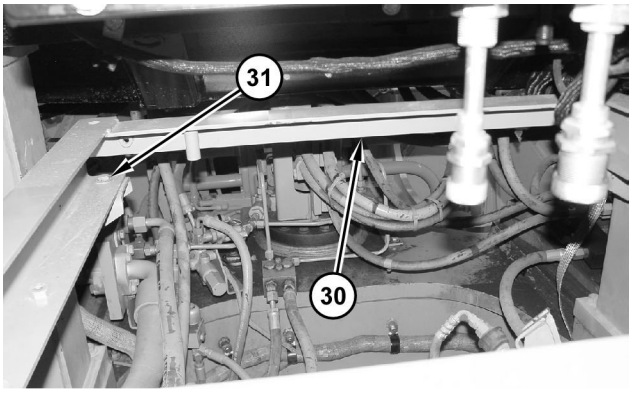


Illustration 148 g01240083

12. Install bolts (31) onto panel assembly (30).

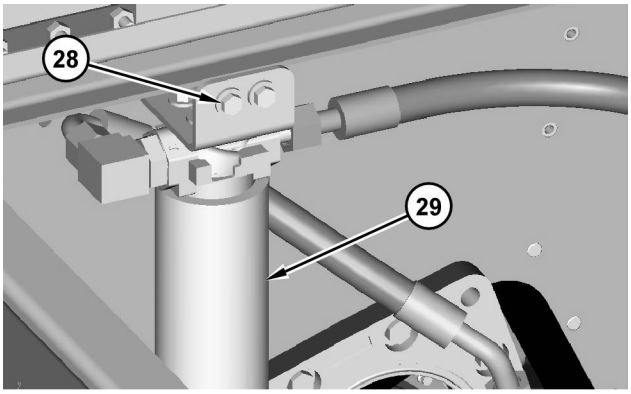


Illustration 149 g01240058

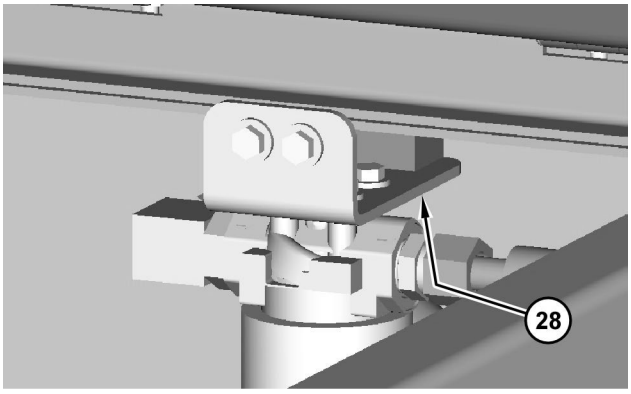


Illustration 150 g01253247

13. Position hydraulic oil filter base (29) and install bolts (28).

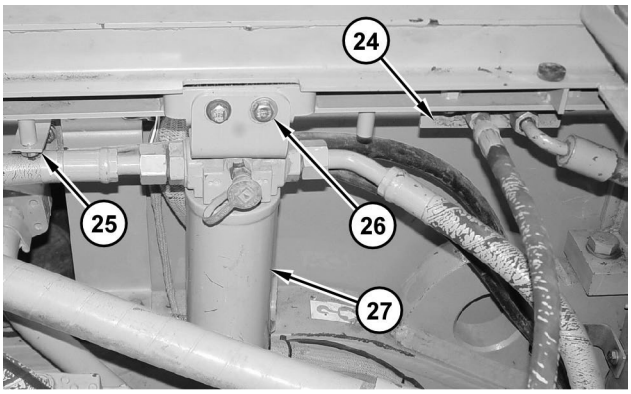


Illustration 151 g01239611

14. Position hydraulic oil filter base (27) and install bolts (26). Install bracket (25). Install bracket (24).

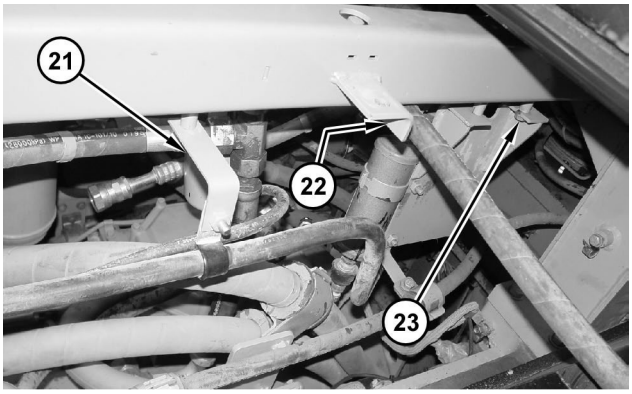


Illustration 152 g01239018

15. Install bolts (23). Install clip (22). Install bracket (21).

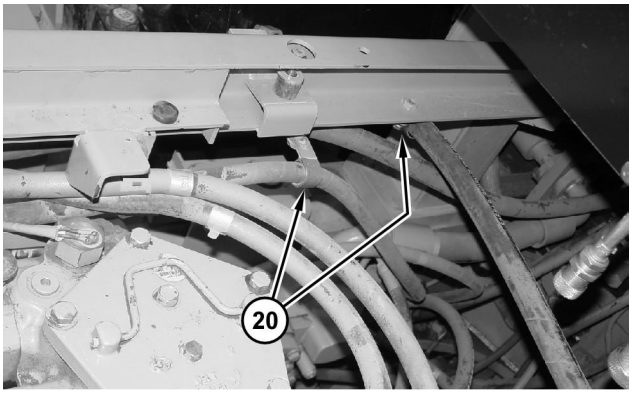


Illustration 153 g01239016

16. Install clips (20).

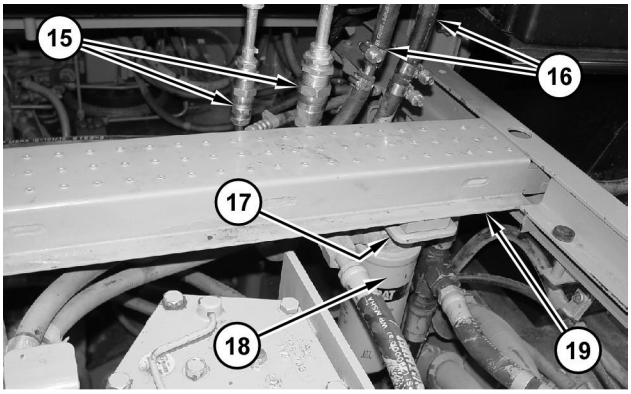


Illustration 154 g01239015

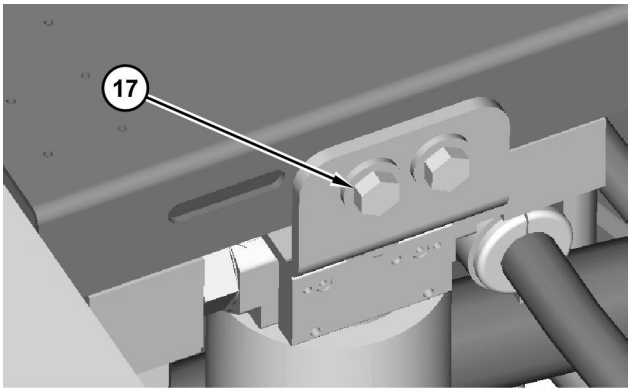


Illustration 155 g01253231

17. Install brace (19).

18. Position hydraulic oil filter base (18) and install bolts (17).

19. Connect hose assemblies (16).

20. Connect hose assemblies (15).

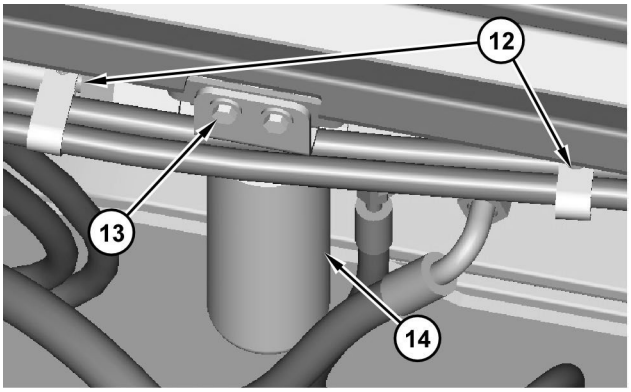


Illustration 156 g01239011

21. Position hydraulic oil filter base (14) and install bolts (13).

22. Install clips (12).

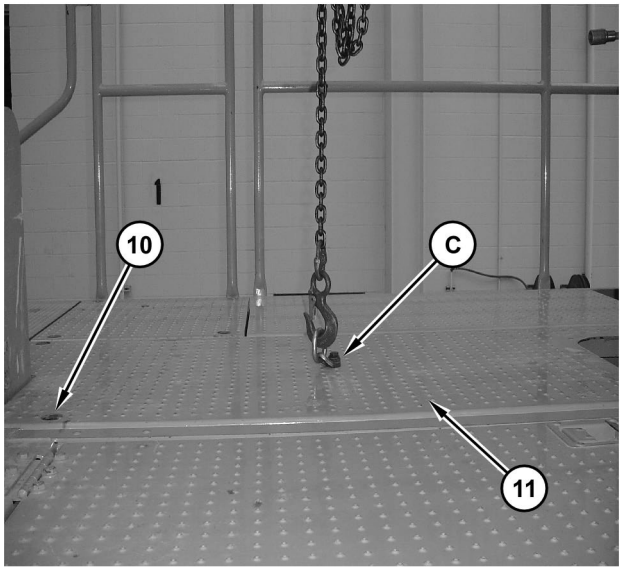


Illustration 157 g01253170

23. Use Tooling (C) and a suitable lifting device in order to install cover assembly (11). The weight of cover assembly (11) is approximately 118 kg (260 lb). Install bolts (10).

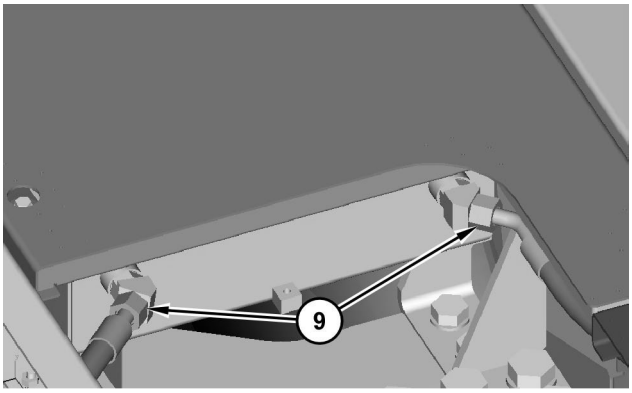


Illustration 158 g01253162

24. Connect hose assemblies (9).

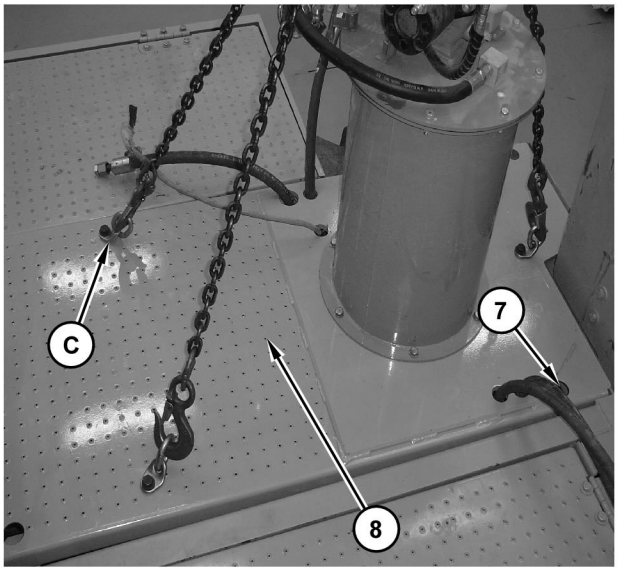


Illustration 159 g01253114

25. Use Tooling (C) and a suitable lifting device in order to install cover assembly (8). The weight of cover assembly (8) is approximately 159 kg (350 lb). Install bolts (7).

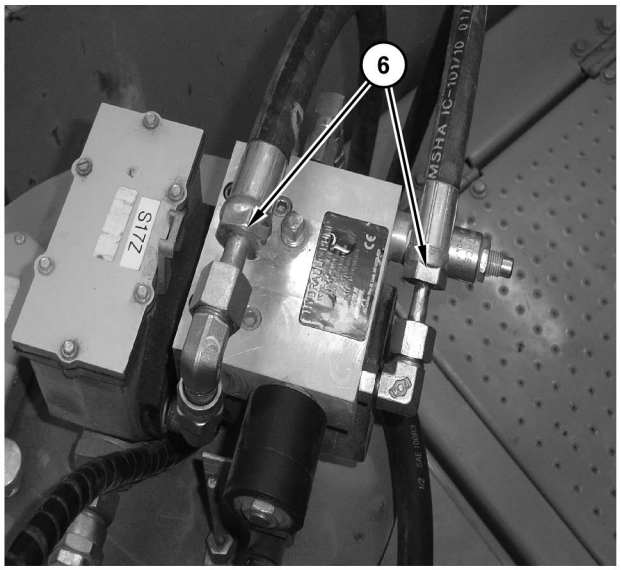


Illustration 160 g01252754

26. Connect hose assemblies (6).

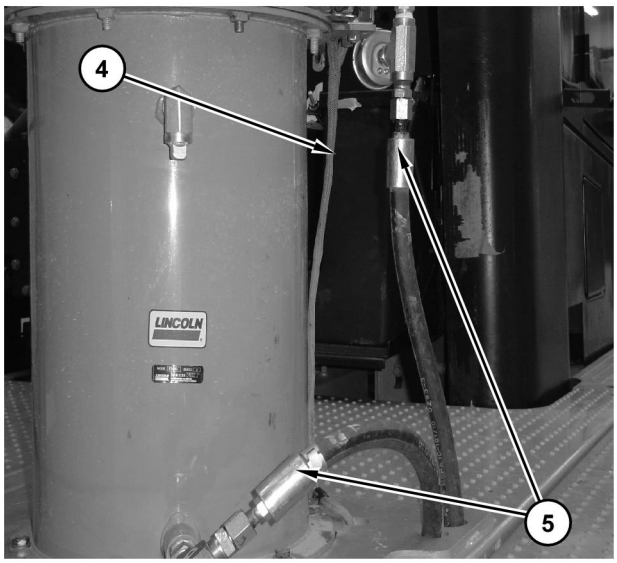


Illustration 161 g01252739

27. Connect hose assemblies (5). Connect harness assembly (4) and the mounting hardware.

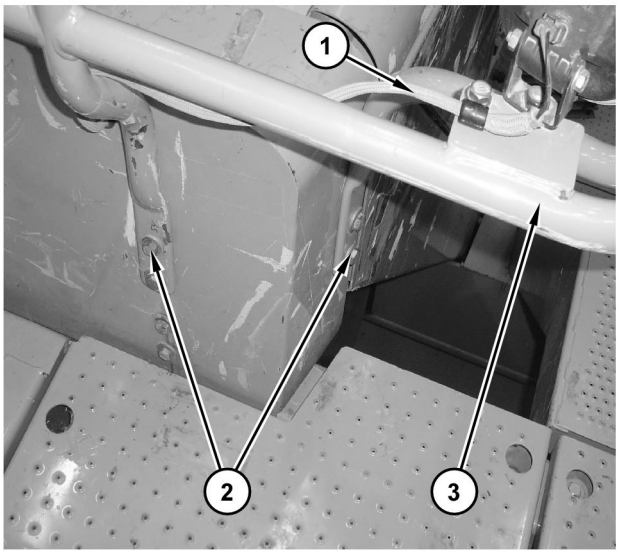


Illustration 162 g01252702

28. Use two people in order to install handrail assembly (3). Install bolts (2). Connect harness assembly (1). Repeat for the opposite side.

29. Open the heater hose valves.

End By:

a. Install the input drive shaft. Refer to Disassembly and Assembly, “Input Drive Shaft - Remove and Install”.

b. Install the implement hydraulic pump. Refer to Disassembly and Assembly, “Piston Pump (Tandem, Implement) - Install”.

c. Install the steering pump. Refer to Disassembly and Assembly, “Piston Pump (Steering) - Install”.

i02495105

Modulating Valve (Torque Converter Lockup Clutch) - Remove and Install

SMCS Code: 3139-010-VC

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hot oil spray.

Make sure all attachments have been lowered, oil is cool and the pressure has been released from the hydraulic system before removing any components or lines.

Be sure there is no pressure in the tubing before it is disconnected from the fitting.

Do not allow hot oil or components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help prevent fluid loss and this will help to prevent contaminants from entering the system.

Note: The modulating valve for the torque converter lockup clutch is mounted on the torque converter below the steering pump.

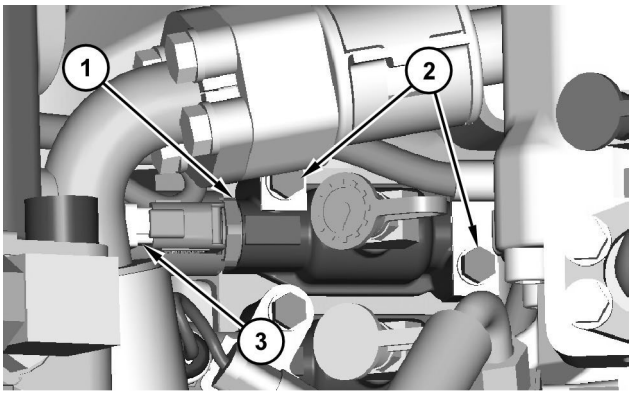


Illustration 163 g01247459

1. Disconnect harness assembly (3).

2. Remove bolts (2).

3. Remove modulating valve (1).

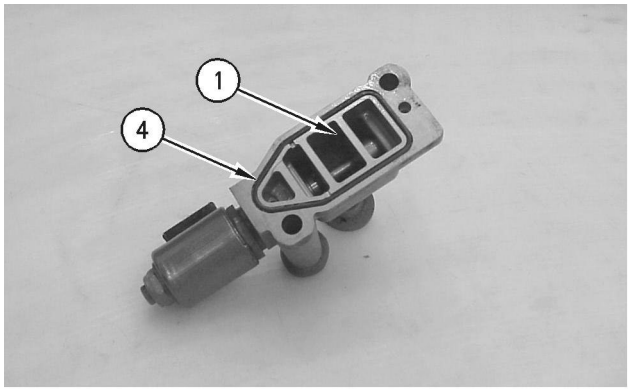


Illustration 164 g00681068

4. Remove seal (4) from modulating valve (1).

Installation Procedure

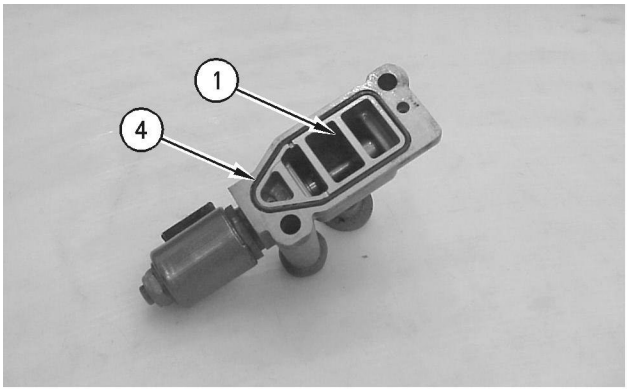


Illustration 165 g00681068

1. Install a new seal (4) on modulating valve (1).

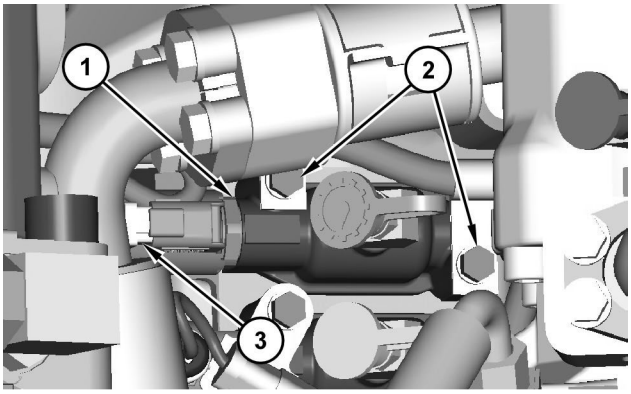


Illustration 166 g01247459

2. Install modulating valve (1).

3. Install bolts (2).

4. Connect harness assembly (3).

End By:

a. Disconnect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02495101

Modulating Valve (Torque Converter Impeller Clutch) - Remove and Install

SMCS Code: 3139-010-VC

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Personal injury can result from hot oil spray.

Make sure all attachments have been lowered, oil is cool and the pressure has been released from the hydraulic system before removing any components or lines.

Be sure there is no pressure in the tubing before it is disconnected from the fitting.

Do not allow hot oil or components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help prevent fluid loss and this will help to prevent contaminants from entering the system.

Note: The modulating valve for the torque converter impeller clutch is mounted on the torque converter below the steering pump.

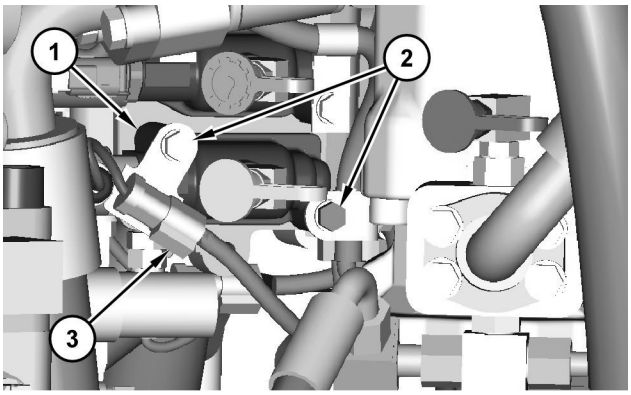


Illustration 167 g01247452

1. Disconnect harness assembly (3).

2. Remove bolts (2).

3. Remove modulating valve (1).

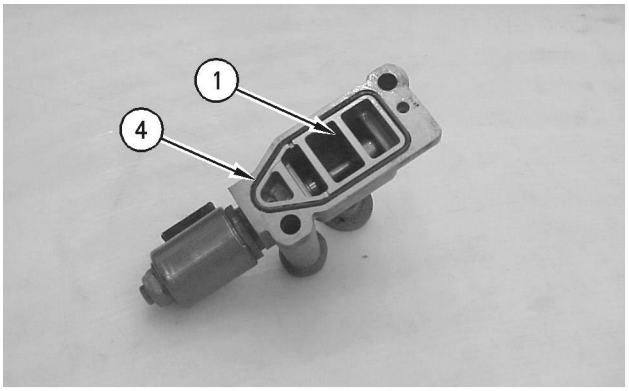


Illustration 168 g00681068

4. Remove seal (4) from modulating valve (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

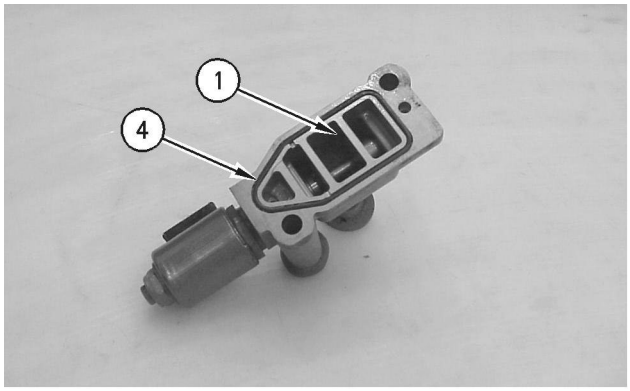


Illustration 169 g00681068

1. Install a new seal (4) on modulating valve (1).

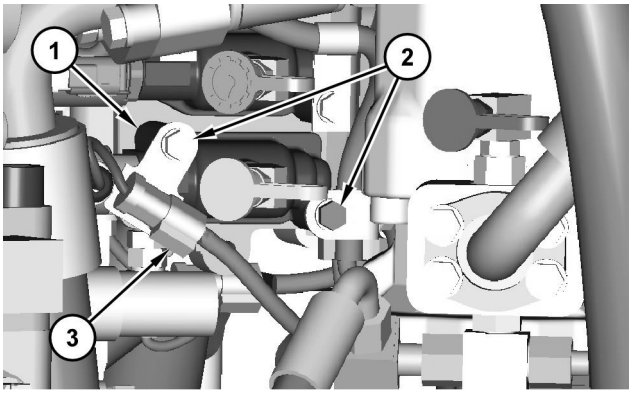


Illustration 170 g01247452

2. Install modulating valve (1).

3. Install bolts (2).

4. Connect harness assembly (3).

End By:

a. Disconnect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02495219

Relief Valve (Torque Converter Outlet) - Remove

SMCS Code: 3133-011-OL

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

c. Remove the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

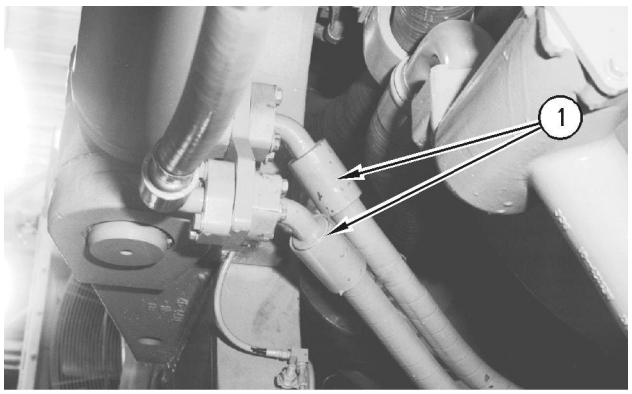


Illustration 171 g00860722

1. Disconnect hose assemblies (1) from the steering cylinder in order to gain access to the relief valve.

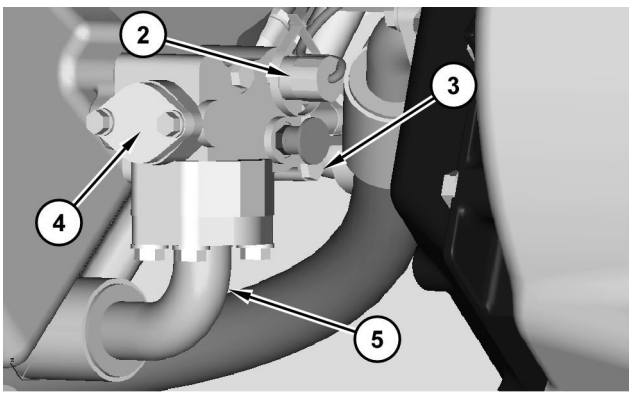


Illustration 172 g01247611

2. Disconnect hose assembly (5) from relief valve (4).

3. Disconnect harness assembly (2) from relief valve (4).

4. Remove bolts (3).

5. Remove relief valve (4).

i02495224

Relief Valve (Torque Converter Outlet) - Disassemble

SMCS Code: 3133-015-OL

Disassembly Procedure

Start By:

a. Remove the torque converter outlet relief valve. Refer to Disassembly and Assembly, "Relief Valve (Torque Converter Outlet) - Remove".

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

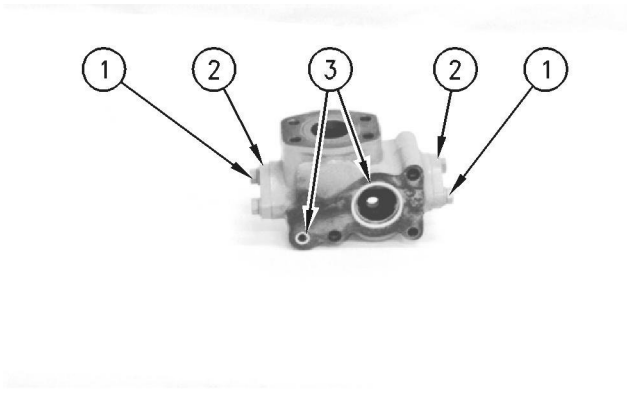


Illustration 173 g00860754

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Slowly remove bolts (1) and covers (2) from the relief valve.
2. Remove O-ring seals (3) from the relief valve.

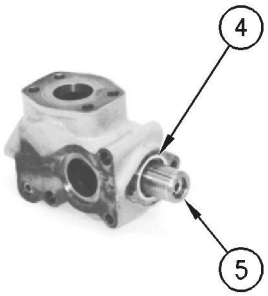


Illustration 174 g00860756

3. Remove O-ring seal (4) from each end of the relief valve.
4. Remove spool assembly (5) from the relief valve.

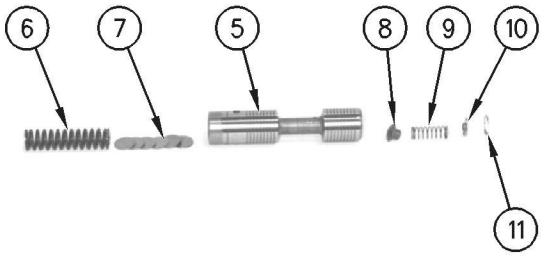


Illustration 175 g00860757

5. Remove spring (6) and shims (7). Remove retaining ring (11), retainer (10), spring (9), and poppet (8) from spool (5).

i02495226

Relief Valve (Torque Converter Outlet) - Assemble

SMCS Code: 3133-016-OL

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

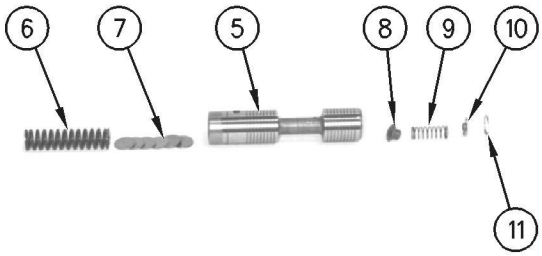


Illustration 176 g00860757

1. Place poppet (8), spring (9) and retainer (10) into position in spool (5).
2. Install retaining ring (11).
3. Install shims (7) and spring (6) in the end of spool (5).

4. Place spool (5) into position in the relief valve body.

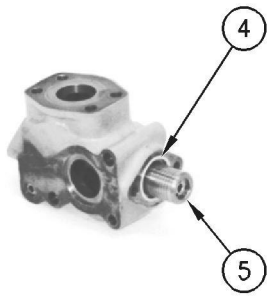


Illustration 177 g00860756

5. Install O-ring seal (4) in the valve body. Repeat this procedure for the opposite end.

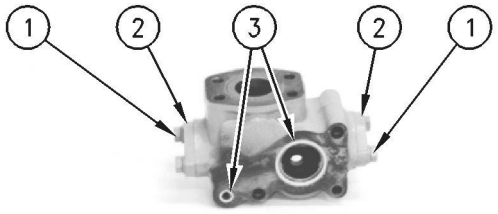


Illustration 178 g00860754

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

6. Place covers (2) into position on the relief valve body.

7. Install bolts (1).

8. Install O-ring seals (3).

End By:

a. Install the torque converter outlet relief valve. Refer to Disassembly and Assembly, "Relief Valve (Torque Converter Outlet) - Install".

i02495223

Relief Valve (Torque Converter Outlet) - Install

SMCS Code: 3133-012-OL

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Inspect the O-ring seals. Replace O-ring seals that are worn or damaged.

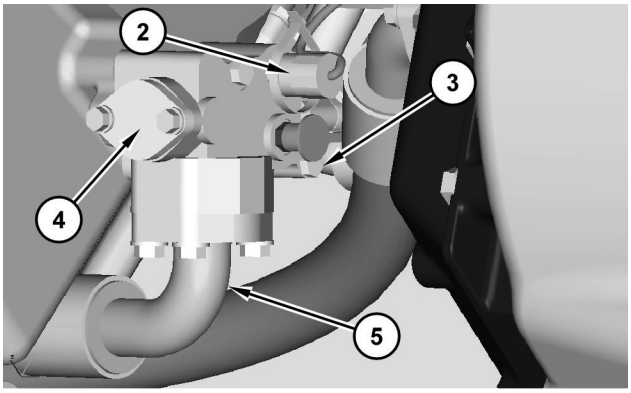


Illustration 179 g01247611

1. Install relief valve (4).

2. Install bolts (3).

3. Connect harness assembly (2) to relief valve (4).

4. Connect hose assembly (5).

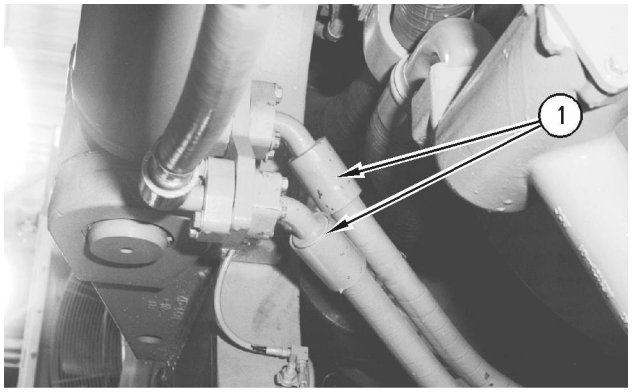


Illustration 180 g00860722

5. Connect hose assemblies (1).

End By:

a. Install the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install”.

b. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02495189

Torque Converter Priority Valve - Remove

SMCS Code: 3180-011

Removal Procedure

Start By:

a. Remove the hydraulic fan pump. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic Fan) - Remove”.

b. Remove the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmisson) - Remove and Install”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hot oil or hot components.

At operating temperature, oil is hot and under pressure. Hot oil can cause burns.

Remove the fill cap only when the engine is stopped, and the fill cap is cool enough to touch with your bare hand.

Do not allow hot oil or components to contact skin.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on the hose assemblies for installation purposes. Plug the hose assemblies. This will help to prevent fluid loss and this will help to prevent contaminants from entering the system.

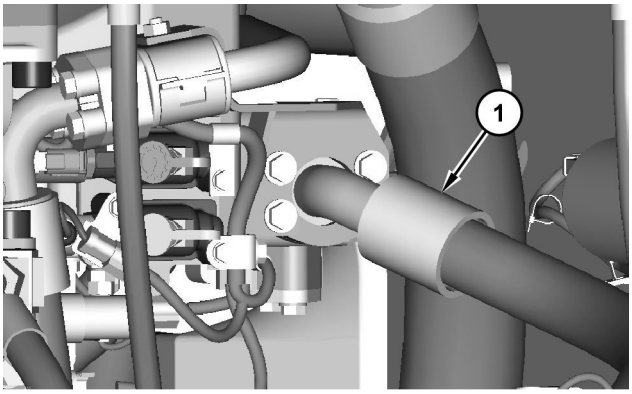


Illustration 181 g01247572

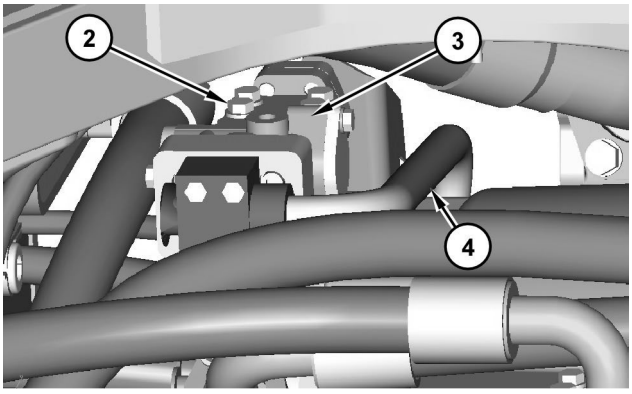


Illustration 182 g01247576

Note: Priority valve (3) for the torque converter is mounted on the left side of the torque converter.

1. Disconnect hose assembly (1) from torque converter priority valve (3).

2. Disconnect tube assembly (4).

3. Remove bolts (2) and torque converter priority valve (3) from the torque converter.

i02495193

Torque Converter Priority Valve - Disassemble

SMCS Code: 3180-015

Disassembly Procedure

Table 7

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1853	Pliers	1

Start By:

a. Remove the priority valve for the torque converter. Refer to Disassembly and Assembly, "Torque Converter Priority Valve - Remove" for the machine that is being serviced.

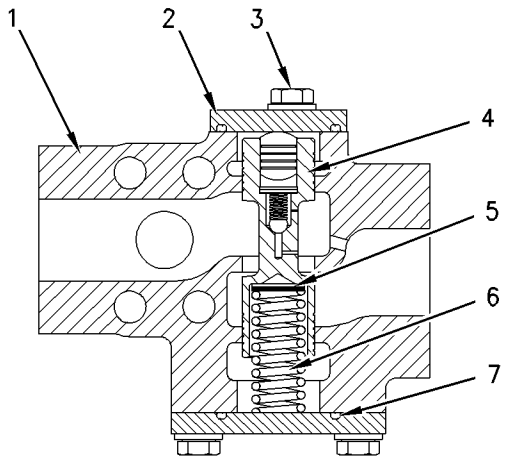


Illustration 183 g00681704

1. Remove four bolts (3) and the washers.

2. Remove two covers (2) from valve body assembly (1).

3. Remove spring (6), shims (5) and spool assembly (4) from valve body assembly (3).

4. Remove O-ring seal (7) from each cover (2).

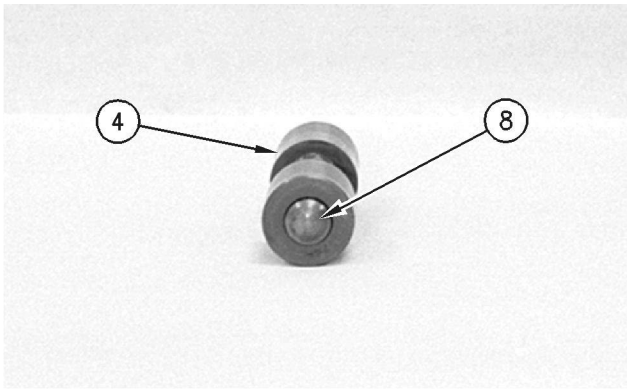


Illustration 184 g00681712

5. Remove slug (8) from spool assembly (4).

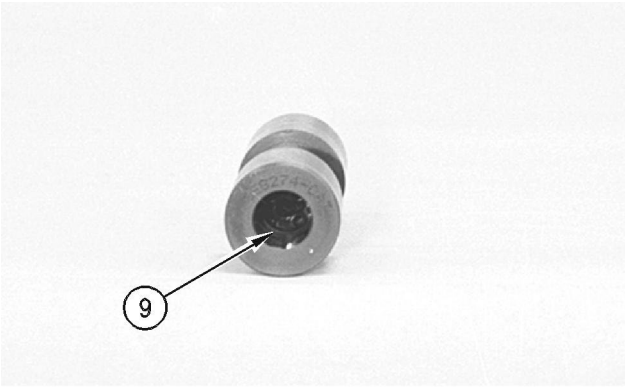


Illustration 185 g00369752

6. Use Tooling (A) in order to remove retaining ring (9).

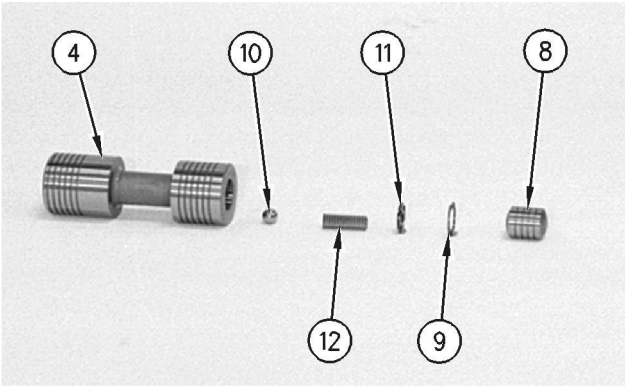


Illustration 186 g00681758

7. Remove ball (10), spring (12) and retainer (11) from spool assembly (4).

i02495194

Torque Converter Priority Valve - Assemble

SMCS Code: 3180-016

Assembly Procedure

Table 8

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1853	Pliers	1

Note: Thoroughly clean all parts of the priority valve for the torque converter prior to assembly. Put clean oil on all internal parts.

1. Check the condition of the O-ring seals. If the O-ring seals are worn or damaged, use a new part for replacement.

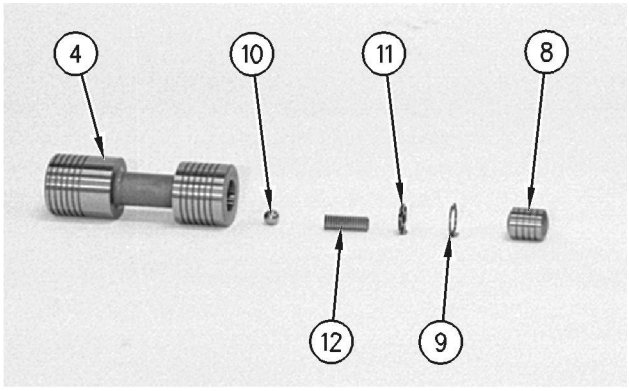


Illustration 187 g00681758

2. Install ball (10), spring (12) and retainer (11) in spool assembly (4).

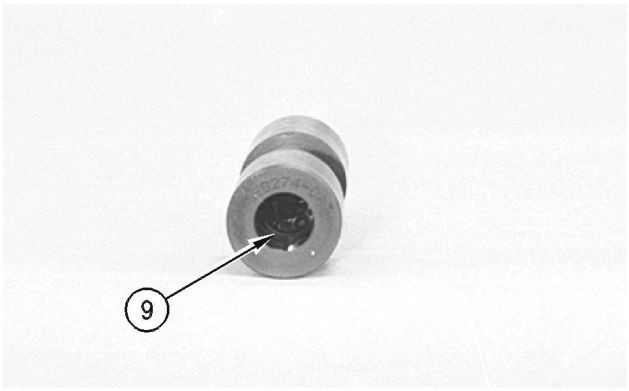


Illustration 188 g00369752

3. Use Tooling (A) in order to install retaining ring (9).

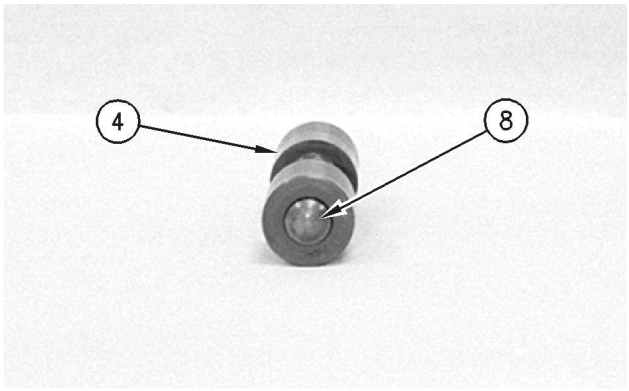


Illustration 189 g00681712

4. Install slug (8) in spool assembly (4).

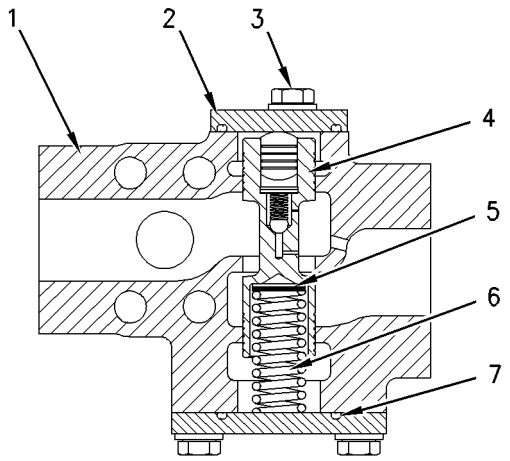


Illustration 190 g00681704

5. Install shims (5), spring (6), and spool assembly (4) in valve body assembly (1).

6. Install two O-ring seals (7) and two covers (2) on the valve body.

7. Install bolts (3) and the washers.

End By:

a. Install the torque converter priority valve. Refer to Disassembly and Assembly, "Torque Converter Priority Valve - Install"for the machine that is being serviced.

i02495191

Torque Converter Priority Valve - Install

SMCS Code: 3180-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

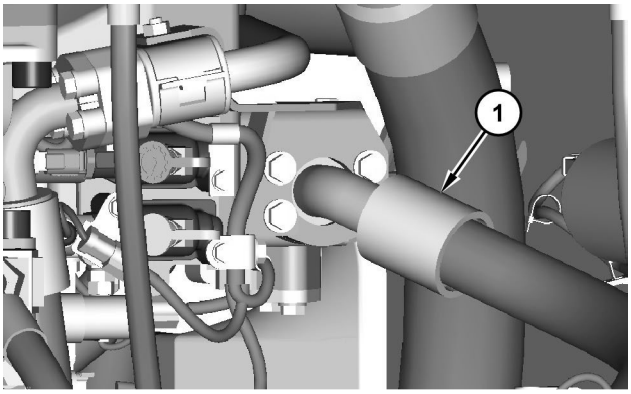


Illustration 191 g01247572

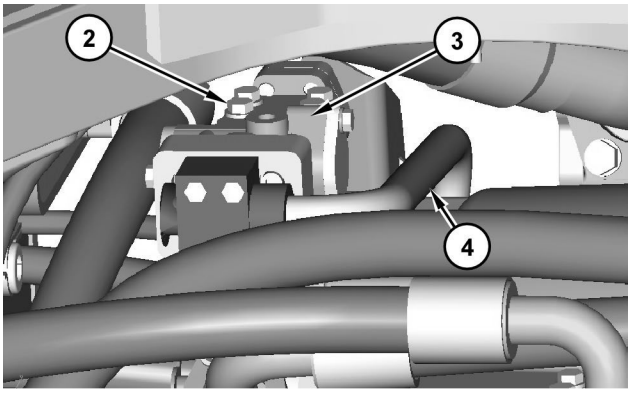


Illustration 192 g01247576

1. Position torque converter priority valve (3) and install bolts (2) onto the torque converter.

2. Connect hose assembly (1) to torque converter priority valve (3).

3. Connect tube assembly (4).

End By:

a. Install the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install” .

b. Install the hydraulic fan pump. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic Fan) - Install”.

i02504690

Input Drive Shaft - Remove and Install

SMCS Code: 3253-010-IV

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

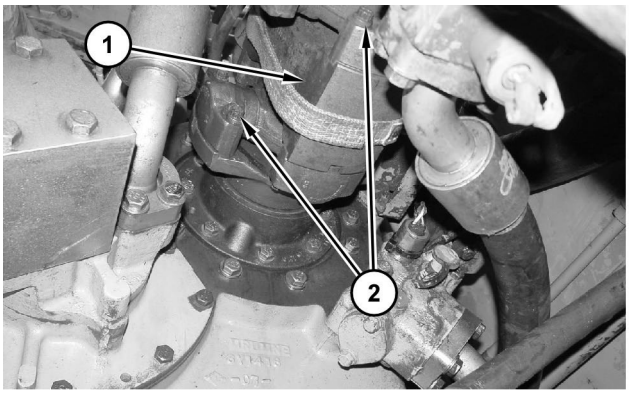


Illustration 193 g01253842

1. Attach a suitable lifting device onto input drive shaft (1). The weight of input drive shaft (1) is approximately 29.4833 kg (65 lb).

2. Remove bolts (2).

3. Use the suitable lifting device in order to lower input drive shaft (1) to the ground.

Installation Procedure

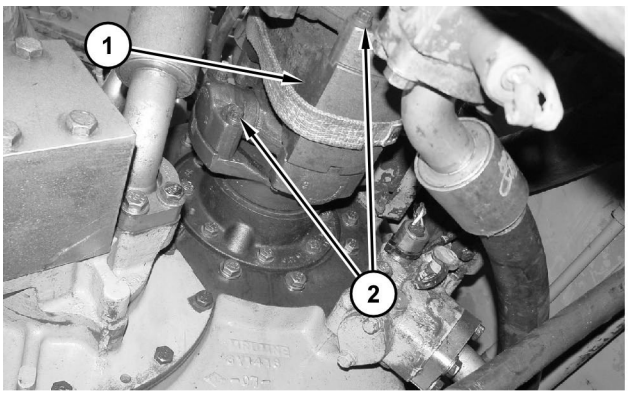


Illustration 194 g01253842

1. Use a suitable lifting device in order to install input drive shaft (1). The weight of input drive shaft (1) is approximately 35 kg (65 lb).

2. Install bolts (2).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02494586

Transmission Oil Pump - Remove

SMCS Code: 3066-011

Removal Procedure

Start By:

a. Release the pressure from the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

b. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

c. Remove the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install”.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

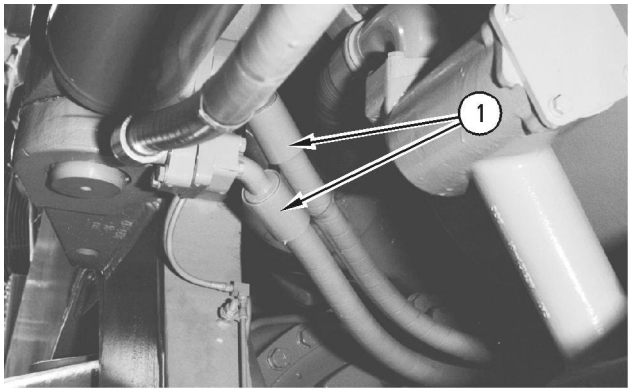


Illustration 195 g00860873

1. Disconnect hose assemblies (1) from the right steering cylinder in order to access the transmission oil pump.

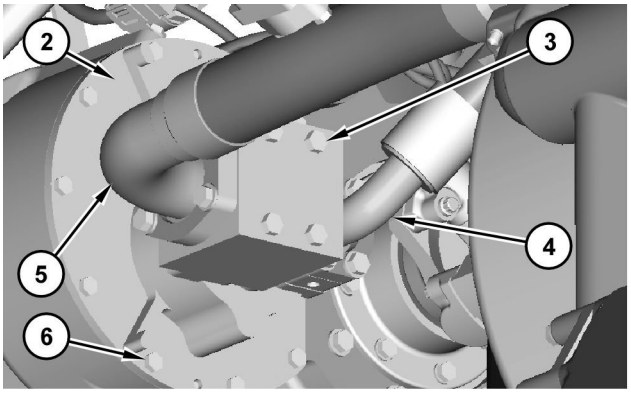


Illustration 196 g01247201

2. Disconnect hose assembly (4) from transmission oil pump (2).

3. Remove bolts (3) in order to position hose assembly (5) out of the way.

4. Remove bolts (6) from transmission oil pump (2).

5. Remove transmission oil pump (2).

Note: Tilt the transmission oil pump and lift out the transmission oil pump in order to clear the meshing gears inside the transmission oil pump.

i02494996

Transmission Oil Pump - Disassemble

SMCS Code: 3066-015

Disassembly Procedure

Table 9

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Gp	1

Start By:

a. Remove the transmission oil pump. Refer to Disassembly and Assembly, “Transmission Oil Pump - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

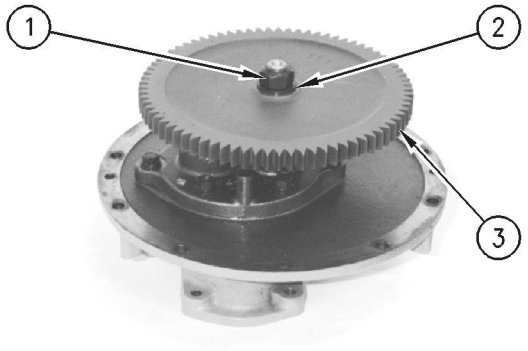


Illustration 197 g00861020

1. Put an alignment mark across the manifold, the body, and the cover of the transmission oil pump for assembly purposes.

2. Loosen locknut (1). Do not remove the locknut.

3. Use a suitable puller in order to loosen gear (3), if necessary.

4. Remove locknut (1), washer (2), and gear (3).

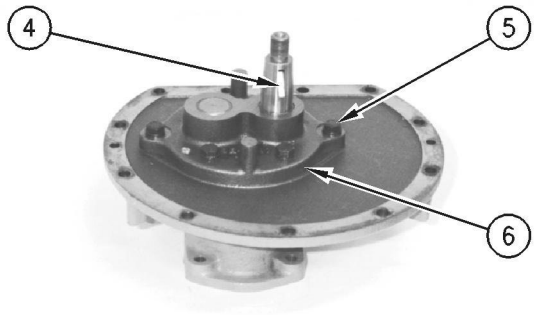


Illustration 198 g00861052

5. Remove woodruff key (4).

6. Remove bolts (5).

7. Remove cover assembly (6).

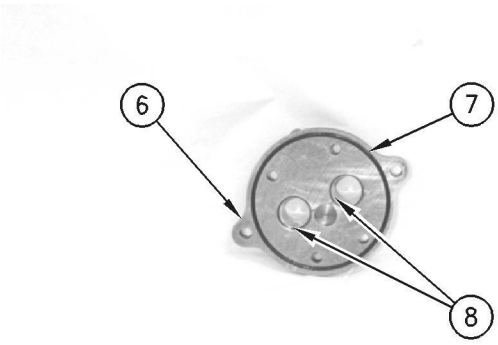


Illustration 199 g00861054

8. Remove O-ring seal (7). Use Tooling (A) in order to remove sleeve bearings (8) from cover assembly (6).

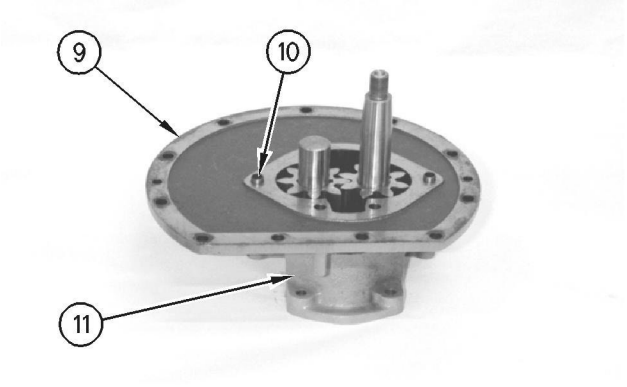


Illustration 200 g00861056

9. Remove body assembly (9) from manifold assembly (11).

10. Remove dowels (10) from body assembly (9).

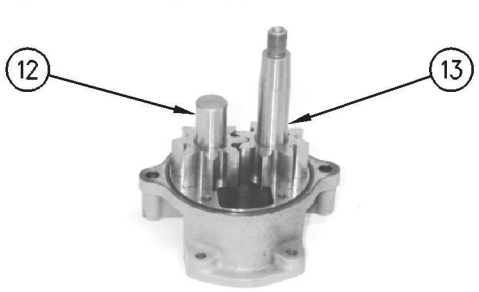


Illustration 201 g00861058

11. Remove idler gear assembly (12).

12. Remove drive gear assembly (13).

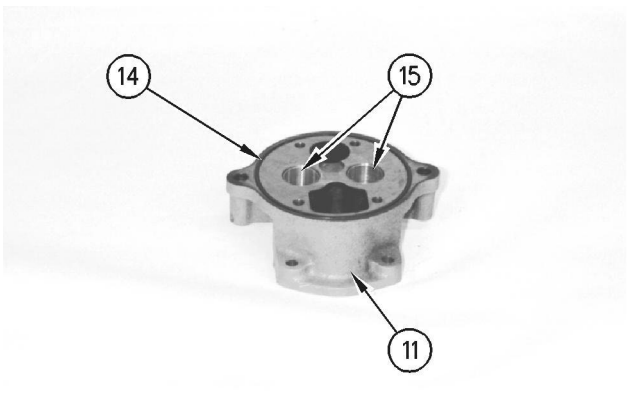


Illustration 202 g00861059

13. Remove O-ring seal (14). Use Tooling (A) in order to remove sleeve bearings (15) from manifold assembly (11).

i02494999

Transmission Oil Pump - Assemble

SMCS Code: 3066-016

Assembly Procedure

Table 10

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Gp	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Thoroughly clean all parts of the transmission oil pump prior to assembly.

1. Check the condition of all O-ring seals. If any O-ring seals are damaged, use new parts for replacement.

2. Put clean transmission oil on all internal parts of the transmission oil pump.

Note: Sleeve bearings (8) and (15) are identical.

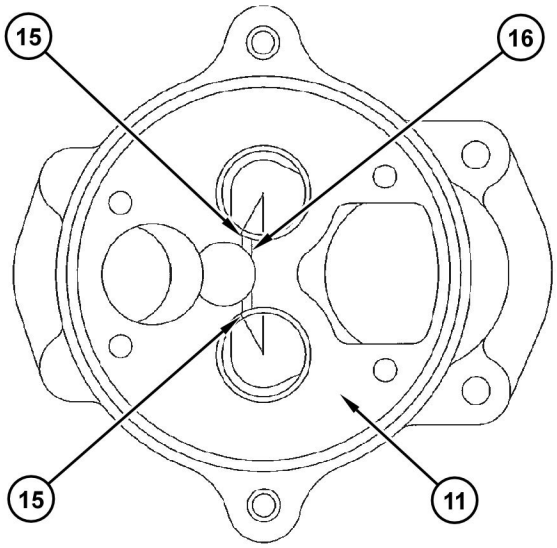


Illustration 203 g01247334

3. Use Tooling (A) in order to install sleeve bearings (15) in manifold assembly (11). The joint surfaces for the sleeve bearings must be 30 ± 15 degrees from the centerline through the bores of the sleeve bearing. The joint surfaces must be toward outlet ports (16). Make sure that the sleeve bearings are 1.50 ± 0.25 mm (0.059 ± 0.010 inch) below the machined surface of manifold assembly (11).

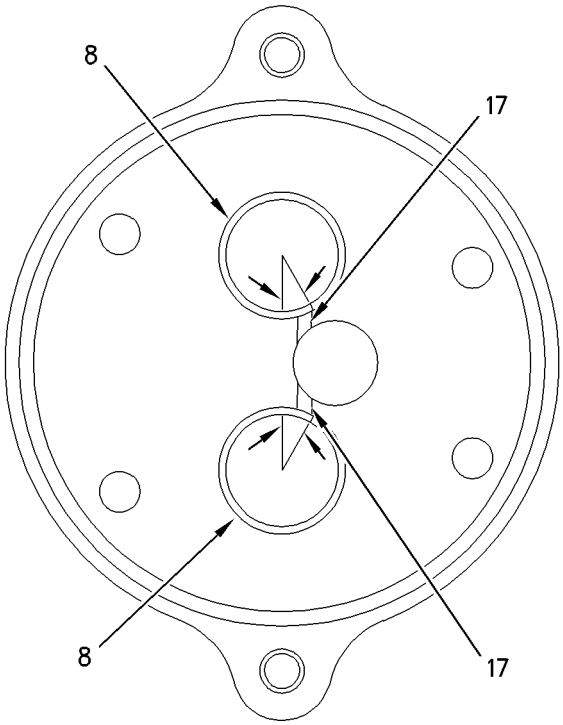


Illustration 204 g01247335

4. Use Tooling (A) in order to install sleeve bearings (8) in cover assembly (6). The joint surfaces for the sleeve bearings must be 30 ± 15 degrees from the centerline through the bore of the sleeve bearing. The joint surfaces must be toward outlet ports (17). Make sure that the sleeve bearings are 1.50 ± 0.25 mm (0.059 ± 0.010 inch) below the machined surface of cover assembly (6).

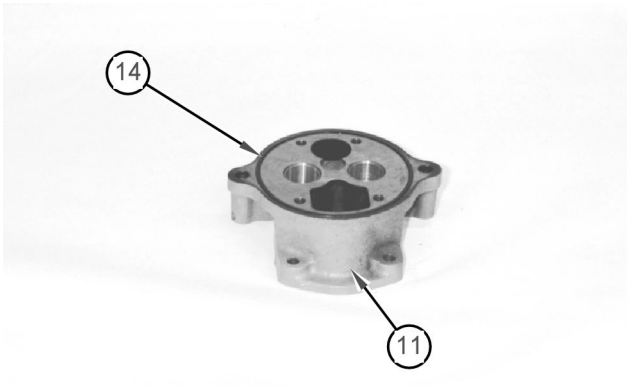


Illustration 205 g01247338

5. Install O-ring seal (14) into manifold assembly (11).

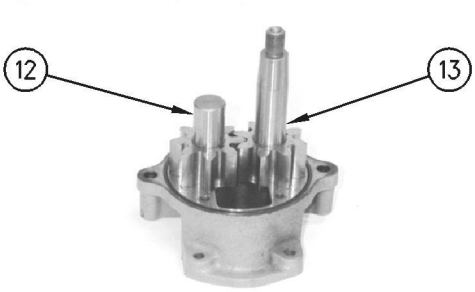


Illustration 206 g00861058

6. Install drive gear assembly (13) and idler gear assembly (12) into the original bores in the manifold assembly.

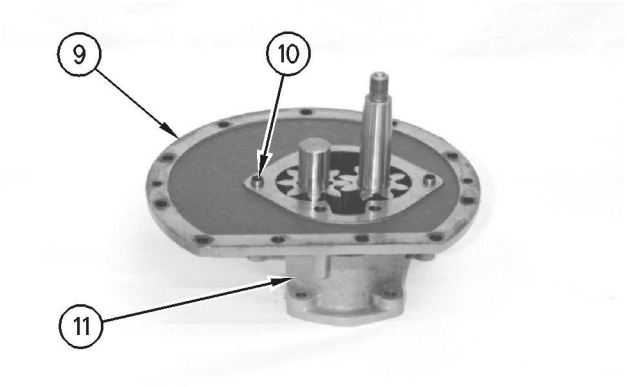


Illustration 207 g00861056

7. Install dowels (10) into body assembly (9).

8. Install body assembly (9) to manifold assembly (11).

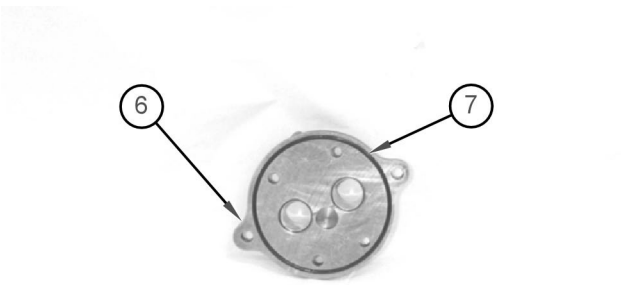


Illustration 208 g01247341

9. Install O-ring seal (7) into cover assembly (6).

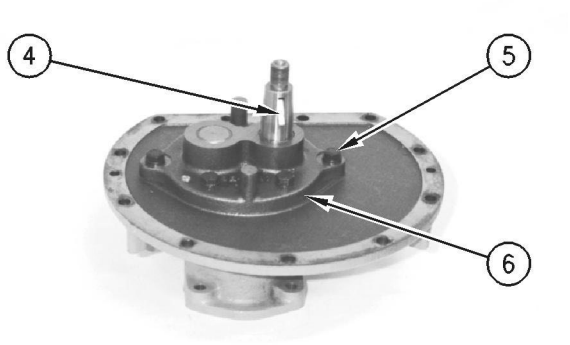


Illustration 209 g00861052

10. Install cover assembly (6).

11. Install bolts (5) to the manifold.

12. Install woodruff key (4).

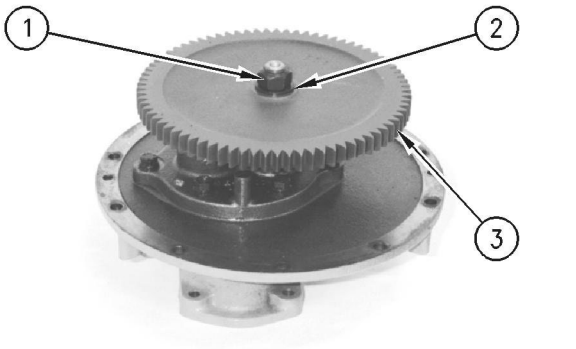


Illustration 210 g00861020

13. Install gear (3), washer (2), and locknut (1) on drive gear assembly (12). Tighten locknut (1) to a torque of 110 ± 13 N·m (81 ± 10 lb ft).

Note: Lubricate the pump with transmission oil. The pump shaft must be able to rotate freely by hand.

End By:

a. Install the transmission oil pump. Refer to Disassembly and Assembly, "Transmission Oil Pump - Install" for the machine that is being serviced.

i02494587

Transmission Oil Pump - Install

SMCS Code: 3066-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

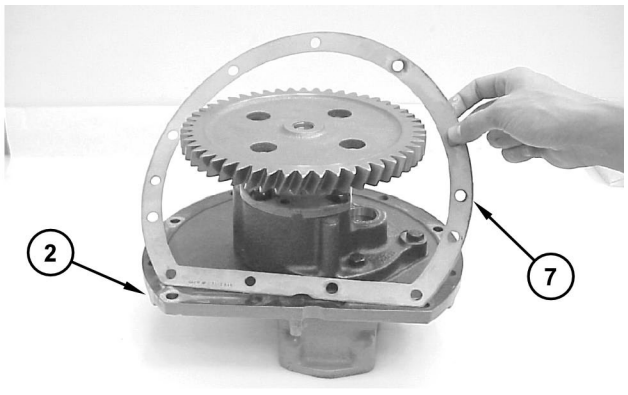


Illustration 211 g01247290
Typical Example

1. Install gasket (7) onto transmission oil pump (2).

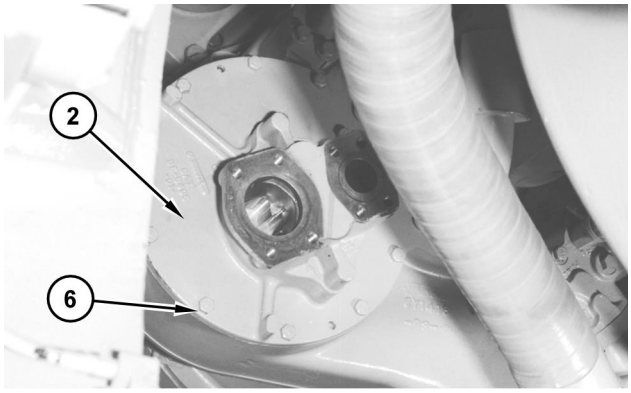


Illustration 212 g01247300

2. Install transmission oil pump (2).

3. Install bolts (6).

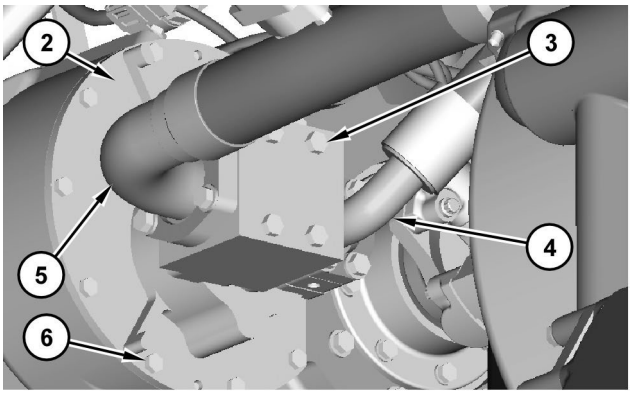


Illustration 213 g01247201

4. Connect hose assembly (4) onto transmission oil pump (2).

5. Position hose assembly (5) and install bolts (3).

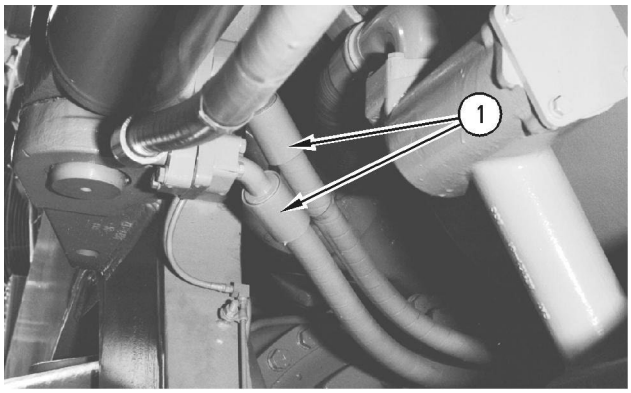


Illustration 214 g00860873

6. Connect hose assemblies (1) to the right steering cylinder.

End By:

a. Install the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install” for the machine that is being serviced.

b. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02495442

Transmission Hydraulic Control Valve - Remove

SMCS Code: 3073-011

Removal Procedure

Start By:

a. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Open the access door behind the cab.

2. Turn the heater control valves to the OFF position.

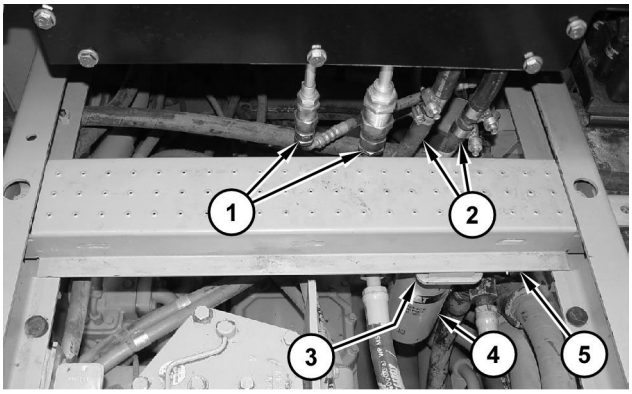


Illustration 215 g01247801

3. Disconnect hose assemblies (1). Disconnect hoses (2).

4. Remove bolts (3) and position filter base (4) out of the way.

5. Remove brace (5).

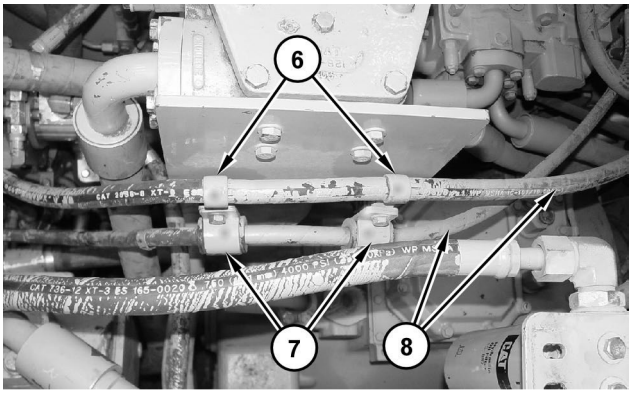


Illustration 216 g01247810

6. Remove clips (6) and clips (7). Position hose assemblies (8) out of the way.

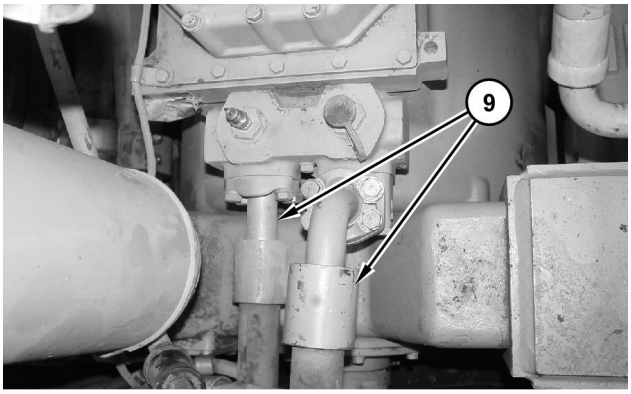


Illustration 217 g01247813

7. Disconnect hose assemblies (9).

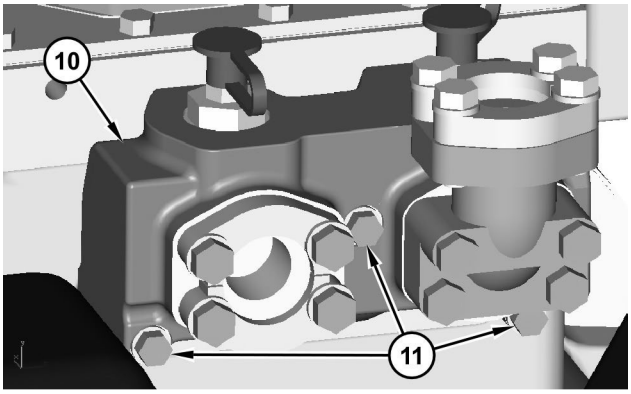


Illustration 218 g01247829

8. Remove bolts (11) in order to remove manifold (10).

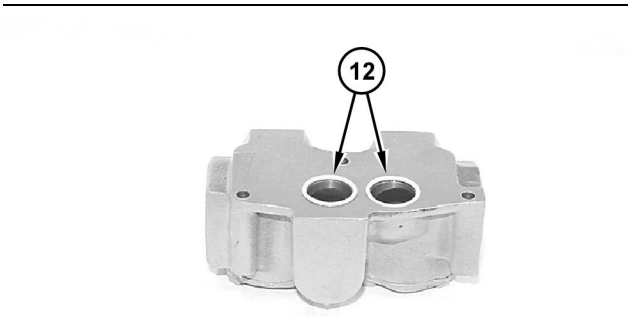


Illustration 219 g01247923

9. Remove O-ring seals (12).

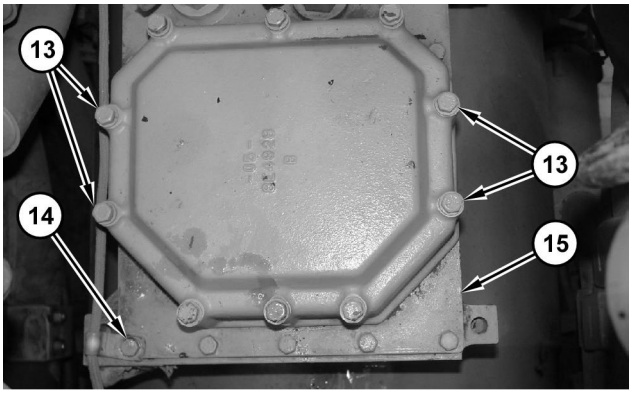


Illustration 220 g01247924

10. Remove bolts (13). Remove bolts (14) in order to remove cover assembly (15).

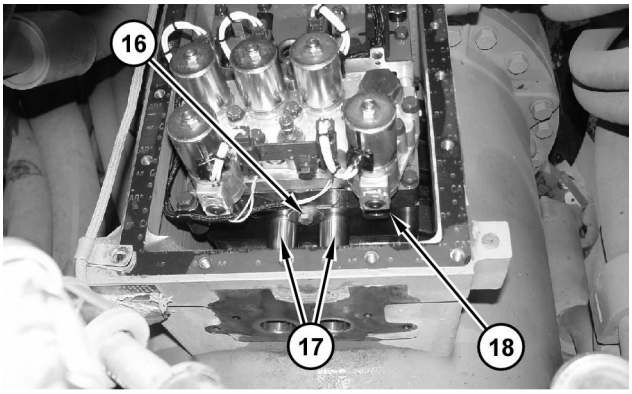


Illustration 221 g01247926

11. Remove bolt (16) in order to remove sleeves (17) from transmission hydraulic control valve (18).

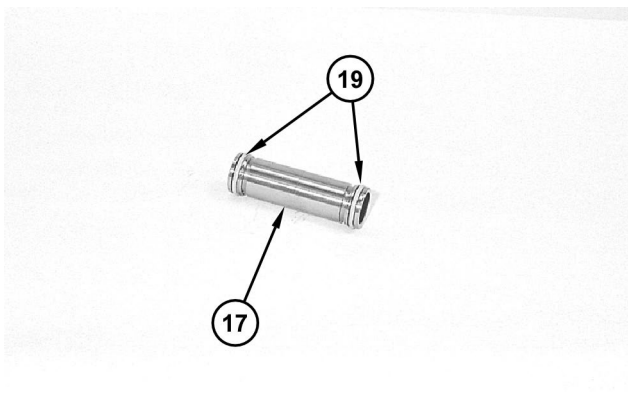


Illustration 222 g01248284

12. Remove O-ring seals (19) from each sleeve (17).

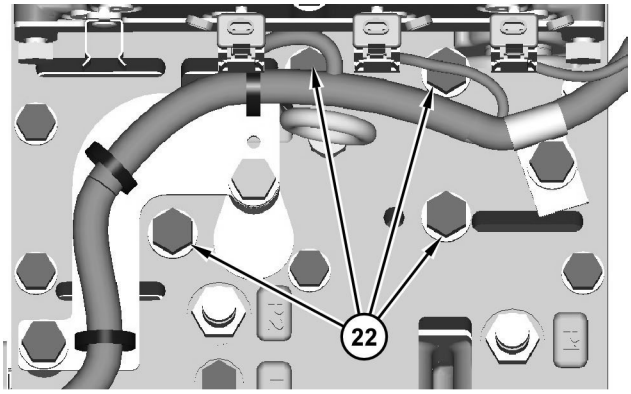


Illustration 223 g01254640

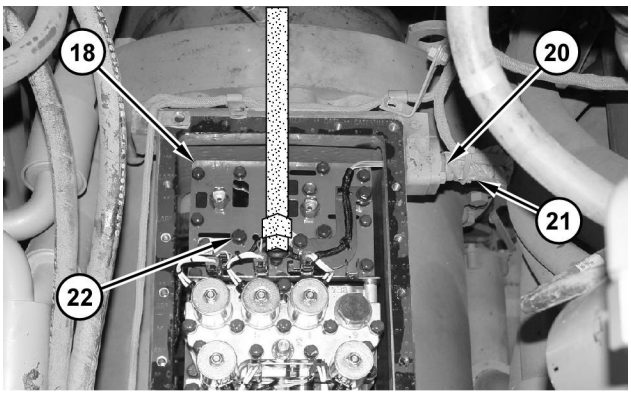


Illustration 224 g01247941

13. Remove bolts (22) from transmission hydraulic control valve (18).

14. Disconnect harness assembly (21). Remove nut (20) and retract the connector.

15. Use a suitable lifting device in order to remove transmission hydraulic control valve (18) from the transmission. The weight of transmission hydraulic control valve (18) is approximately 55 kg (120 lb).

i02495270

Transmission Hydraulic Control Valve - Disassemble

SMCS Code: 3073-015

Disassembly Procedure

Start By:

a. Remove the transmission hydraulic control valve. Refer to Disassembly and Assembly, "Transmission Hydraulic Control Valve - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

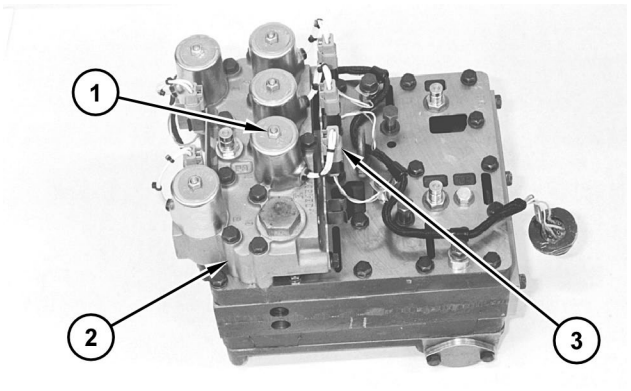


Illustration 225 g01247654

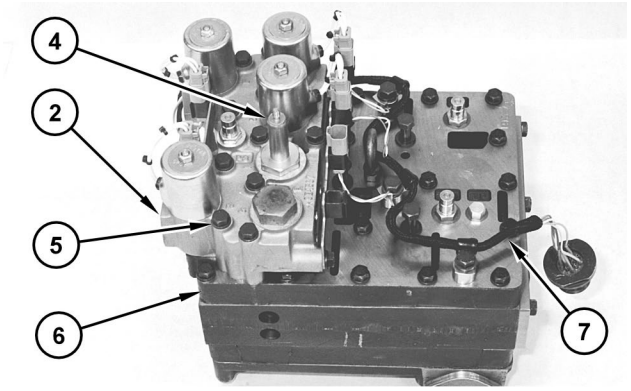


Illustration 226 g01247651

1. Disconnect harness assembly (3).

2. Remove locknut (1) and the washer from cartridge assembly (4).

3. Remove the coil assembly.

4. Remove cartridge assembly (4) from oil manifold (2).

5. Repeat Steps 1 through 4 in order to remove the remaining solenoid valves.

6. Remove the bolts from the clamps that hold harness assembly (7).

7. Remove bolts (5) from oil manifold (2).

8. Remove oil manifold (2) and harness assembly (7) from oil manifold (6).

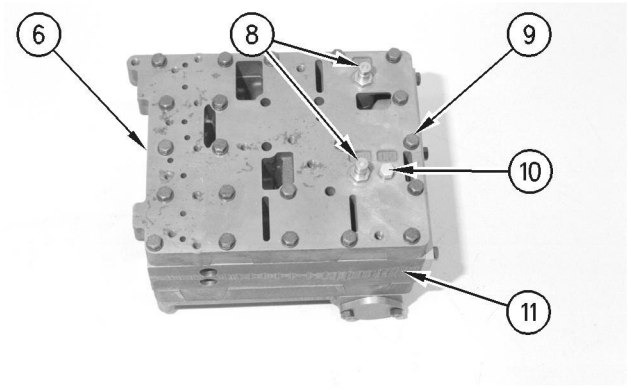


Illustration 227 g00864525

9. Remove nipples (8) from oil manifold (6).

10. Remove plug (10) from oil manifold (6).

11. Remove bolts (9) from oil manifold (6).

12. Remove oil manifold (6) from valve assembly (11).

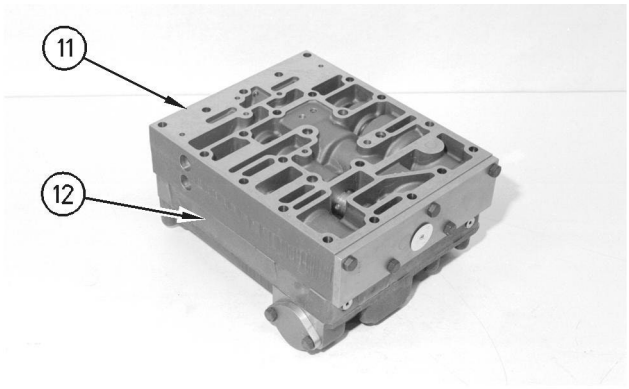


Illustration 228 g00864526

13. Remove valve assembly (11) from plate (12).

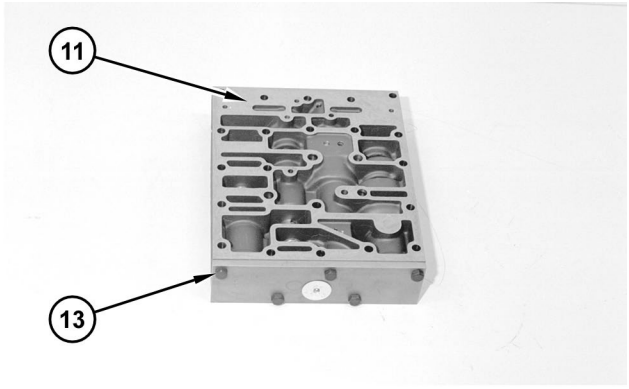


Illustration 229 g01247703

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

14. Remove bolts (13) from valve assembly (11).

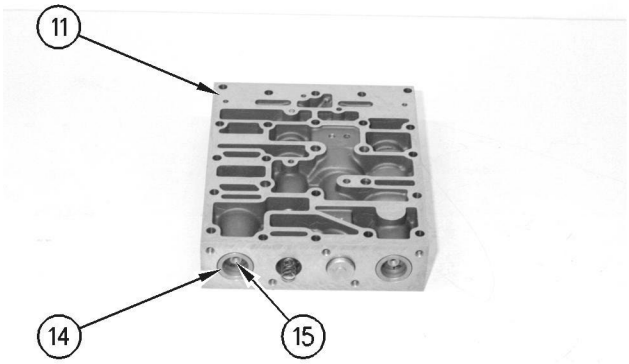


Illustration 230 g00864529

15. Remove stop (14) and spool (15) from valve assembly (11).

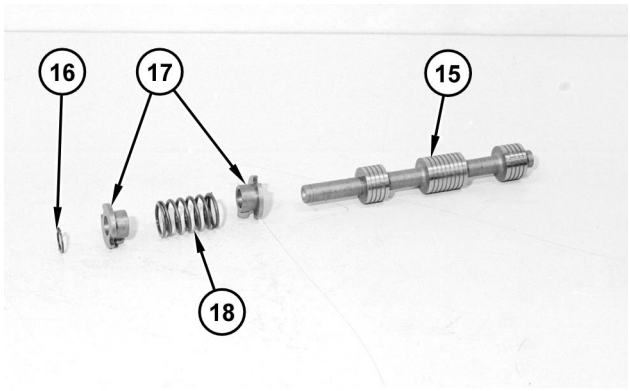


Illustration 231 g01250222

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

16. Remove retaining ring (16), retainers (17), and spring (18) from spool (15).

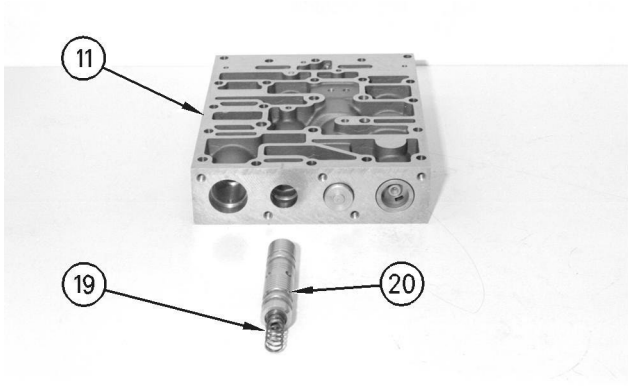


Illustration 232 g00864533

17. Remove spring (19) and spool (20) from valve assembly (11).

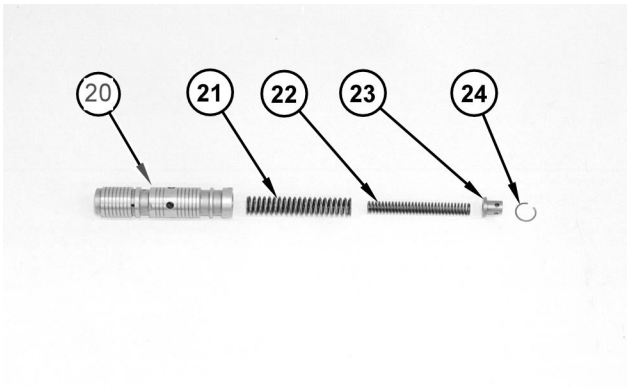


Illustration 233 g01250216

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

18. Remove retaining ring (24), retainer (23), spring (22), and spring (21) from spool (20).

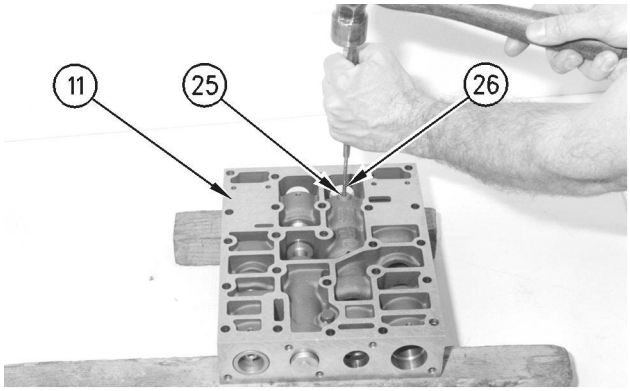


Illustration 234 g00864537

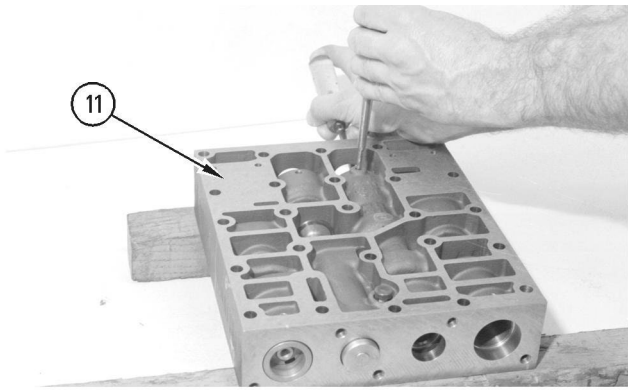


Illustration 235 g00864539

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

Note: Spool (20) and spool (25) are located in the same bore of valve assembly (11). Spool (25) must be removed from the end opposite spool (20).

19. Turn over valve assembly (11). Position valve assembly (11) on suitable blocks, as shown.

20. Use a suitable punch in order to drive pin (26) into valve assembly (11) until pin (26) is clear of spool (25). Do not remove the punch at this time.

21. Use a suitable screwdriver in order to depress spool (25).

22. Remove the punch from the hole for pin (26).

23. Slowly remove the screwdriver that is depressing spool (25). This will relieve the spring force against spool (25).

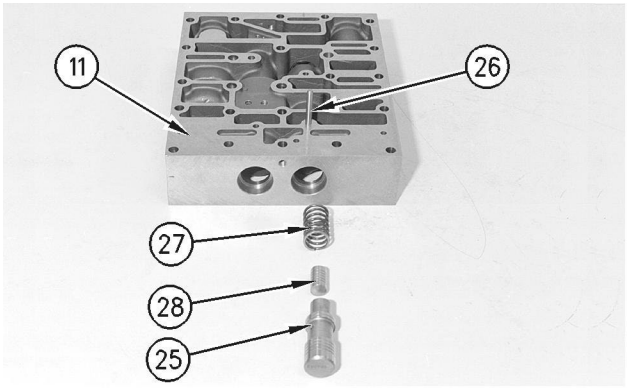


Illustration 236 g00864540

24. Remove slug (28) from spool (25).

25. Remove spring (27) from valve assembly (11).

26. Remove pin (26).

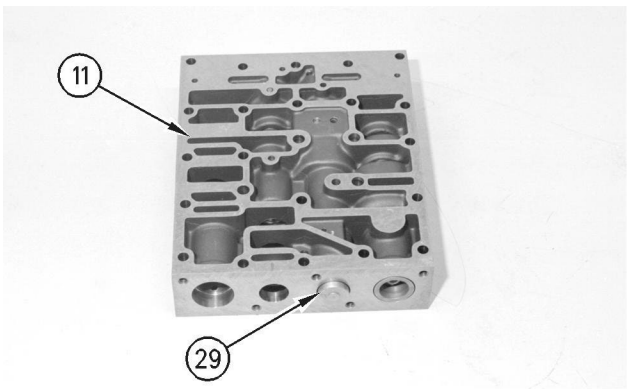


Illustration 237 g00864541

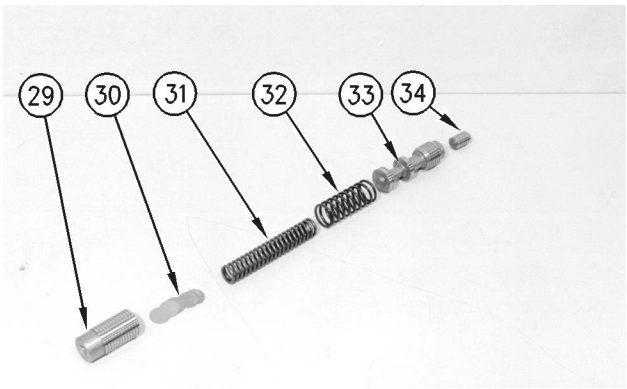


Illustration 238 g00864542

27. Reposition valve assembly (11), as shown.

28. Remove piston (29) from valve assembly (11).

29. Remove spacers (30) from the inside diameter of piston (29).

30. Remove spring (31) and spring (32) from valve assembly (11).

31. Remove spool (33) from valve assembly (11).

32. Remove slug (34) from spool (33).

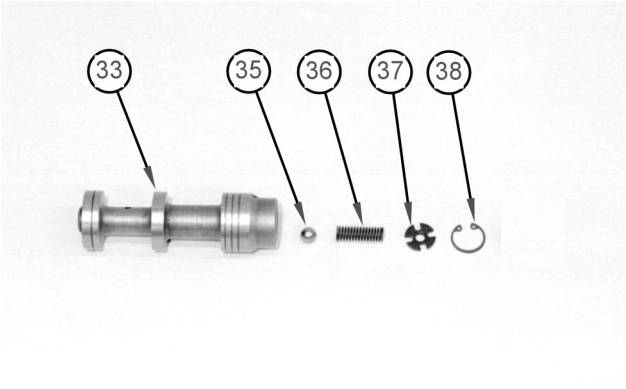


Illustration 239 g01250213

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

33. Remove retaining ring (38), retainer (37), spring (36), and ball (35) from spool (33).

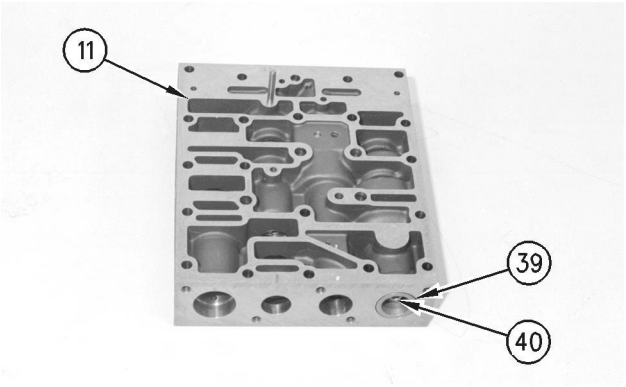


Illustration 240 g00864546

34. Remove stop (39) and spool (40) from valve assembly (11).

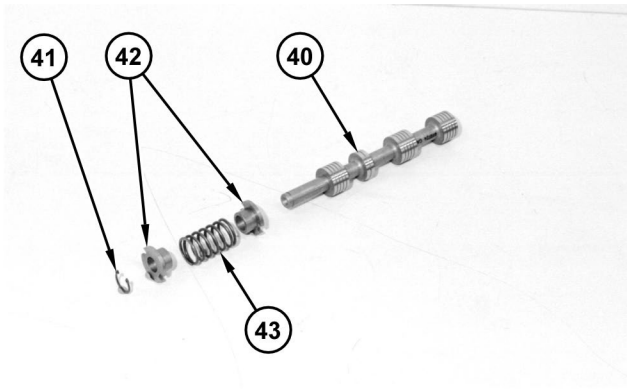


Illustration 241 g01250196

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

35. Remove retaining ring (41), retainers (42), and spring (43) from spool (40).

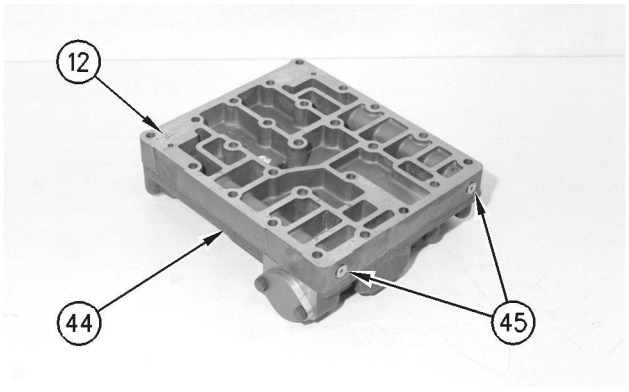


Illustration 242 g00864558

36. Remove plate (12) from valve (44).

37. Remove plugs (45) and the O-ring seals from plate (12).

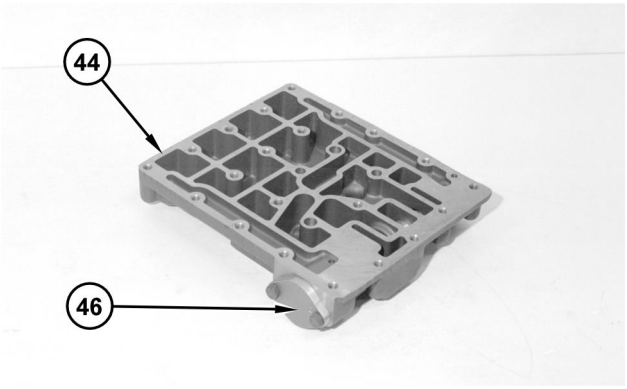


Illustration 243 g01247709

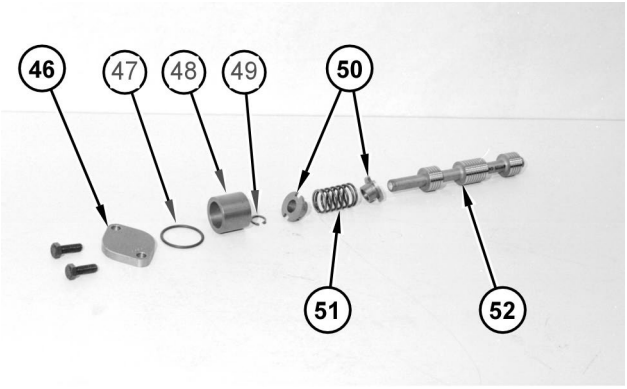


Illustration 244 g01247711

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

38. Remove the bolts and cover (46) from valve (44).

39. Remove O-ring seal (47).

40. Remove stop (48) from valve (44).

41. Remove spool (52) from valve (44).

42. Remove retaining ring (49), retainers (50), and spring (51) from spool (52).

i02495417

Transmission Hydraulic Control Valve - Assemble

SMCS Code: 3073-016

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

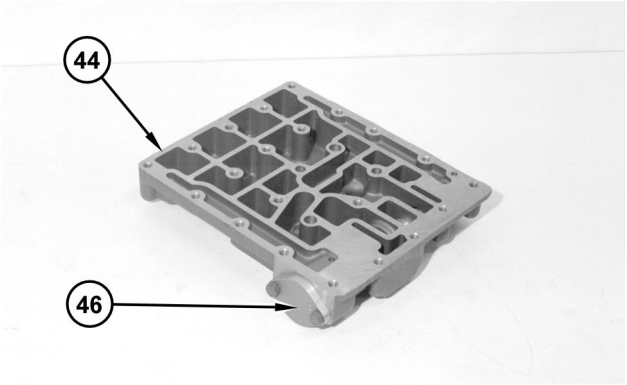


Illustration 245 g01247709

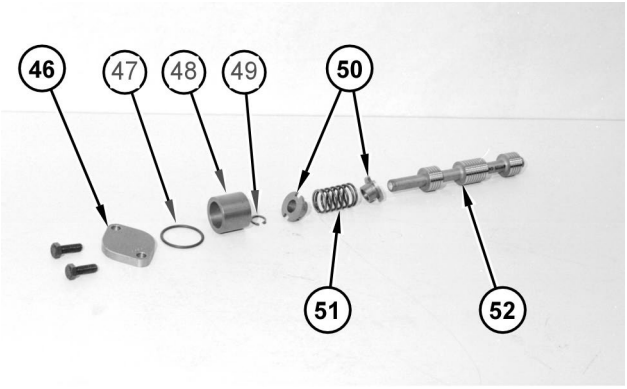


Illustration 246 g01247711

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Install retainers (50), spring (51), and retaining ring (49) onto spool (52).

2. Install spool (52), stop (48), O-ring seal (47), cover (46), and the bolts onto valve (44). Tighten the bolts to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

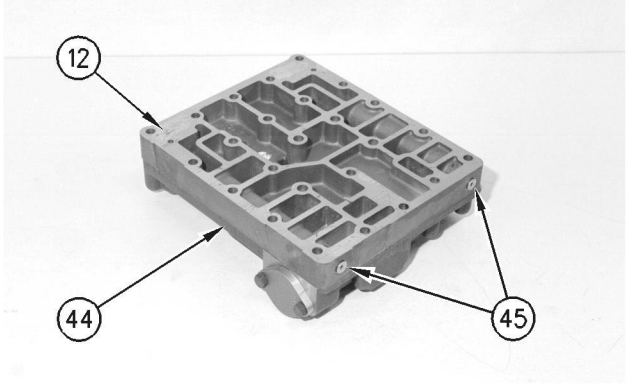


Illustration 247 g00864558

3. Install the O-ring seals and plugs (45) into plate (12).

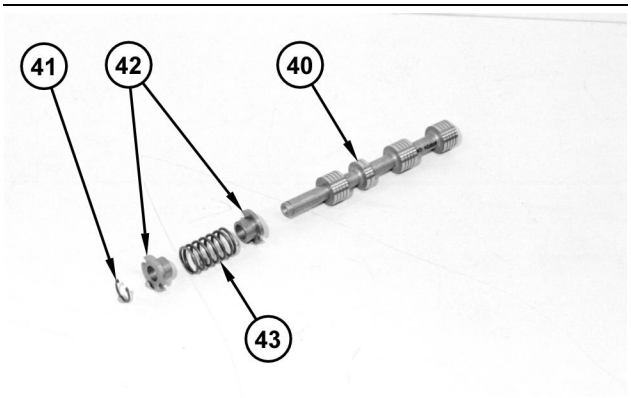


Illustration 248 g01250196

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

4. Install retainers (42), spring (43), and retaining ring (41) onto spool (40).

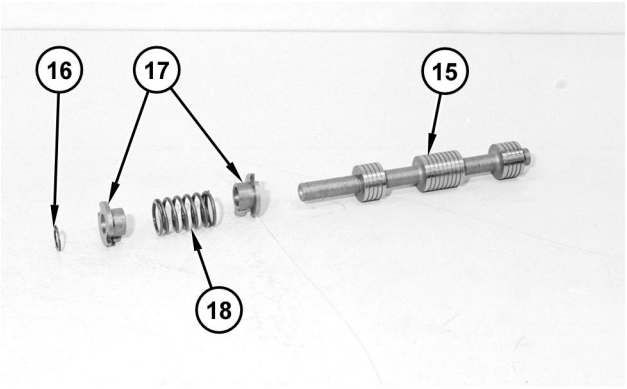


Illustration 249 g01250222

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

5. Install retainers (17), spring (18), and retaining ring (16) onto spool (15).

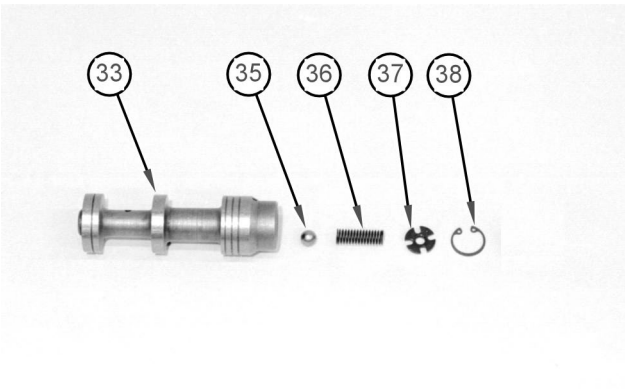


Illustration 250 g01250213

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

6. Install ball (35), spring (36), retainer (37), and retaining ring (38) into spool (33).

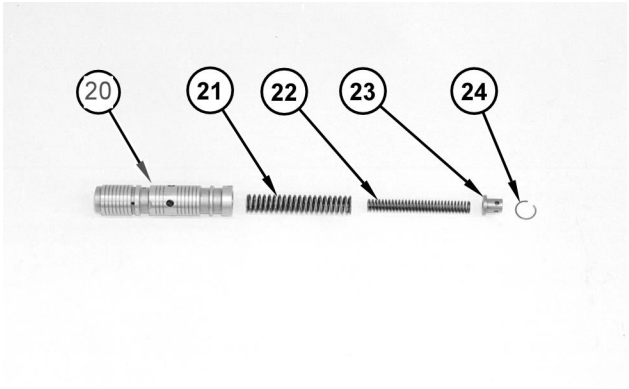


Illustration 251 g01250216

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

7. Install spring (21), spring (22), retainer (23), and retaining ring (24) onto spool (20).

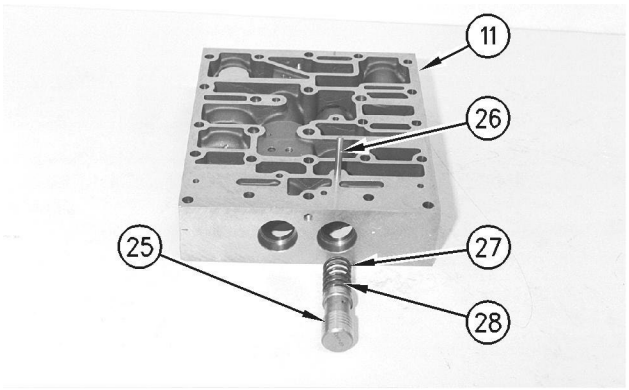


Illustration 252 g00864866

8. Install slug (28) and spring (27) onto spool (25).

9. Position valve assembly (11) and pin (26), as shown. Pin (26) must be clear of the bore for spool (25).

10. Install slug (28), spring (27), and spool (25) into valve assembly (11).

11. Use a suitable screwdriver in order to depress spool (25) into the bore of valve assembly (11).

12. Use a soft faced hammer in order to drive pin (26) into valve assembly (11).

13. Remove the screwdriver that is depressing spool (25).

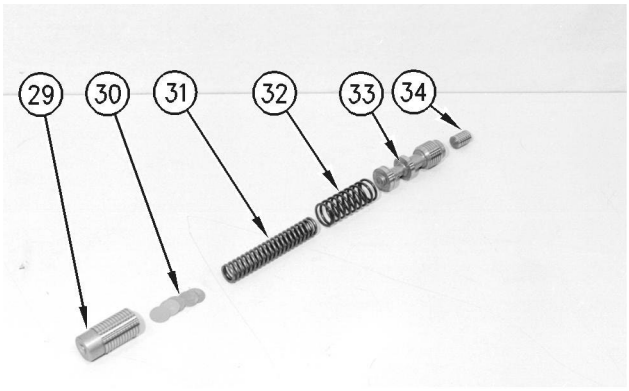


Illustration 253 g00864542

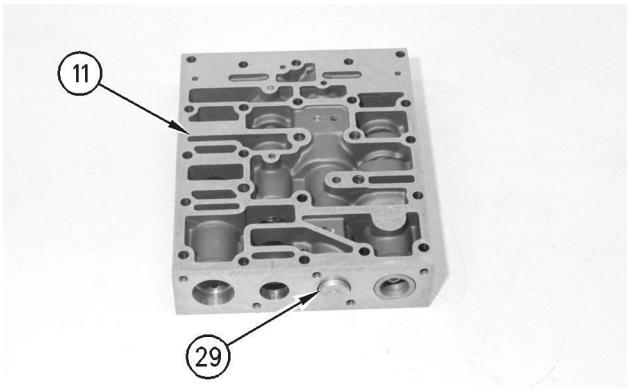


Illustration 254 g00864541

14. Install spacers (30) into piston (29).

15. Install slug (34), spool (33), spring (32), spring (31), piston (29), and spacers (30) into the original locations in the bore of valve assembly (11).

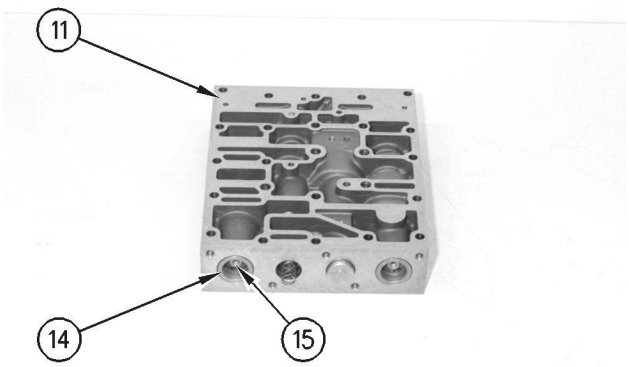


Illustration 255 g00864529

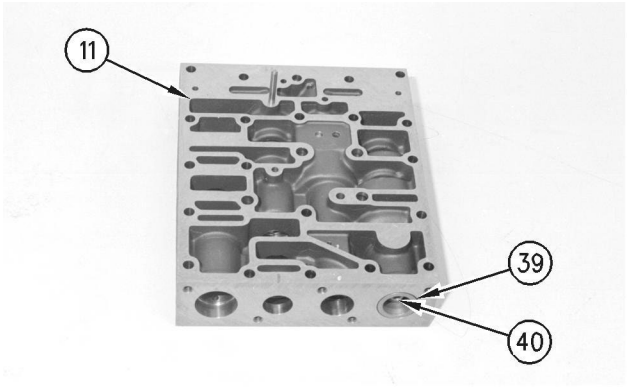


Illustration 256 g00864546

16. Install spool (15) and spool (40) into the original locations in valve assembly (11).

17. Install stop (14) and stop (39) into the original locations in valve assembly (11).

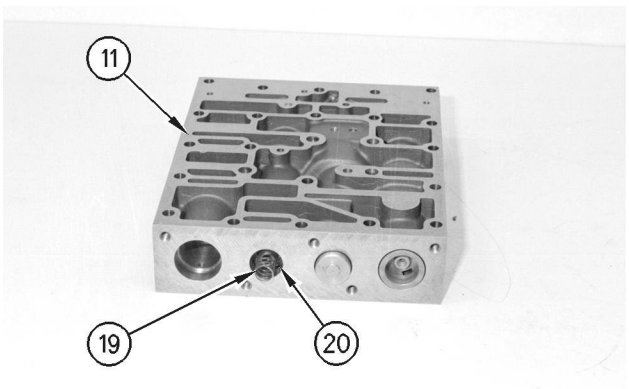


Illustration 257 g00864532

18. Install spool (20) and spring (19) into the original locations in valve assembly (11).

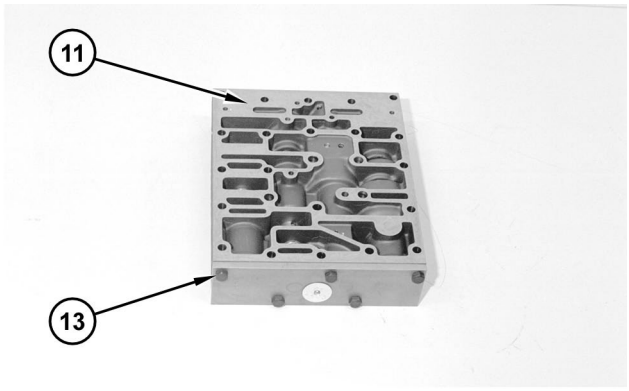


Illustration 258 g01247703

19. Install the O-ring seals and the cover onto valve assembly (11). Install bolts (13). Tighten the bolts (13) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

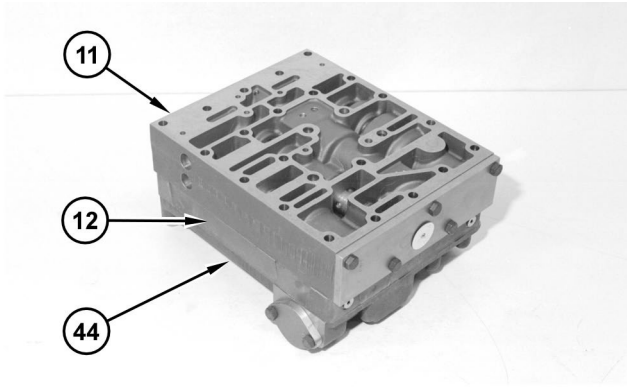


Illustration 259 g01250410

20. Install plate (12) and valve (11) into the original location on valve (44).

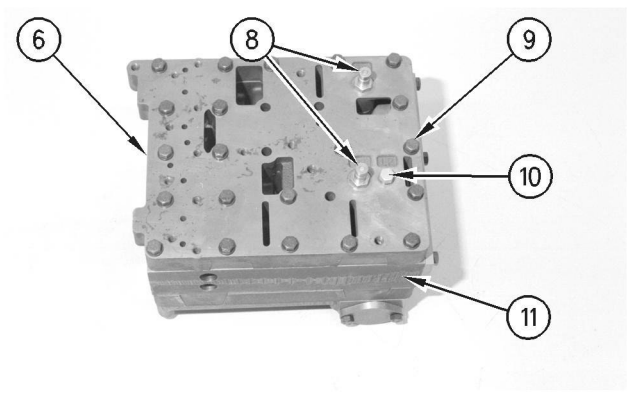


Illustration 260 g00864525

21. Install oil manifold (6). Install bolts (9). Tighten bolts (9) to a torque of 30 ± 4 N·m (22 ± 3 lb ft). Install plug (10) and nipples (8).

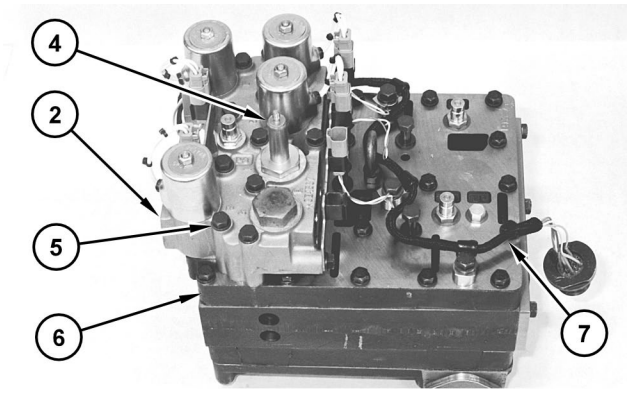


Illustration 261 g01247651

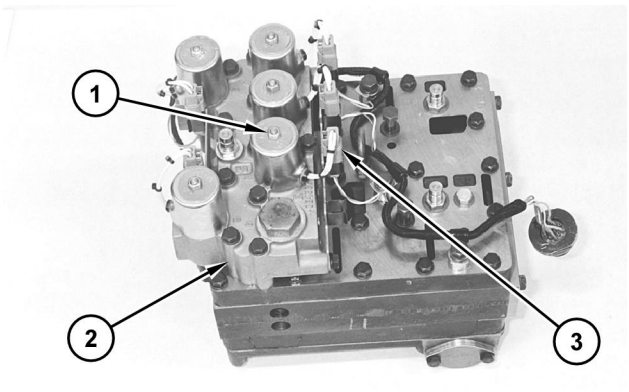


Illustration 262 g01247654

22. Install oil manifold (2). Install harness assembly (7) onto oil manifold (2). Tighten bolts (5) to a torque of 30 ± 4 N·m (22 ± 3 lb ft).

23. Install the bolts for the clamps and harness assembly (7).

24. Install cartridge assembly (4) to oil manifold (2). Tighten the cartridge assembly to a torque of 50 ± 5 N·m (37 ± 4 lb ft).

25. Install the coil assembly, the washer, and locknut (1) onto cartridge assembly (4). Tighten locknut (1) to a torque of 9 ± 0.5 N·m (80 ± 4 lb in).

26. Connect harness assembly (3) to the clip.

27. Repeat Steps 24 through 26 for the remaining solenoid valves.

End By:

a. Install the transmission hydraulic control valve. Refer to Disassembly and Assembly, “Transmission Hydraulic Control Valve - Install”.

i02495443

Transmission Hydraulic Control Valve - Install

SMCS Code: 3073-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the mating surfaces of the transmission hydraulic control valve and the transmission.

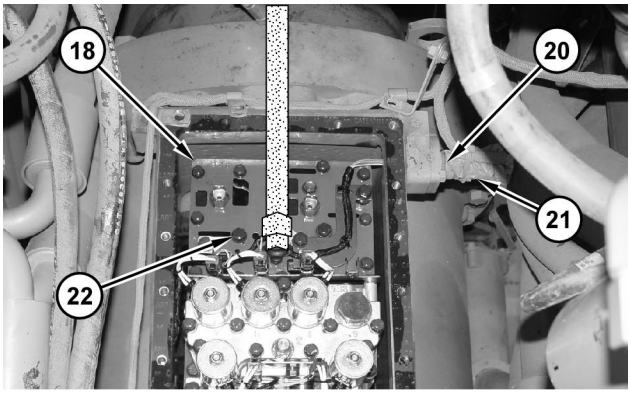


Illustration 263 g01247941

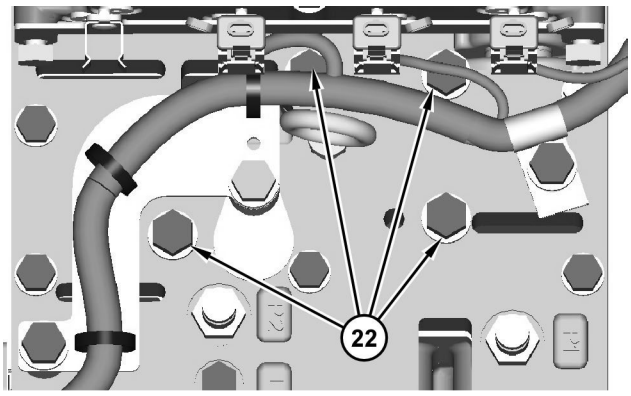


Illustration 264 g01254640

2. Use a suitable lifting device in order to position transmission hydraulic control valve (18), as shown. The weight of transmission hydraulic control valve (18) is approximately 55 kg (120 lb).

3. Position harness assembly (21) and install nut (20) onto the connector. Connect harness assembly (21).

4. Install bolts (22) onto transmission hydraulic control valve (18).

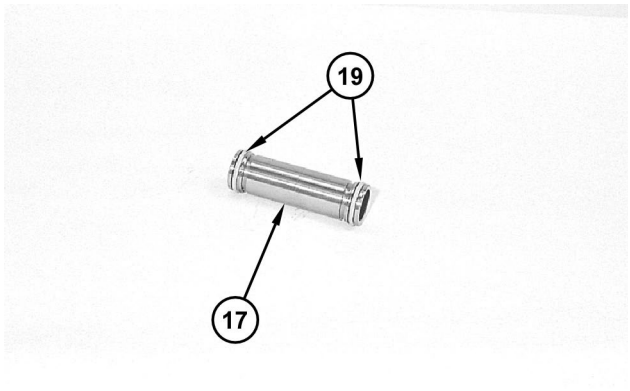


Illustration 265 g01248284

5. Lubricate O-ring seals (19). Install O-ring seals (19) onto each sleeve (17).

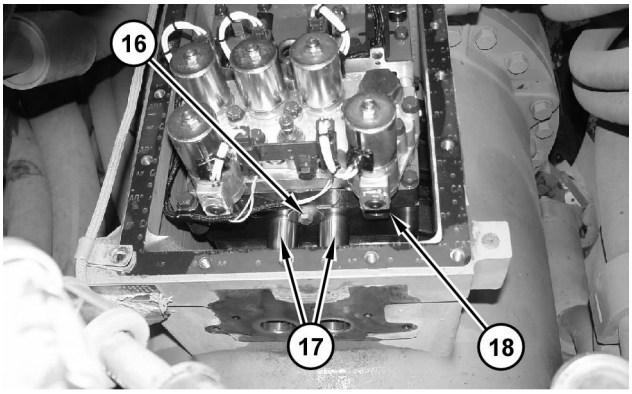


Illustration 266 g01247926

6. Install sleeves (17) into transmission hydraulic control valve (18). Install bolt (16).

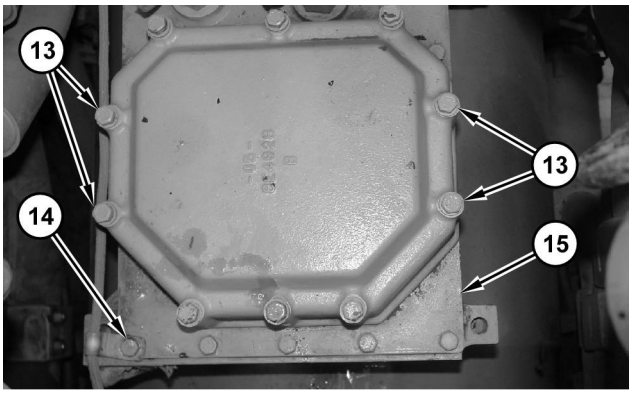


Illustration 267 g01247924

7. Install cover assembly (15). Install bolts (14). Install bolts (13).

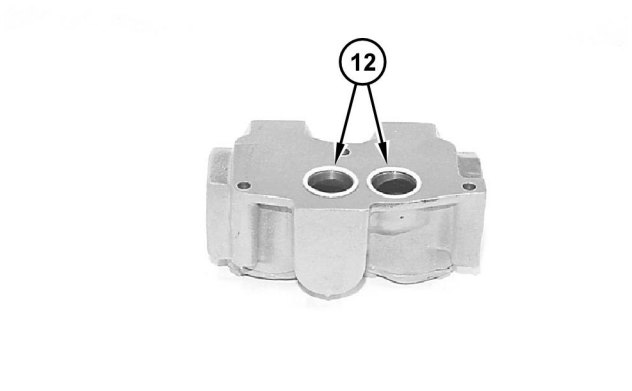


Illustration 268 g01247923

8. Install O-ring seals (12).

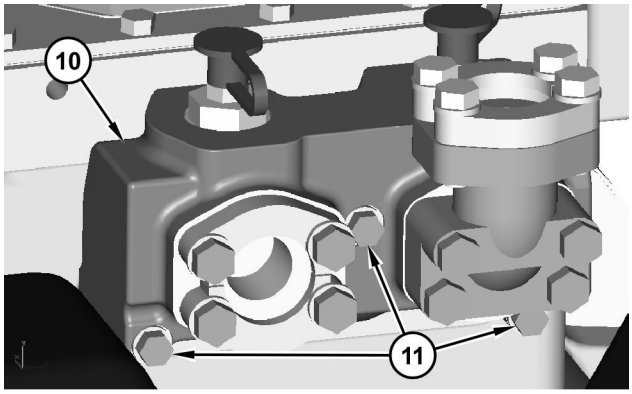


Illustration 269 g01247829

9. Position manifold (10) and install bolts (11).

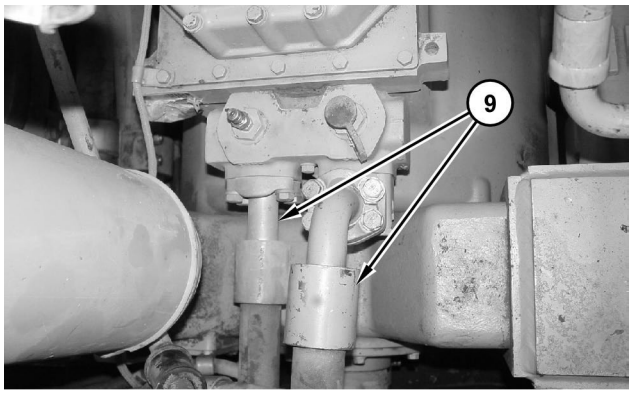


Illustration 270 g01247813

10. Connect hose assemblies (8).

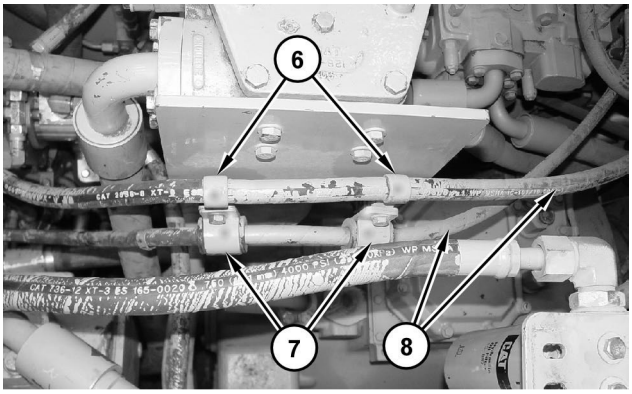


Illustration 271 g01247810

11. Position hose assemblies (8) and install clips (7) and clips (6).

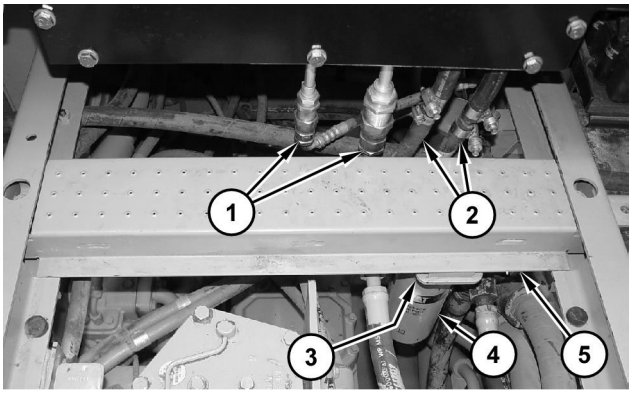


Illustration 272 g01247801

12. Install brace (5).

13. Position filter base (4) and install bolts (3).

14. Connect hoses (2). Connect hose assemblies (1).

15. Turn the heater control valves to the ON position.

16. Close the access door behind the cab.

i02495166

Magnetic Filter Screen and Housing - Remove

SMCS Code: 3159-012-MGS

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, "Steering Frame Lock - Separate and Connect".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help prevent fluid loss and this will help to prevent contaminants from entering the system.

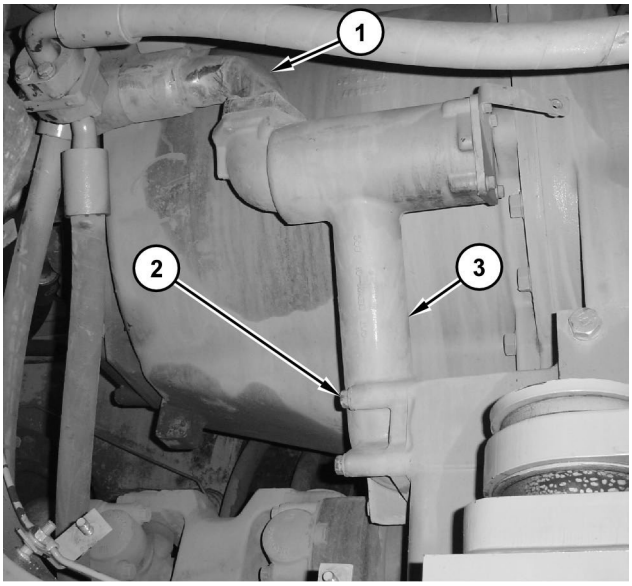


Illustration 273 g01247555

1. Drain the output transfer gear case into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Transmission oil - Change”.

2. Disconnect hose assembly (1).

3. Remove bolts (2).

4. Remove magnetic filter screen and housing assembly (3) from the output transfer gear case.

i02495169

Magnetic Filter Screen and Housing - Disassemble

SMCS Code: 3159-015-MGS

Disassembly Procedure

Start By:

a. Remove the magnetic filter screen tube assembly. Refer to Disassembly and Assembly, “Magnetic Filter Screen and Housing - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

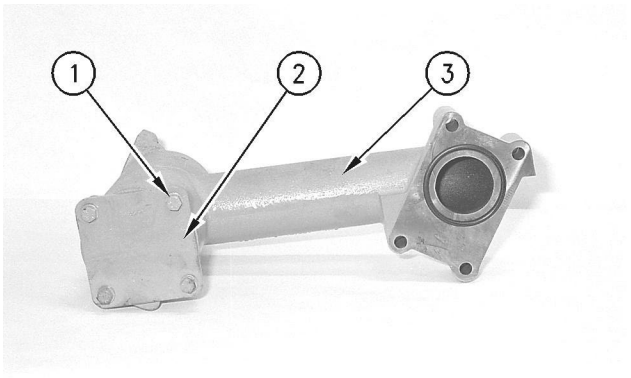


Illustration 274 g00865254

1. Remove bolts (1).

2. Remove cover (2) from magnetic filter screen housing (3).

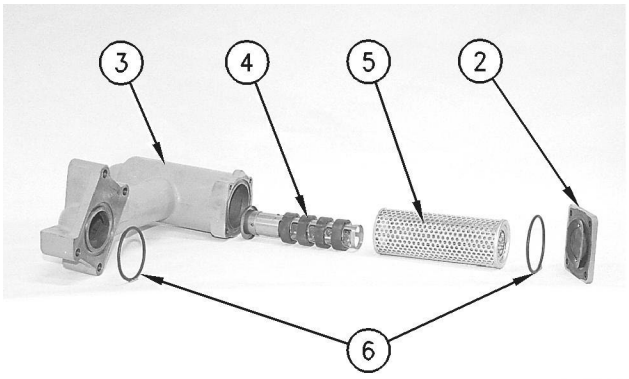


Illustration 275 g00865255

3. Remove tube assembly (4), suction screen (5), and O-ring seals (6) from magnetic filter screen housing (3).

i02495170

Magnetic Filter Screen and Housing - Assemble

SMCS Code: 3159-016-MGS

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

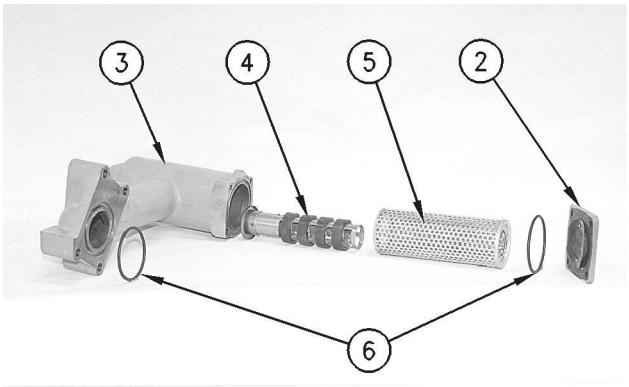


Illustration 276 g00865255

1. Install O-ring seals (6) into cover (2) and magnetic filter screen housing (3).

2. Install tube assembly (4) and suction screen (5) into magnetic filter screen housing (3).

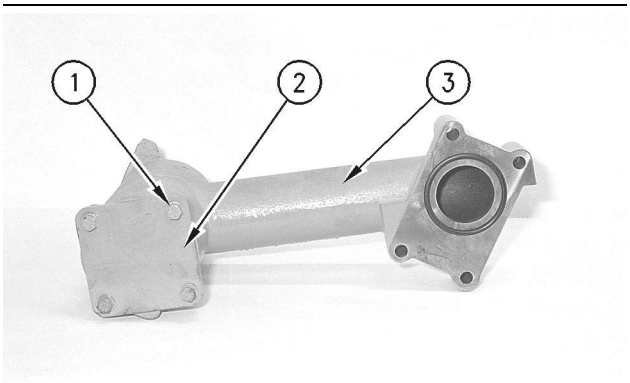


Illustration 277 g00865254

3. Install cover (2) and bolts (1) onto magnetic filter screen housing (3).

End By:

a. Install the magnetic filter screen tube assembly. Refer to Disassembly and Assembly, “Magnetic Filter Screen and Housing - Install”.

i02495167

Magnetic Filter Screen and Housing - Install

SMCS Code: 3159-012-MGS

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

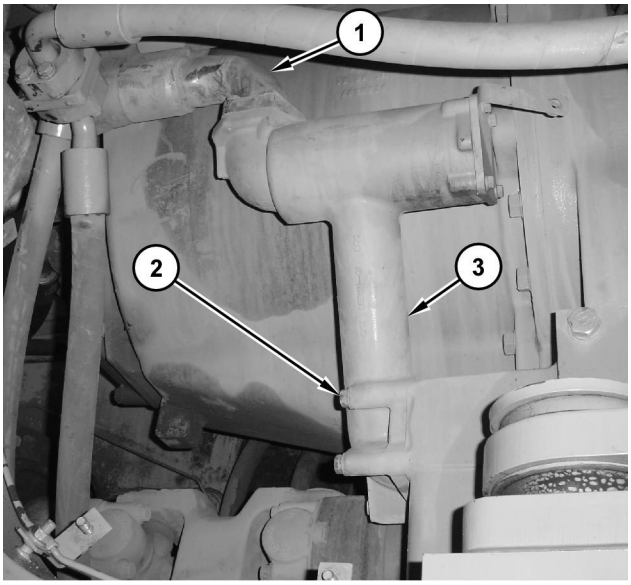


Illustration 278 g01247555

1. Install magnetic filter screen and housing assembly (3).

2. Install bolts (2) onto the output transfer gear case.

3. Connect hose assembly (1).

4. Fill the output transfer gear case. Refer to Operation and Maintenance Manual, “Transmission oil - Change”.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02496583

Transmission and Transfer Gears - Remove

SMCS Code: 3002-011-IV; 3002-011-OJ

Removal Procedure

Table 11

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	138-7575	Link Bracket	2
C	1U-9204	Lever Puller Hoist	1
D	140-7742	Sleeve	2

Start By:

a. Remove the cab. Refer to Disassembly and Assembly, “Cab - Remove”.

b. Remove the input drive shaft. Refer to Disassembly and Assembly, “Input Drive Shaft - Remove and Install”.

c. Remove the rear drive shaft. Refer to Disassembly and Assembly, “Drive Shaft (Rear) - Remove and Install”.

d. Remove the transmission filter housing. Refer to Disassembly and Assembly, “Magnetic Filter Screen and Housing - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

At operating temperature the implement hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible injury, release the pressure in the implement hydraulic system before hydraulic lines or components are disconnected or removed.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

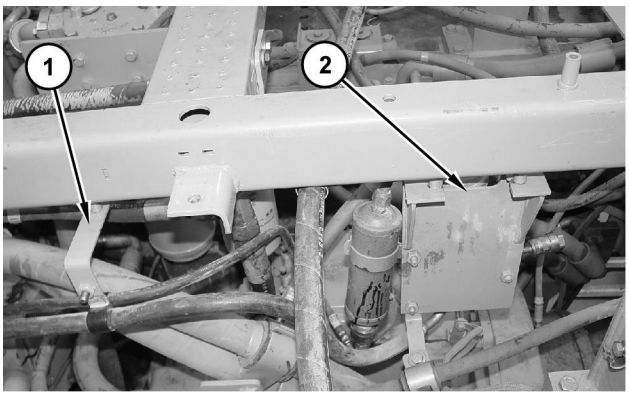


Illustration 279 g01248669

1. Disconnect bracket (1) and position the bracket out of the way.

2. Disconnect bracket (2) and position the bracket out of the way.

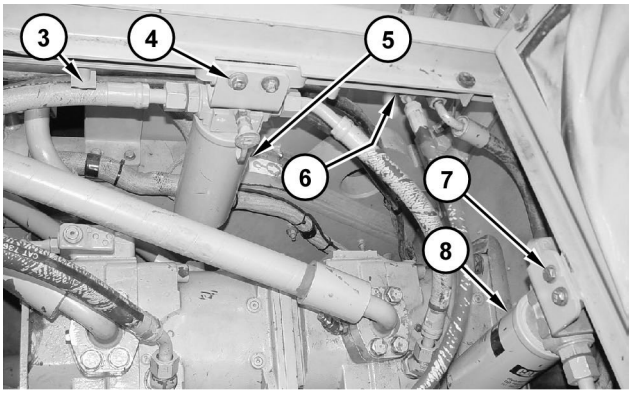


Illustration 280 g01248681

3. Disconnect bracket (3). Remove bolts (4) and position filter base assembly (5) out of the way. Remove bolts (6). Remove bolts (7) and position filter base assembly (8) out of the way.

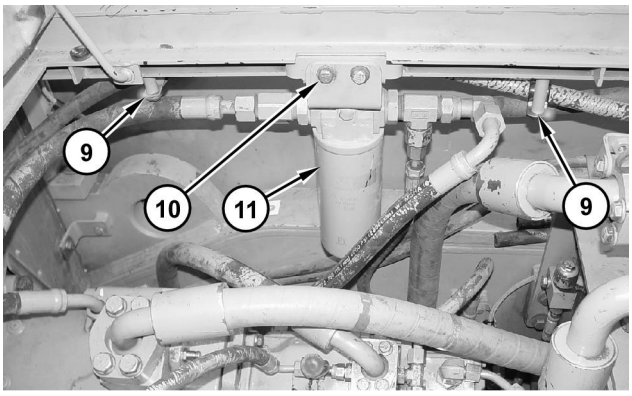


Illustration 281 g01248687

4. Remove clips (9). Remove bolts (10) and position filter base assembly (11) out of the way.

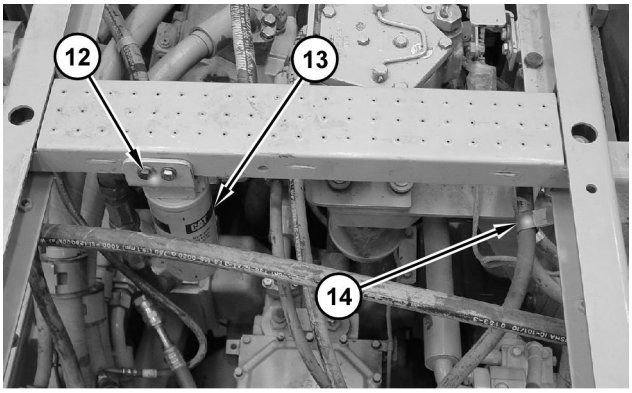


Illustration 282 g01248691

5. Remove bolts (12) and position filter base assembly (13) out of the way. Remove clip (14).

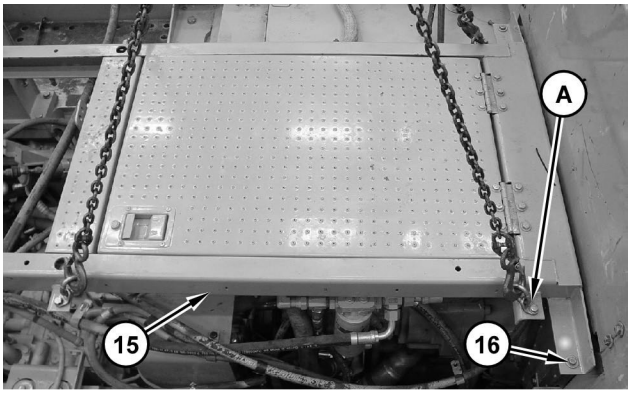


Illustration 283 g01248696

6. Attach Tooling (A) and a suitable lifting device onto panel assembly (15). The weight of panel assembly (15) is approximately 82 kg (180 lb).

7. Remove bolts (16) from both ends of panel assembly (15) in order to remove panel assembly (15).

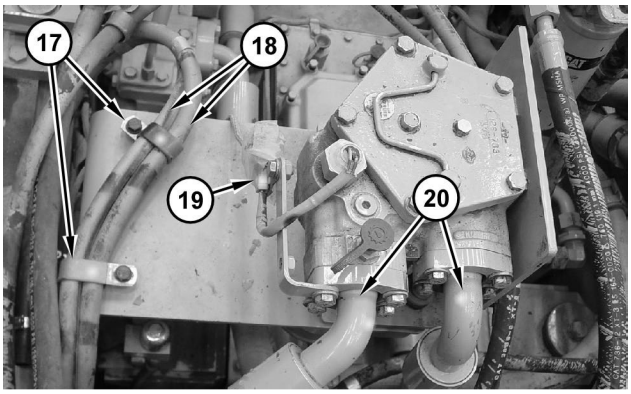


Illustration 284 g01248712

8. Remove clips (17) and position hoses (18) out of the way.

9. Disconnect harness assembly (19).

10. Disconnect hose assemblies (20).

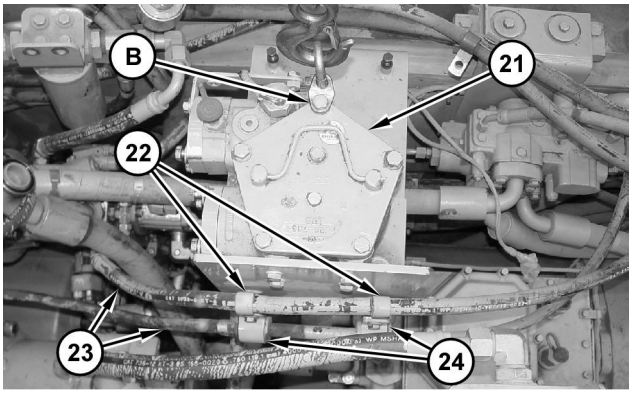


Illustration 285 g01248719

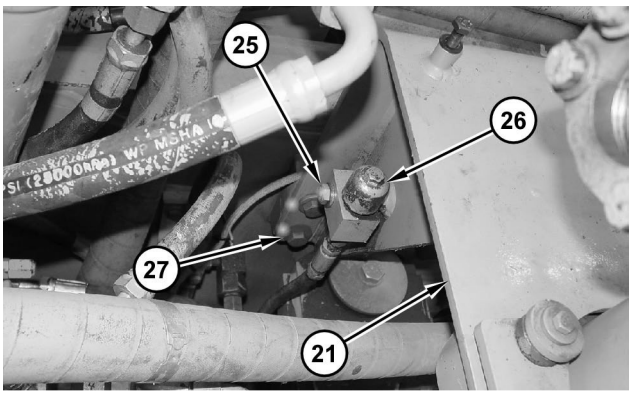


Illustration 286 g01248842

11. Attach Tooling (B) onto transmission filter (21).

12. Remove clips (22) and clips (24). Position hose assemblies (23) out of the way.

13. Remove bolt (25) and position oil breather (26) out of the way.

14. Remove bolts (27).

15. Use Tooling (B) and a suitable lifting device in order to remove transmission filter (21). The weight of transmission filter (21) is approximately 70 kg (155 lb).

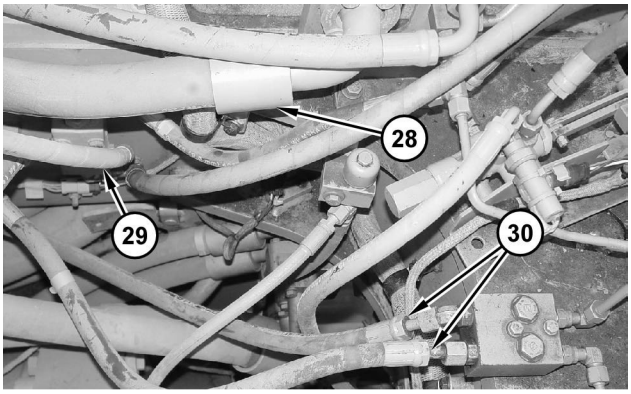


Illustration 287 g01248893

16. Disconnect hose assembly (28). Disconnect hose assembly (29). Disconnect hose assemblies (30).

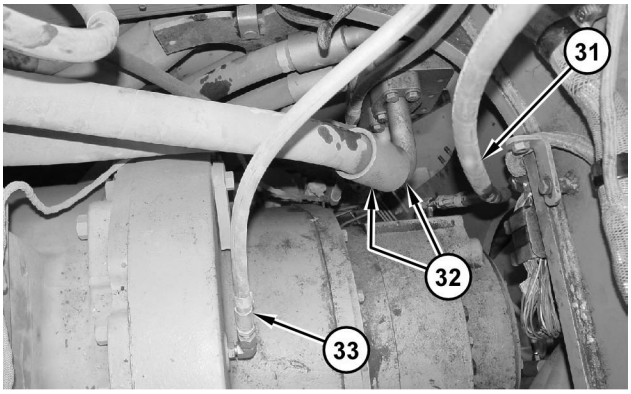


Illustration 288 g01248909

17. Disconnect hose assembly (31). Disconnect hose assemblies (32). Disconnect hose assembly (33).

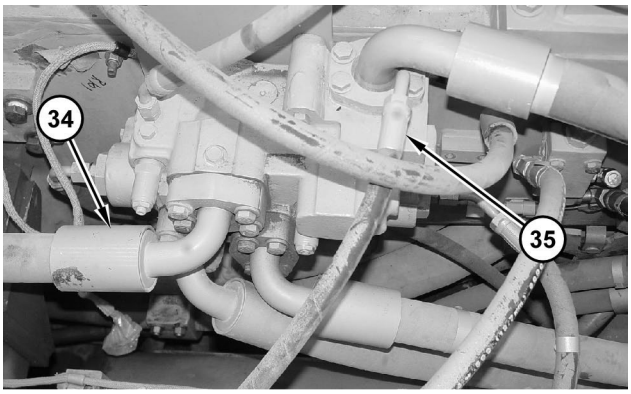


Illustration 289 g01248917

18. Disconnect hose assembly (34). Disconnect hose assembly (35).

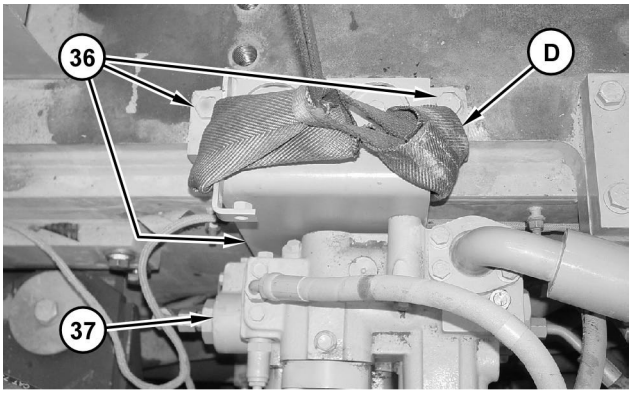


Illustration 290 g01248929

19. Attach Tooling (D) and a suitable lifting device onto steering valve (37). The weight of steering valve (37) is approximately 79 kg (175 lb).

20. Remove bolts (36). Use Tooling (D) and a suitable lifting device in order to remove steering valve (37).

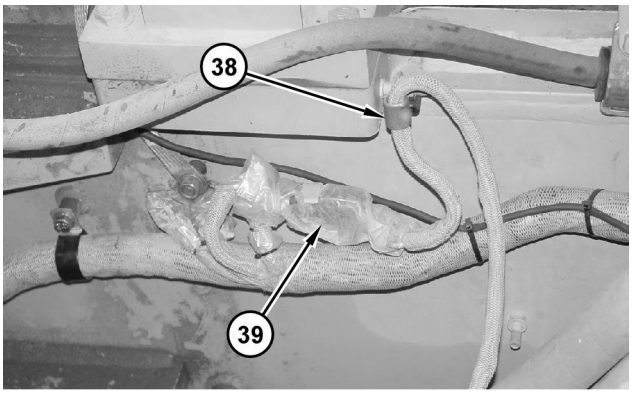


Illustration 291 g01249064

21. Remove clip (38) and disconnect harness assembly (39).

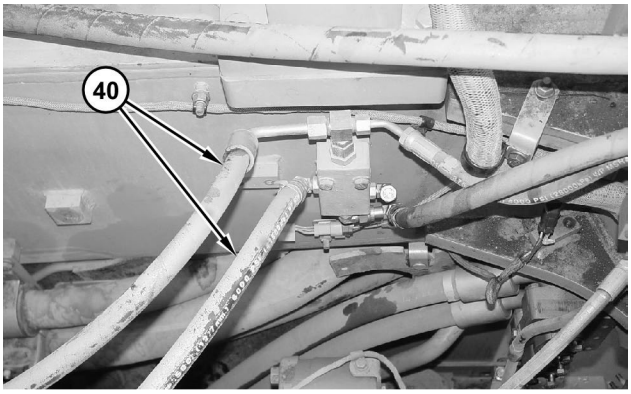


Illustration 292 g01249068

22. Disconnect hose assemblies (40).

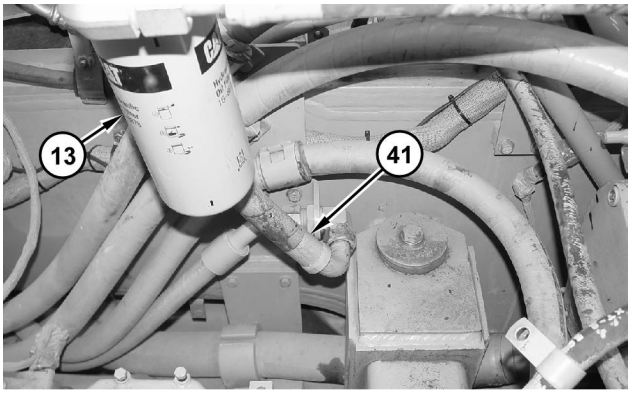


Illustration 293 g01249106

23. Disconnect hose assembly (41) and position filter base assembly (13) out of the way.

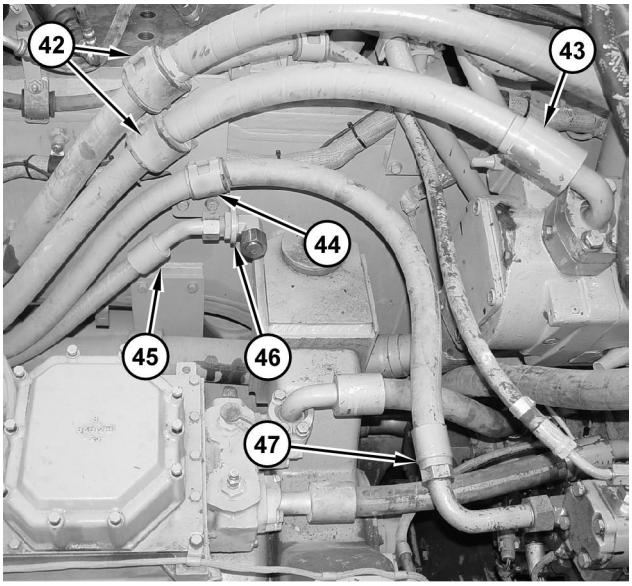


Illustration 294 g01249113

24. Remove clips (42). Disconnect hose assembly (43). Remove clip (44). Disconnect hose assembly (45). Remove bracket (46). Disconnect hose assembly (47).

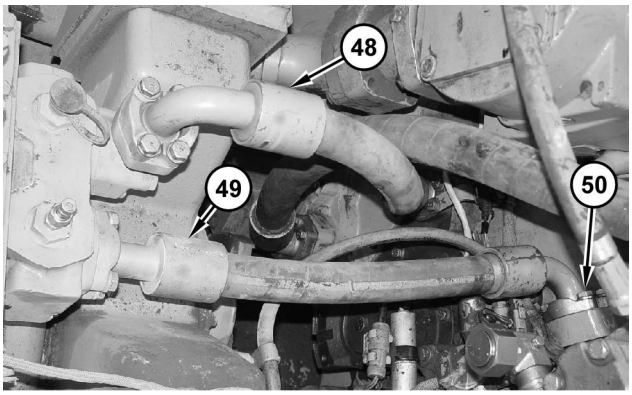


Illustration 295 g01249119

25. Disconnect hose assembly (48). Disconnect hose assembly (49).

26. Loosen bolts (50) in order to position hose assembly (49) out of the way.

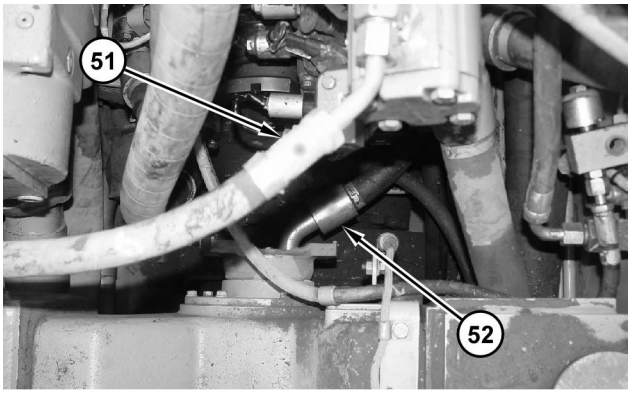


Illustration 296 g01249127

27. Disconnect hose assembly (51). Disconnect hose assembly (52).

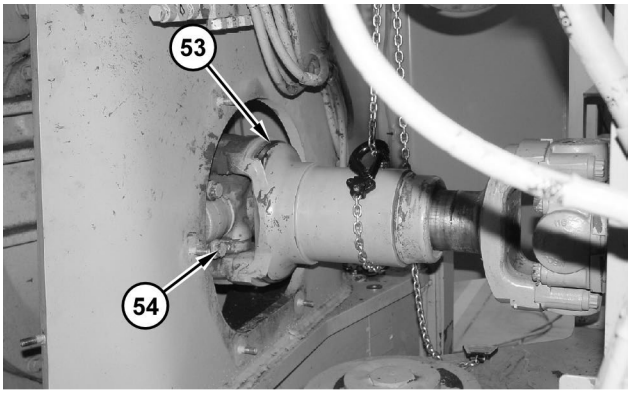


Illustration 297 g01248810

28. Attach a suitable lifting device onto center drive shaft (53). The weight of center drive shaft (53) is approximately 82 kg (180 lb). Remove bolts (54) in order to disconnect center drive shaft (53).

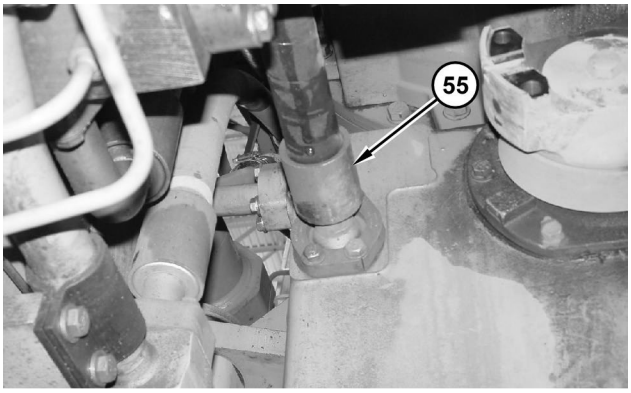


Illustration 298 g01249133

29. Disconnect hose assembly (55).



Illustration 299 g01249142

30. Remove tube assembly (56).

31. Remove sight gauge (57).

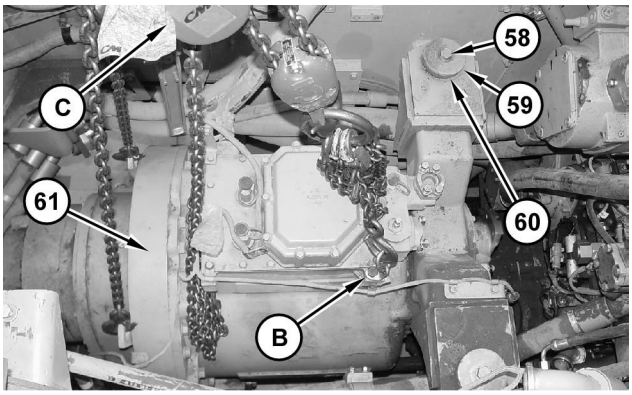


Illustration 300 g01249146

32. Attach Tooling (B), Tooling (C), and a suitable lifting device onto transmission and transfer gears (61). The weight of transmission and transfer gears (61) is approximately 2631 kg (5800 lb).

33. Use Tooling (B), Tooling (C), and a suitable lifting device in order to support the weight of transmission and transfer gears (61).

34. Remove bolts (58), washers (59), and mount assemblies (60) from both side of transmission and transfer gears (61).

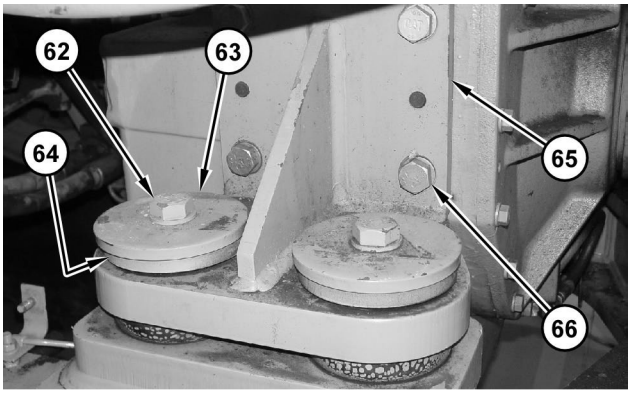


Illustration 301 g01249203

35. Remove bolts (62), washers (63), and mount assemblies (64) from transmission mounting bracket (65).

36. Remove bolts (66).

37. Use two people in order to remove transmission mounting bracket (65). The weight of transmission mounting bracket (65) is approximately 32 kg (70 lb).

38. Repeat Steps 35 through 37 for the opposite side.

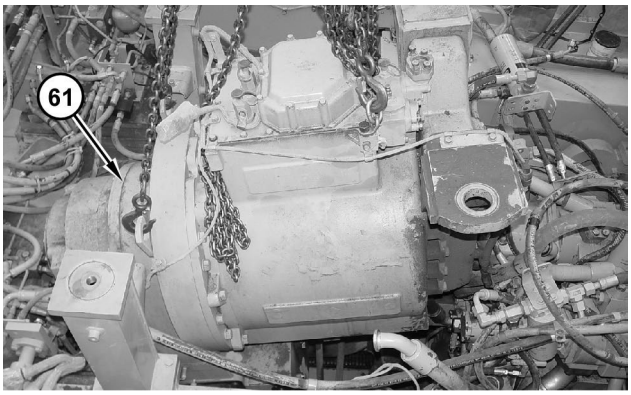


Illustration 302 g01249208

39. Remove the transmission and transfer gears (61). The weight of transmission and transfer gears (61) is approximately 2631 kg (5800 lb).

Note: Transmission and transfer gears (61) must be removed at an angle with the rear of the transmission upward.

i02505298

Transmission from Transfer Gears - Separate

SMCS Code: 3002-076-IV; 3002-076-OJ

Separation Procedure

Table 12

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	4

Start By:

a. Remove the transmission and transfer gears. Refer to Disassembly and Assembly Manual, "Transmission and Transfer Gears - Remove".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

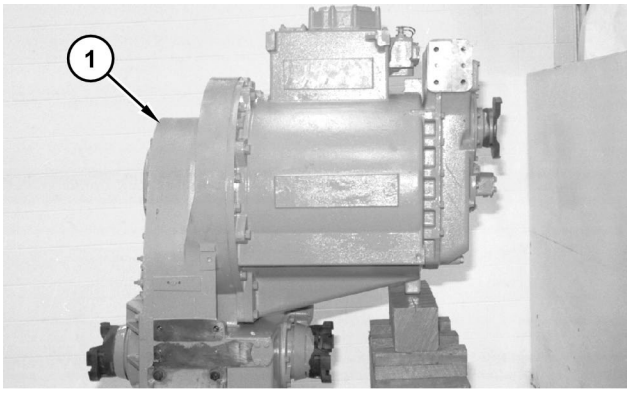


Illustration 303 g01254282

1. Place transmission and transfer gears (1) on suitable blocks, as shown. The weight of transmission and transfer gears (1) is approximately 2306 kg (5080 lb).

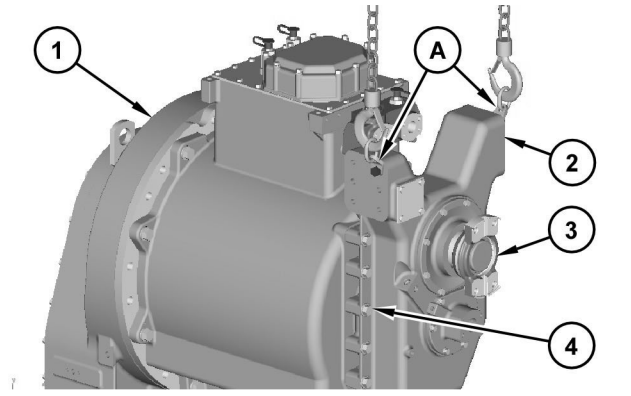


Illustration 304 g01254250

2. Remove yoke assembly (3) from input transfer gears (2).

3. Attach Tooling (A) and a suitable lifting device onto input transfer gears (2), as shown.

4. Remove bolts (4).

5. Use Tooling (A) and the suitable lifting device in order to separate and remove input transfer gears (2) from transmission and transfer gears (1). The weight of input transfer gears (2) is approximately 173 kg (380 lb).

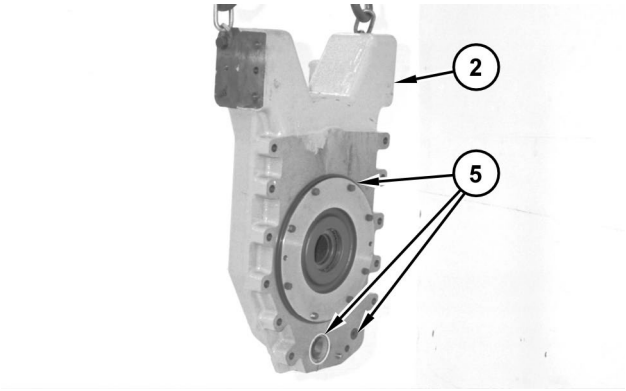


Illustration 305 g01254285

6. Remove O-ring seals (5) from input transfer gears (2).

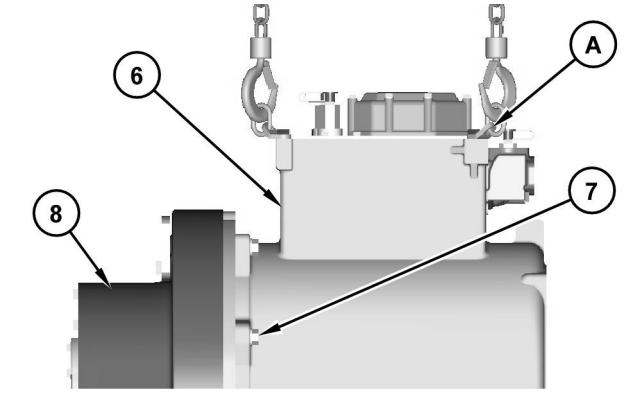


Illustration 306 g01254270

7. Attach Tooling (A) and a suitable lifting device onto transmission (6), as shown.

8. Remove bolts (7).

9. Use Tooling (A) and the suitable lifting device in order to remove transmission (6) from output transfer gears (8). The weight of transmission (6) is approximately 1226 kg (2700 lb). The weight of output transfer gears (8) is approximately 908 kg (2000 lb).

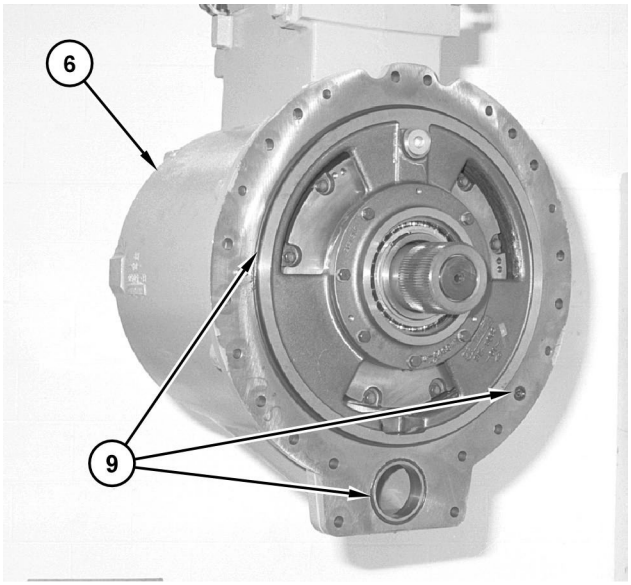


Illustration 307 g01254271

10. Remove O-ring seals (9) from transmission (6).

11. Place transmission (6) on a suitable transmission stand.

i02499644

Input Transfer Gears - Disassemble

SMCS Code: 3159-015-IV

Disassembly Procedure

Table 13

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1H-3112	Bearing Cup Puller	1
	8B-7548	Push-Puller Tool Gp	1
B	8B-7548	Push-Puller Tool Gp	1
	8B-7551	Bearing Puller	1
	8H-0684	Ratchet Wrench	1
	8B-7560	Step Plate	1
C	8B-7548	Push-Puller Tool Gp	1
	8B-7551	Bearing Puller	1
	8H-0684	Ratchet Wrench	1
	8B-7560	Step Plate	1
	1P-0510	Driver Gp	1

Start By:

a. Separate the transfer gears from the transmission. Refer to Disassembly and Assembly, “Transmission from Transfer Gears - Separate”.

1. Place the input transfer gears on suitable blocks.

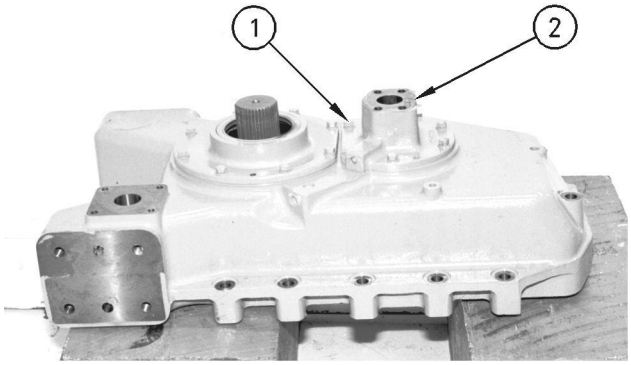


Illustration 308 g00862308

2. Remove bolts (1) from manifold (2).

Note: Bolts (1) can be used as forcing screws in order to loosen manifold (2).

3. Remove manifold (2).

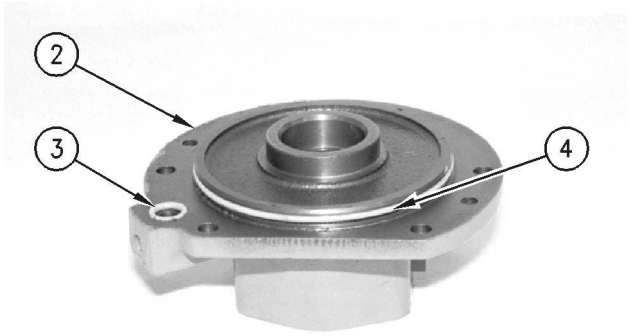


Illustration 309 g00862309

4. Remove O-ring seal (3) and O-ring seal (4) from manifold (2).

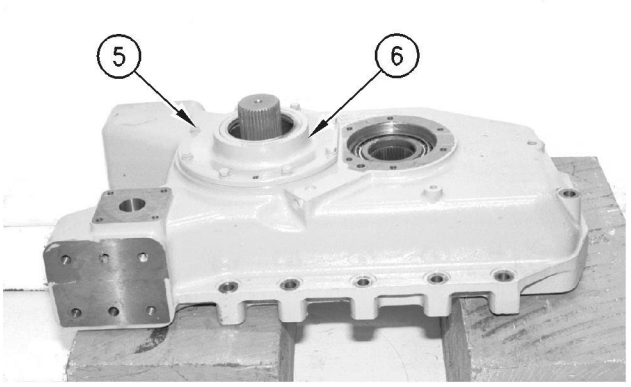


Illustration 310 g00862310

5. Remove bolts (5) from input bearing cage (6).

Note: Bolts (5) can be used as forcing screws in order to loosen input bearing cage (6).

6. Remove input bearing cage (6) from the transfer case assembly.



Illustration 311 g00862311

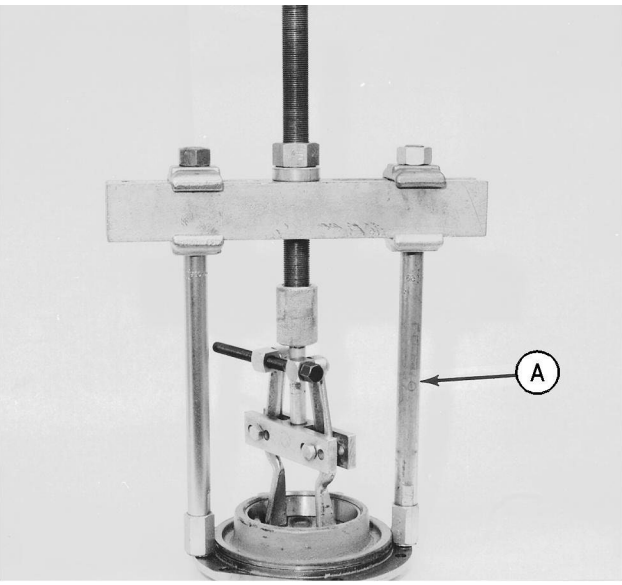


Illustration 312 g00512372
Typical Example

7. Remove O-ring seal (7) from the bearing cage.

8. Use Tooling (A) in order to remove bearing cup (8) from the bearing cage.

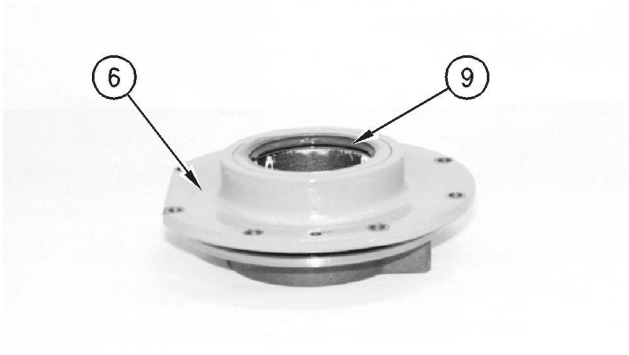


Illustration 313 g00862312

9. Remove lip seal (9) from input bearing cage (6).

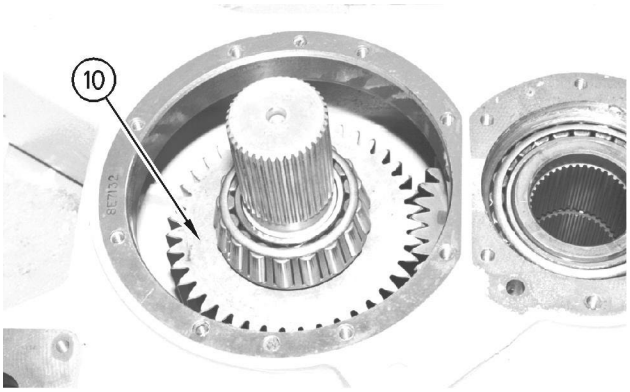


Illustration 314 g00862313

10. Remove input gear assembly (10) from the transfer case.

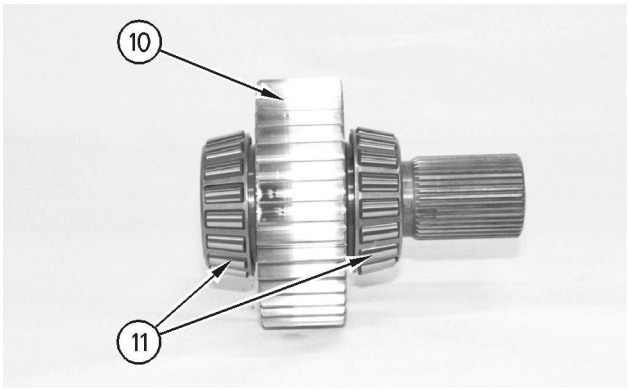


Illustration 315 g00862315

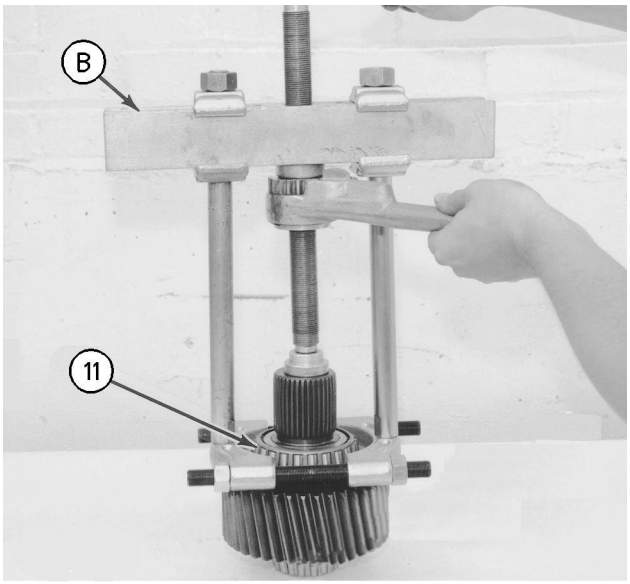


Illustration 316 g00862666

11. Use Tooling (B) in order to remove bearing cones (11) from input gear assembly (10).

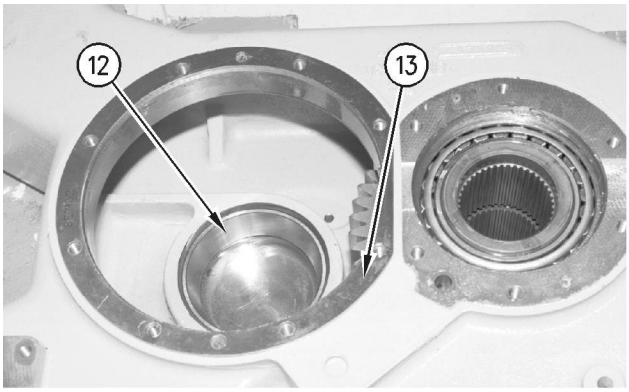


Illustration 317 g00862316

12. Use Tooling (A) in order to remove bearing cup (12).

13. Remove shim pack (13) from the transfer case assembly.

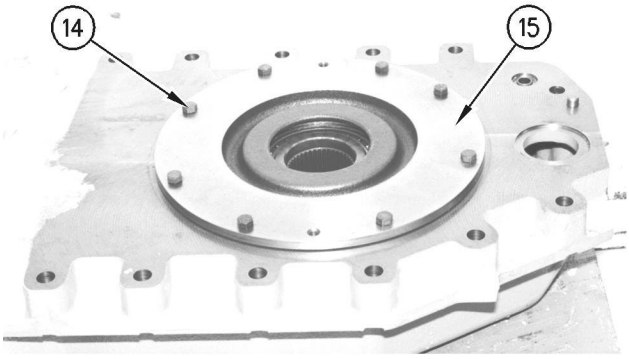


Illustration 318 g00862317

14. Turn over the transfer case assembly, as shown.

15. Remove bolts (14) from output bearing cage (15).

Note: Use bolts (14) as forcing screws, if necessary.



Illustration 319 g00862319

16. Use Tooling (A) in order to remove bearing cup (16) from output bearing cage (15).

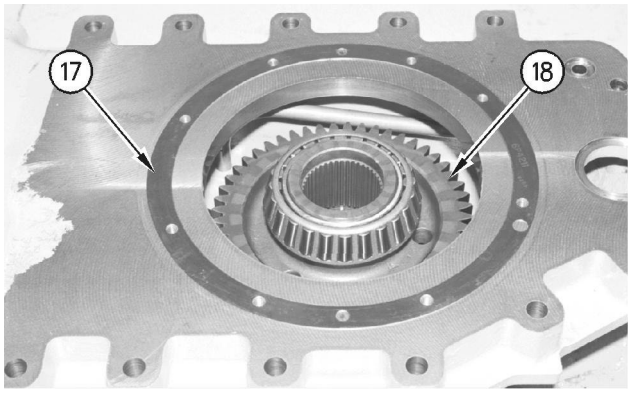


Illustration 320 g00862320

17. Remove shim pack (17) and output gear assembly (18) from transfer case assembly.

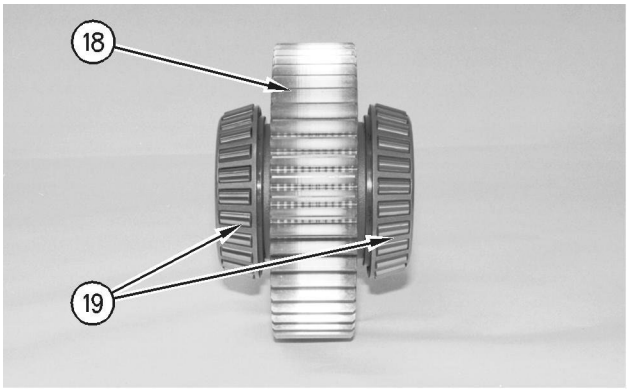


Illustration 321 g00862321

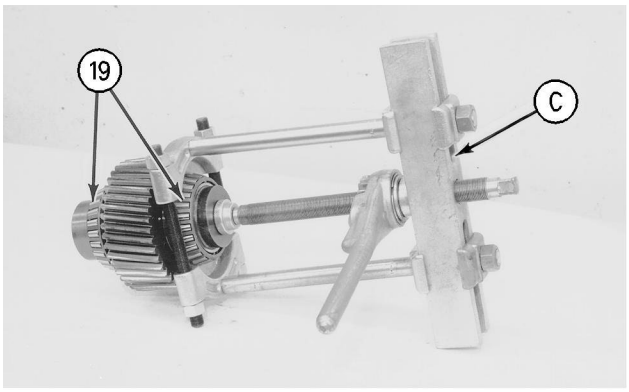


Illustration 322 g00862687
Typical Example

18. Use Tooling (C) in order to remove bearing cones (19) from output gear assembly (18).

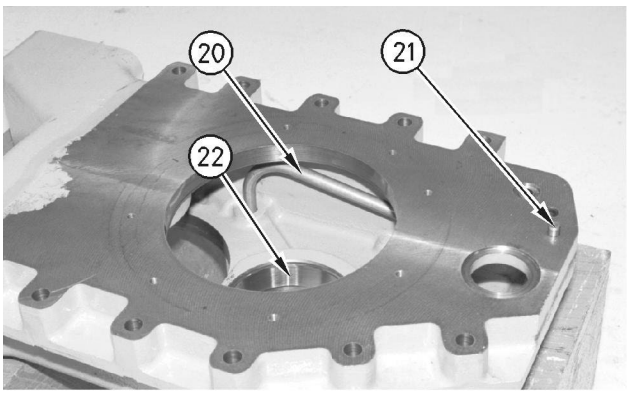


Illustration 323 g00862322

19. Remove tube (20) and dowel (21) from the transfer case assembly.

20. Use Tooling (A) in order to remove bearing cup (22).

i02499645

Input Transfer Gears - Assemble

SMCS Code: 3159-016-IV

Assembly Procedure

Table 14

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Group	1
B	1P-0520	Driver Gp	1

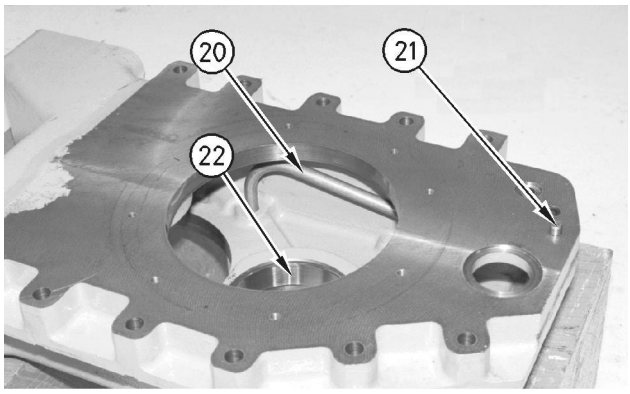


Illustration 324 g00862322

1. Place the transfer case in a horizontal position.

2. Lower the temperature of bearing cup (22). Install bearing cup (22) in the transfer case.

Note: The bearing cups must be seated in the transfer case.

3. Install tube (20) and dowel (21) into the transfer case assembly.

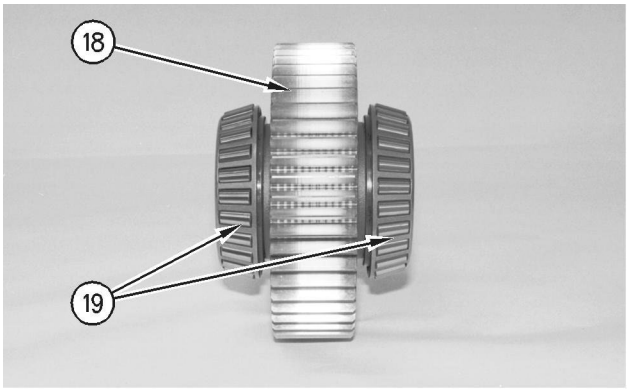


Illustration 325 g00862321

4. Raise the temperature of bearing cones (19) to a maximum temperature of 135 °C (275 °F). Install the bearings on output transfer gear (18).

Note: The bearing cones must be seated on the gear.

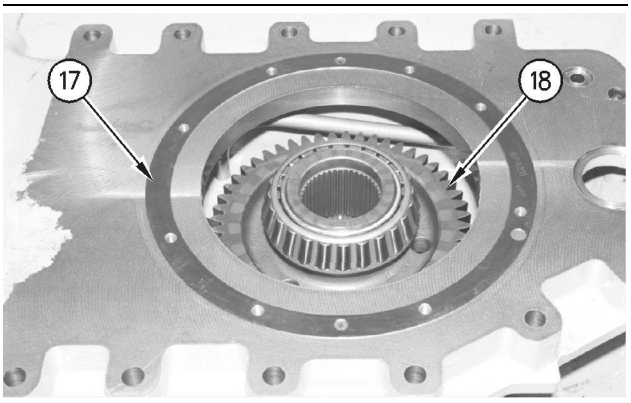


Illustration 326 g00862320

5. Install output transfer gear (18) and shim pack (17) in the transfer case assembly.



Illustration 327 g00862319

6. Lower the temperature of bearing cup (16) and install the bearing cup in the output bearing cage. The bearing cup (16) must be seated in output bearing cage (15).

7. The following steps are used in order to set the bearing end play for the lower transfer gear.

a. With the axis of the output gear in a vertical position, install output bearing cage (15) in the transfer case assembly. Make sure that the bearing cage does not bind in the transfer case assembly.

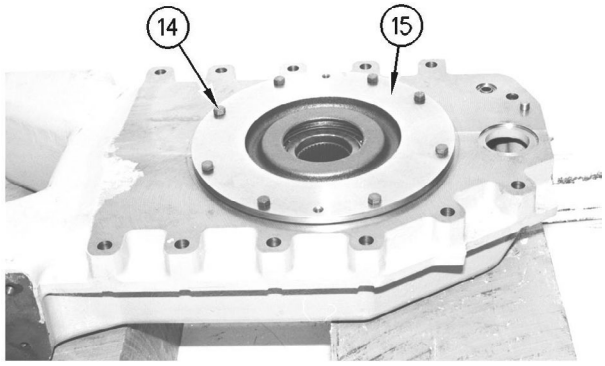


Illustration 328 g00662057

b. Install bolts (14). Tighten the bolts evenly to torque of 47 ± 9 N·m (35 ± 7 lb ft). Rotate the gear for a minimum of three revolutions or rotate the gear until the rolling resistance of the gear diminishes to a steady level.

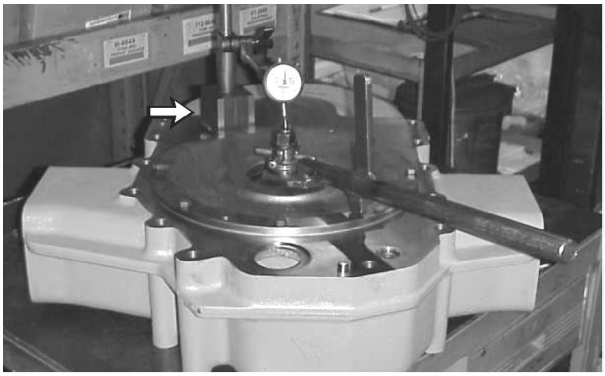


Illustration 329 g00661363
Typical Example

c. Mount Tooling (A) on the input transfer gear housing, as shown. Measure the end play of the gear assembly by lifting on the gear assembly.

Note: The desired end play for the gear is 0.152 mm (.0060 inch). The maximum end play for the gear is 0.203 mm (.0080 inch). The end play of the gear must be measured with a dial indicator in order to determine the correct gear end play.

d. If the end play is not within the correct range, perform Steps 7a through 7c again. Add or remove shims in order to achieve the correct end play.

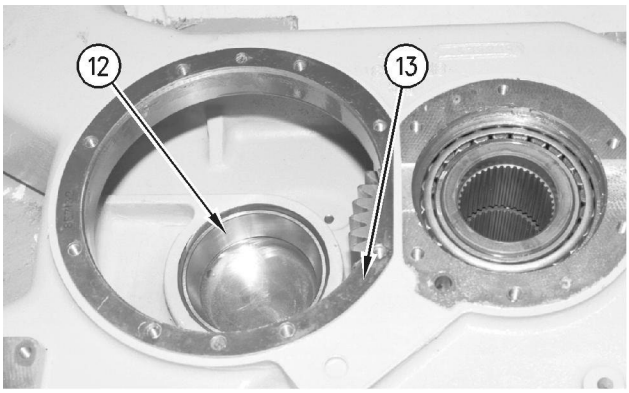


Illustration 330 g00862316

8. Turn over the transfer case assembly.

9. Lower the temperature of bearing cup (12) and install the bearing cup in the transfer case assembly. Use the appropriate equipment in order to handle the bearing cup. The bearing cup (12) must be seated in transfer case assembly.

10. Install shim pack (13).

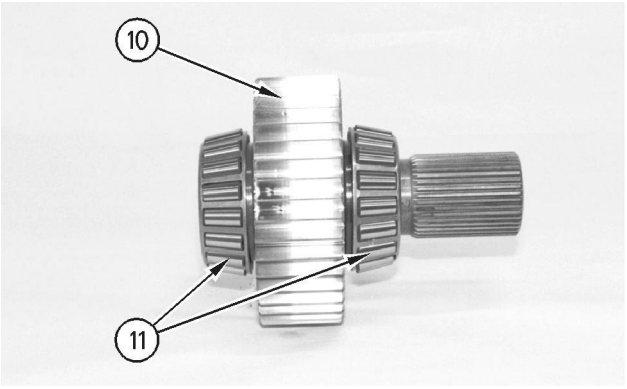


Illustration 331 g00862315

11. Raise the temperature of bearing cones (11) to a maximum temperature of 135 °C (275°F). Install the bearing cones on input transfer gear (10), as shown. The bearing cones must be seated on the gear properly.

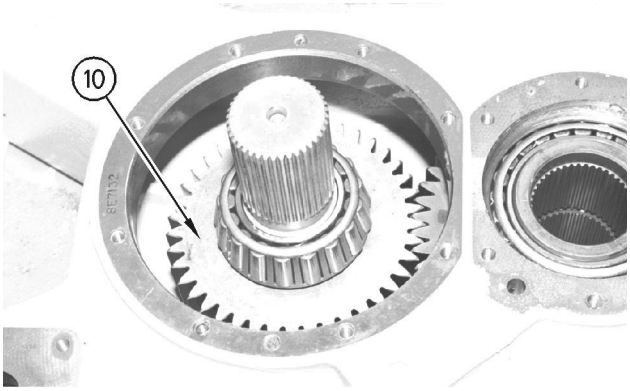


Illustration 332 g00862313

12. Install input gear (10) into the transfer case assembly.

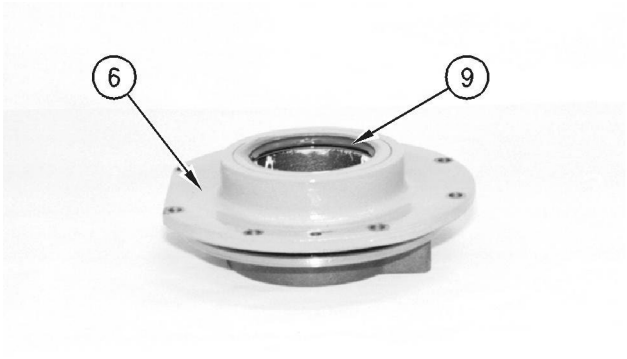


Illustration 333 g00862312

13. Install lip seal (9) into input bearing cage (6). Install the seal so that the lip is facing toward the outside of the input bearing cage. Install the seal until the seal makes contact with the counterbore in the bearing cage.



Illustration 334 g00862311

14. Lower the temperature of bearing cup (8) and install the bearing cup in the input bearing cage. Use the appropriate equipment in order to handle the bearing cup. The bearing cup (8) must be seated in input bearing cage (6).

15. Install O-ring seal (7) in input bearing cage.

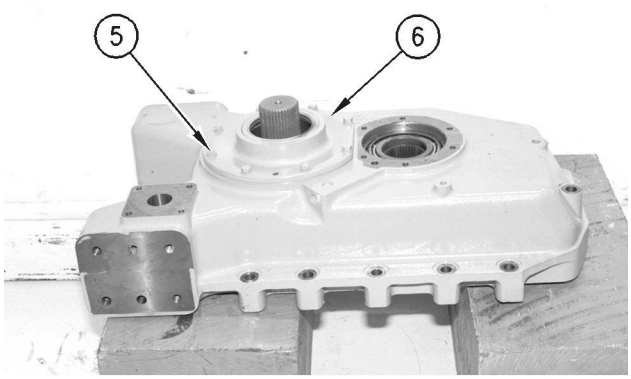


Illustration 335 g00661961

16. With the axis of the input gear in a vertical position, install input bearing cage (6) in the transfer case assembly. Make sure that the bearing cage does not bind in the transfer case assembly.

17. Install bolts (5). Tighten the bolts evenly to torque of 47 ± 9 N·m (35 ± 7 lb ft).

18. Rotate the shaft while tapping the shaft lightly with a mallet, for a minimum of three revolutions or until the rolling resistance of the gear diminishes to a steady level.

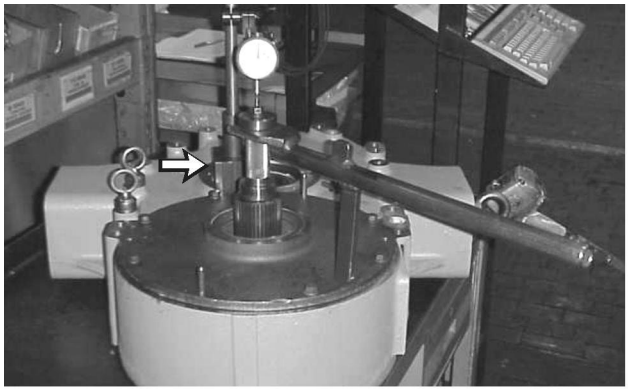


Illustration 336 g00661394
Typical Example

19. Attach Tooling (A) on the transfer case assembly, as shown.

20. Measure the end play of the gear assembly by lifting on the gear assembly.

Note: The desired end play for the gear is 0.152 mm (.0060 inch). The maximum end play for the gear is 0.203 mm (.0080 inch). The end play of the gear must be measured with a dial indicator in order to determine the correct gear end play.

21. If the end play is not within the correct range, repeat Steps 16 through 20. Add or remove shims in order to achieve the correct end play.

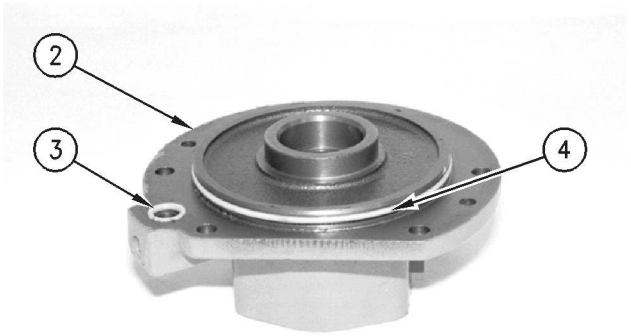


Illustration 337 g00862309

22. Install the O-ring seal (3) and O-ring seal (4) to manifold (2).

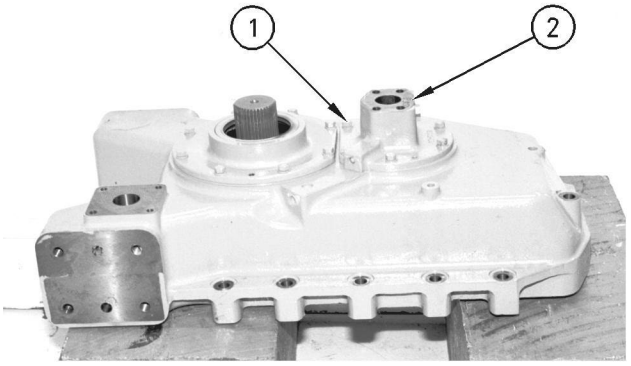


Illustration 338 g00862308

23. Use bolts (1) in order to install manifold (2) on the transfer case assembly.

End By:

a. Connect the transfer gears to the transmission. Refer to Disassembly and Assembly, “Transmission to Transfer Gears - Connect”.

i03454616

Output Transfer Gears - Disassemble

SMCS Code: 3075-015-OJ

Disassembly Procedure

Table 15

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-7409	Eyebolt	1
B	138-7575	Link Bracket	2
C	1P-0520	Driver Gp	1
D	5J-0490	Bolt	2

Start By:

a. Remove the transfer gears. Refer to Disassembly and Assembly, “Transmission from Transfer Gears - Separate” for the machine that is being serviced.

b. Remove the magnetic filter screen tube assembly. Refer to Disassembly and Assembly, “Magnetic Filter Screen and Housing - Remove”.

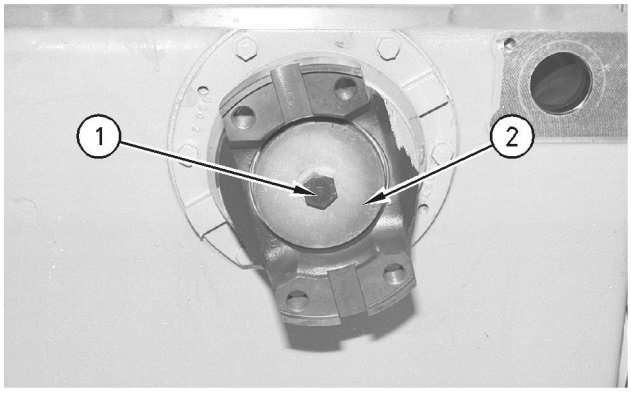


Illustration 339 g00865519

1. Remove bolt (1), retainer (2), and the O-ring seal from the transfer shaft.

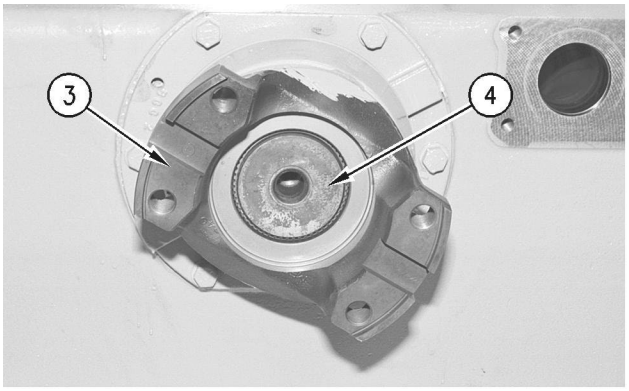


Illustration 340 g00865520

2. Remove yoke (3) from transfer shaft (4).

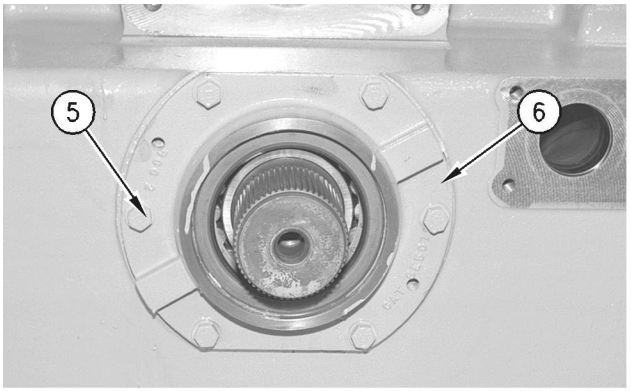


Illustration 341 g00865522

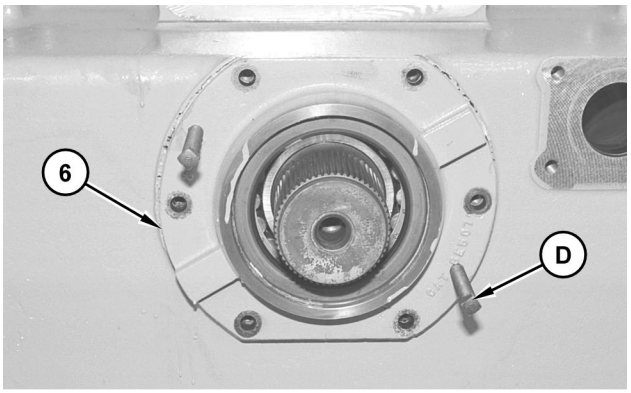


Illustration 342 g01249719

3. Remove bolts (5) from bearing cage (6).

4. Use Tooling (D) in order to separate bearing cage (6) from the transfer gear case. Tighten Tooling (D) evenly in order to separate the bearing cage from the transfer gear case assembly.

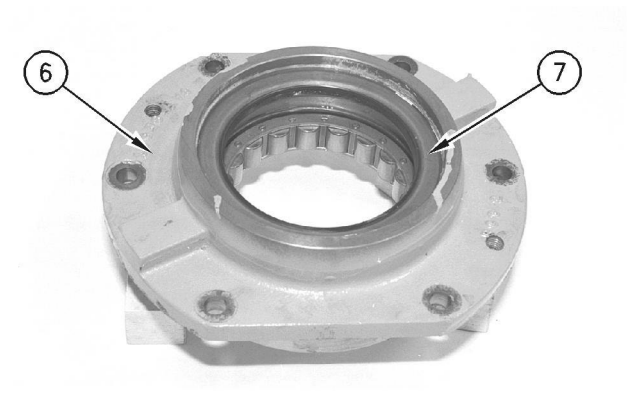


Illustration 343 g00865524

5. Remove lip seal (7) from bearing cage (6).

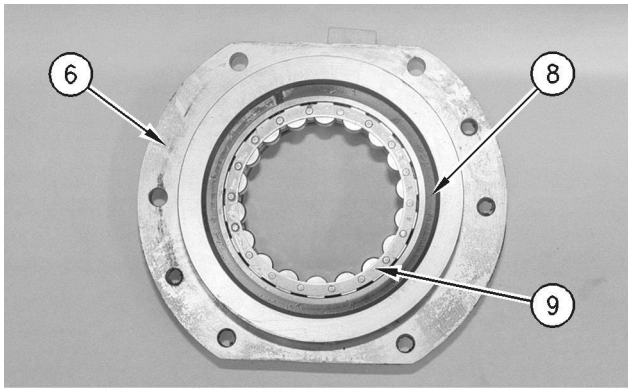


Illustration 344 g00865525

6. Remove ring (8), the race, and roller assembly (9) from bearing cage (6).

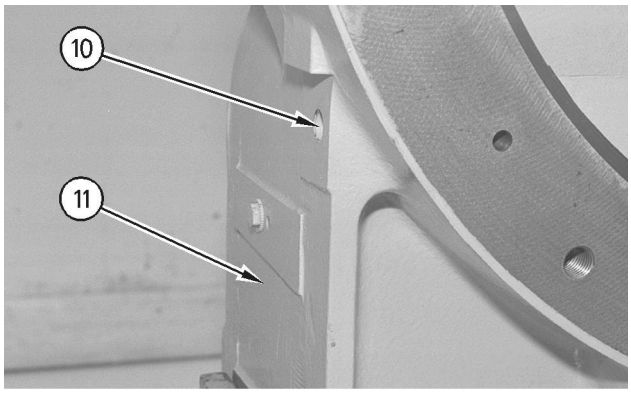


Illustration 345 g00865526

7. Remove cup plug (10) from transfer gear case assembly (11).

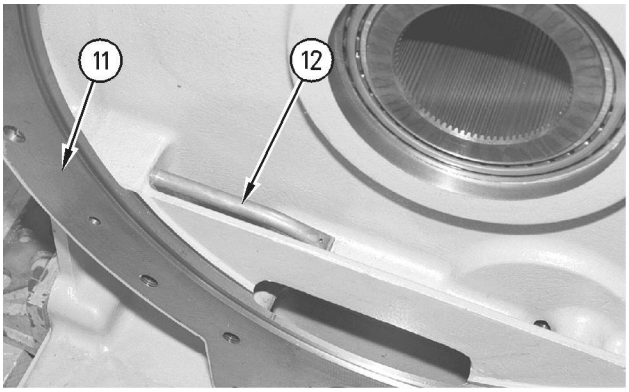


Illustration 346 g00865527

8. Remove tube (12) from transfer gear case assembly (11), if necessary.

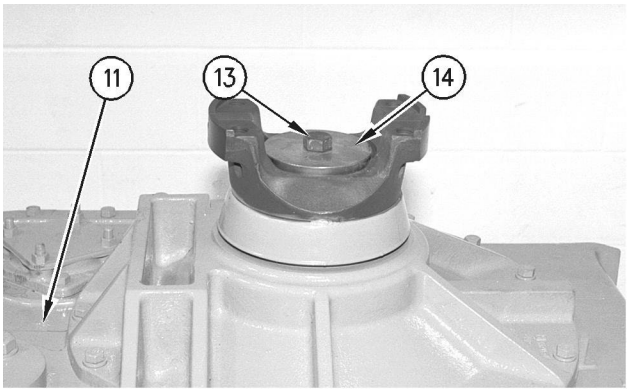


Illustration 347 g00865529

9. Position transfer gear case assembly (11), as shown.

10. Remove bolt (13), retainer (14), and the seal.

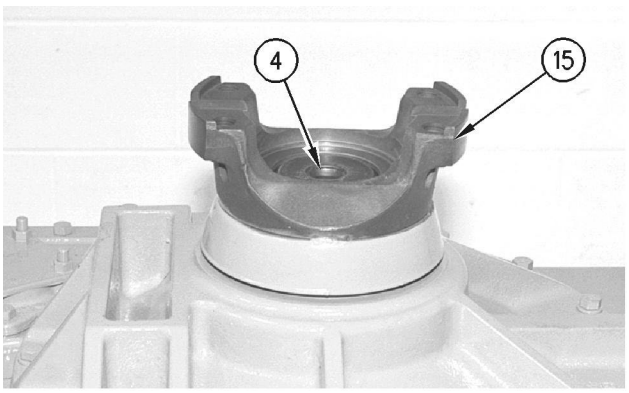


Illustration 348 g00865530

11. Remove yoke (15) from transfer shaft (4).

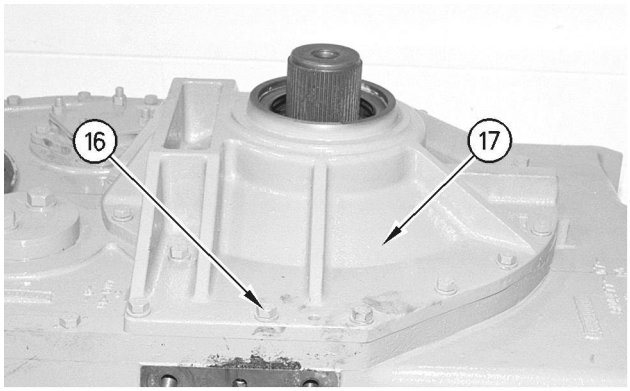


Illustration 349 g00865531

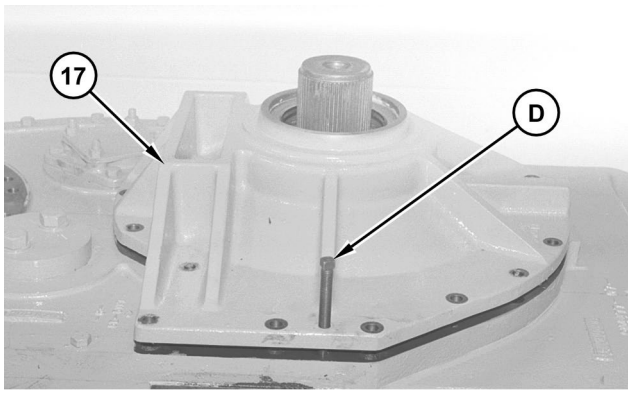


Illustration 350 g01249736

12. Remove bolts (16) from output bearing cage assembly (17).

13. Use Tooling (D) in order to separate output bearing cage (17) from the transfer gear case. Tighten Tooling (D) evenly in order to separate output bearing cage (17) from the transfer gear case.

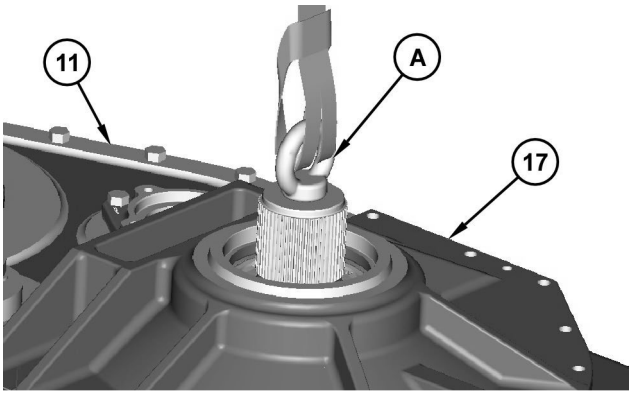


Illustration 351 g01249746

14. Install Tooling (A) onto transfer shaft (4).

15. Use Tooling (A) and a suitable lifting device in order to remove output bearing cage assembly (17) from transfer gear case assembly (11). The weight of bearing cage assembly (17) is 254 kg (560 lb).

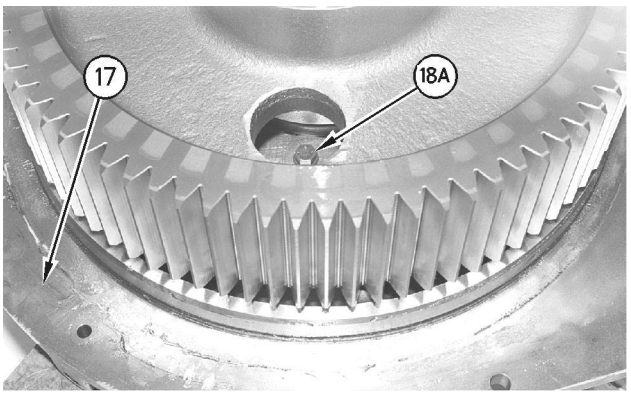


Illustration 352 g00865540

16. Turn over the output bearing cage assembly.

17. Remove bolts (18A) from output bearing cage assembly (17).

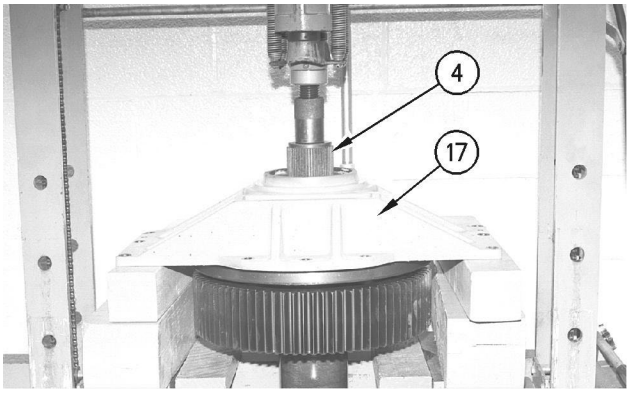


Illustration 353 g00865542

18. Position output bearing cage assembly (17) on a suitable press.

19. Press transfer shaft (4) from output bearing cage assembly (17), as shown.

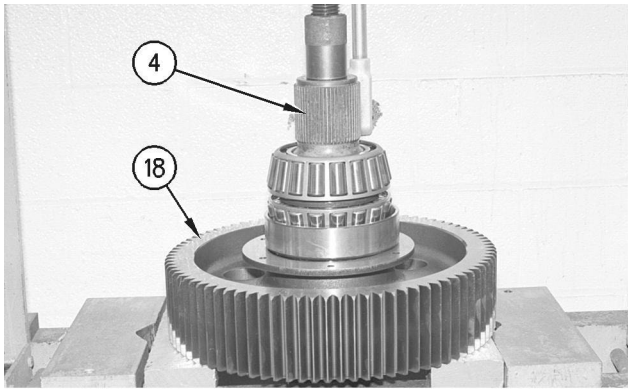


Illustration 354 g00865543

20. Press transfer shaft (4) through output gear (18), as shown. The weight of transfer shaft (4) is approximately 68 kg (150 lb). The weight of output gear (18) is approximately 79 kg (175 lb).

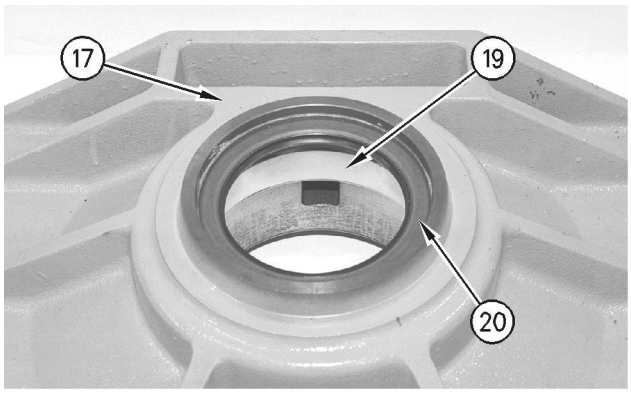


Illustration 355 g00865545

21. Remove bearing cup (19) and lip seal (20) from output bearing cage assembly (17).

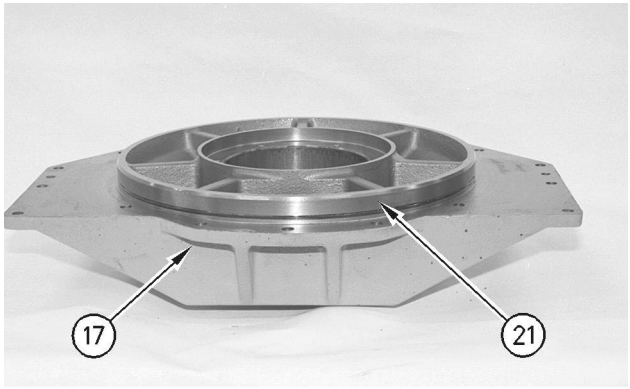


Illustration 356 g00865546

22. Turn output bearing cage assembly (17), as shown.

23. Remove O-ring seal (21).

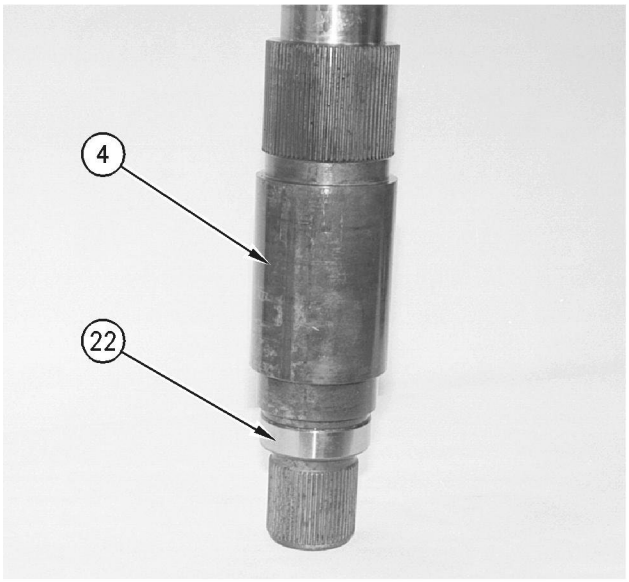


Illustration 357 g00865547

24. Remove bearing race (22) from transfer shaft (4).

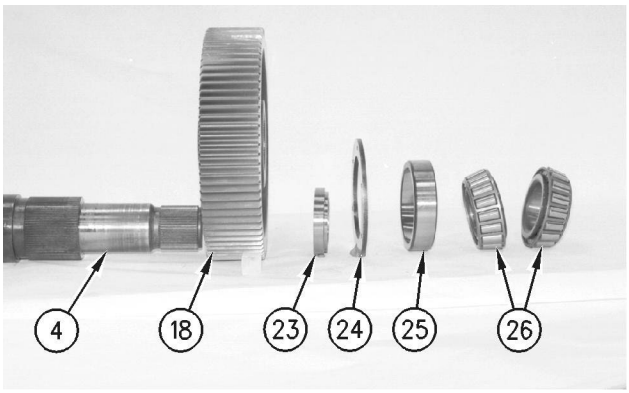


Illustration 358 g00865548

25. Remove bearing cones (26), bearing cup (25), retainer (24), spacer (23), and output gear (18) from transfer shaft (4).

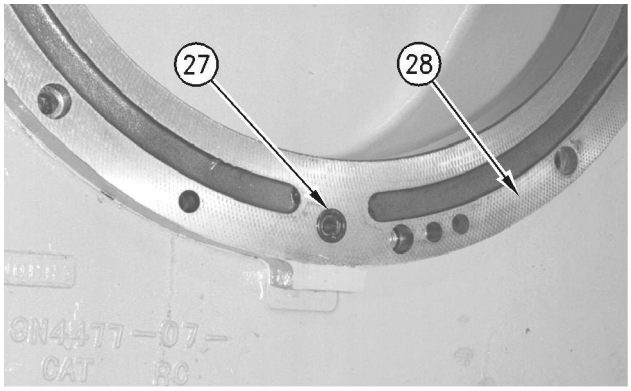


Illustration 359 g00865562

26. Remove O-ring seal (27) from cover (28).

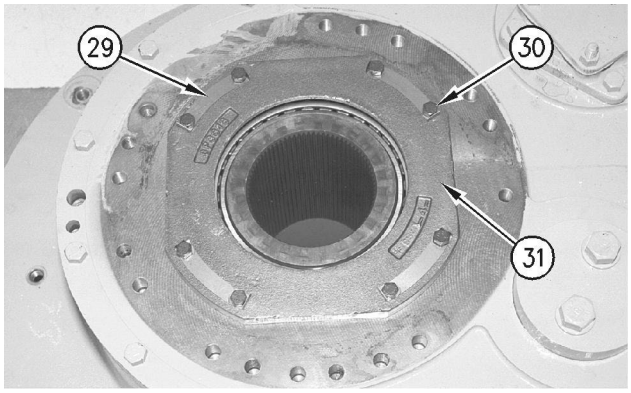


Illustration 360 g00865563

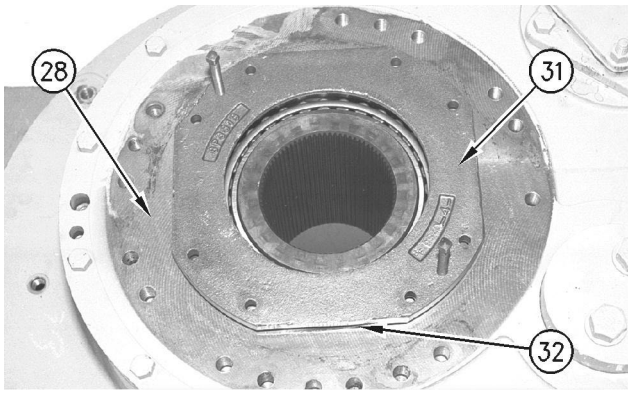


Illustration 361 g00865564

27. Remove bolts (30) and locks (29) from input bearing cage (31).

28. Install Tooling (D) in input bearing cage (31). Tighten Tooling (D) evenly in order to separate the input bearing cage from the transfer gear case assembly.

29. Remove shim pack (32) from cover (28).

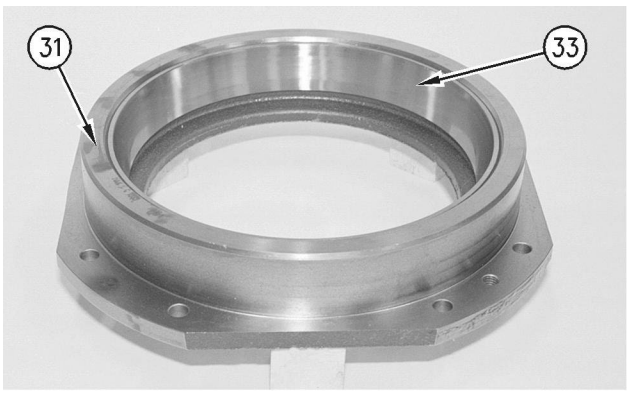


Illustration 362 g00865565

30. Remove bearing cup (33) from input bearing cage (31).

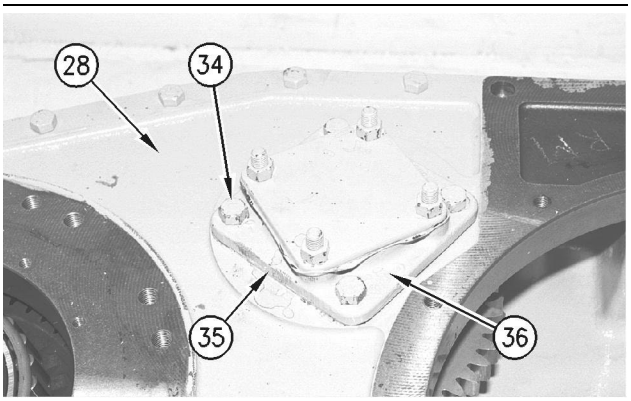


Illustration 363 g00865566

31. Remove bolts (34) from bearing cage assembly (36).

32. Remove the bearing cage assembly from cover (28).

Note: Remove the secondary steering pump in order to remove bearing cage assembly (36), if equipped.

33. Remove shim pack (35) from bearing cage assembly (36).

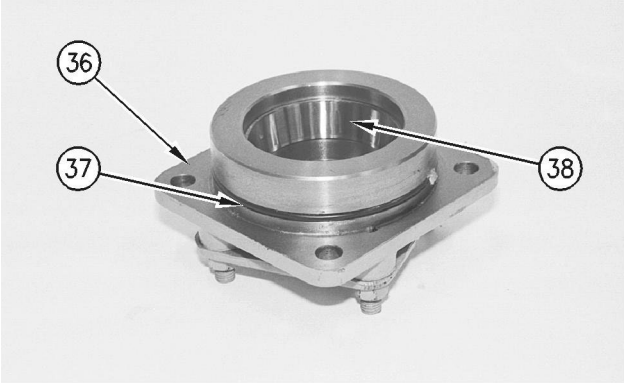


Illustration 364 g00865567

34. Remove O-ring seal (37) and bearing cup (38) from bearing cage assembly (36).

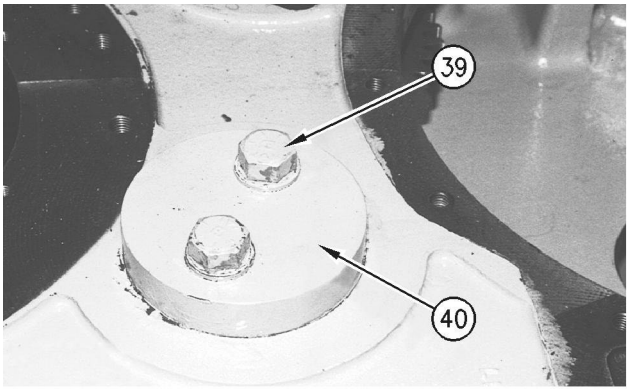


Illustration 365 g00865568

35. Loosen bolts (39). **Do not remove bolts (39) at this time.**

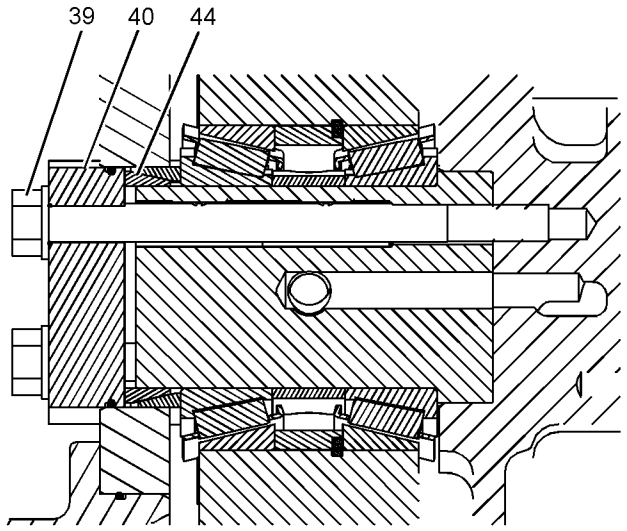


Illustration 366 g01799337

36. Strike bolts (39) or strike the case near the bearing assembly with a dead blow hammer in order to loosen lock assembly (44). Do not strike cover (40).

Note: Lock assembly (44) must be loosened before removing cover (40). Removing cover (40) before lock assembly (44) is loosened may result in personal injury.

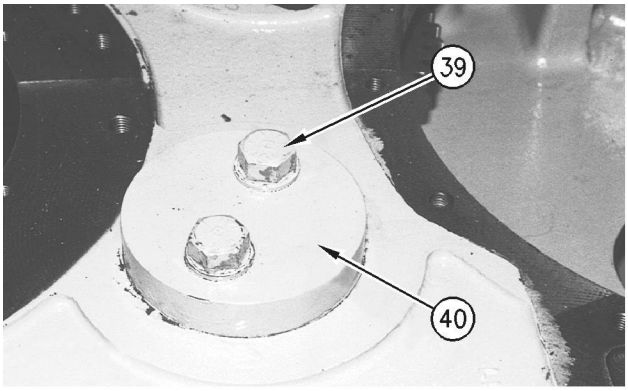


Illustration 367 g00865568

37. Remove bolts (39).

38. Remove cover (40) from the transfer gear case assembly.

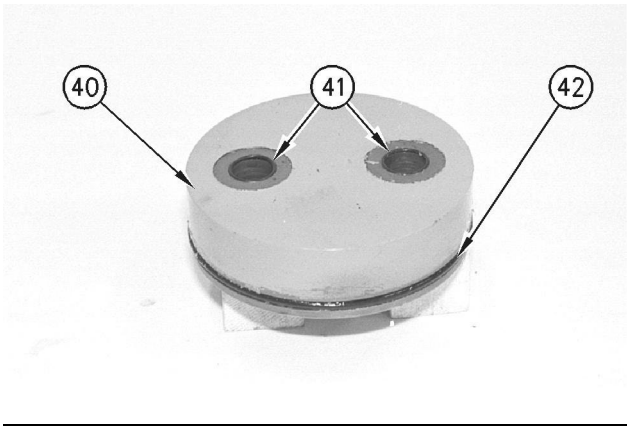


Illustration 368 g00865569

39. Remove O-ring seals (41) and O-ring seal (42) from cover (40).

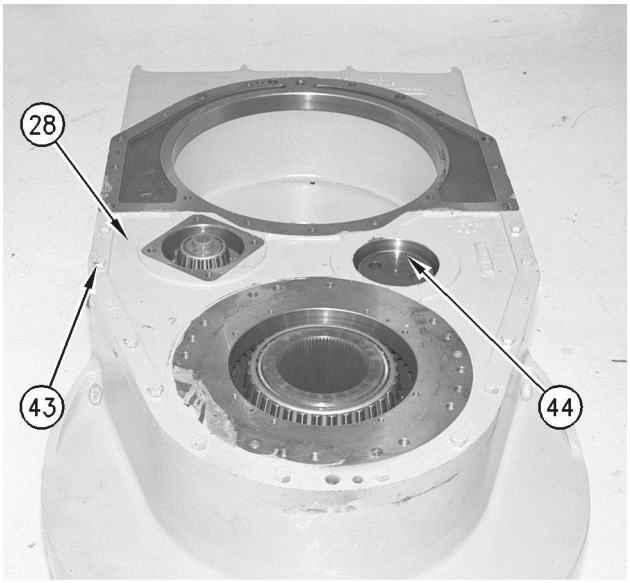


Illustration 369 g00865571

40. Remove bolts (43) from cover (28).

41. Remove one-half of lock assembly (44).

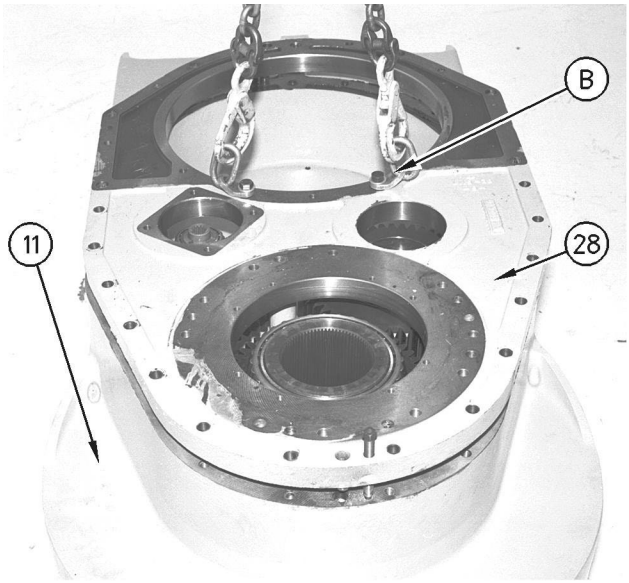


Illustration 370 g00865573

42. Install Tooling (D) in cover (28). Tighten Tooling (D) evenly in order to separate the cover from the transfer gear case assembly.

43. Use Tooling (B) and a suitable lifting device in order to remove cover (28) from the transfer gear case assembly. The weight of cover (28) is approximately 82 kg (180 lb).

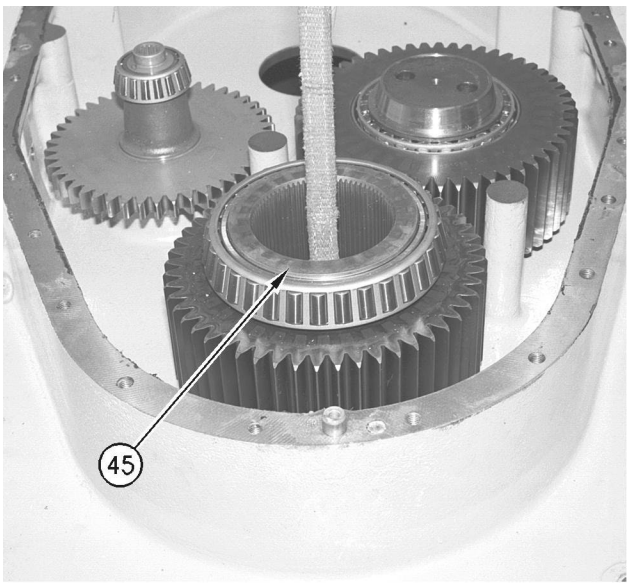


Illustration 371 g00865574

44. Attach a suitable lifting device to a flat piece of steel bar stock, and place the bar stock under the bottom of input gear (45).

45. Lift input gear (45) from the transfer gear case assembly. The weight of input gear (45) is approximately 50 kg (110 lb).

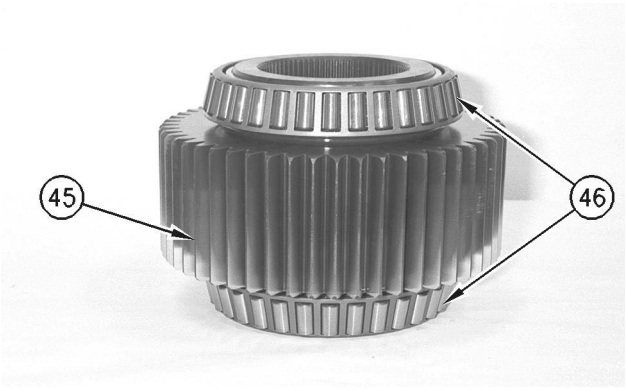


Illustration 372 g00865576

46. Remove bearing cones (46) from input gear (45).

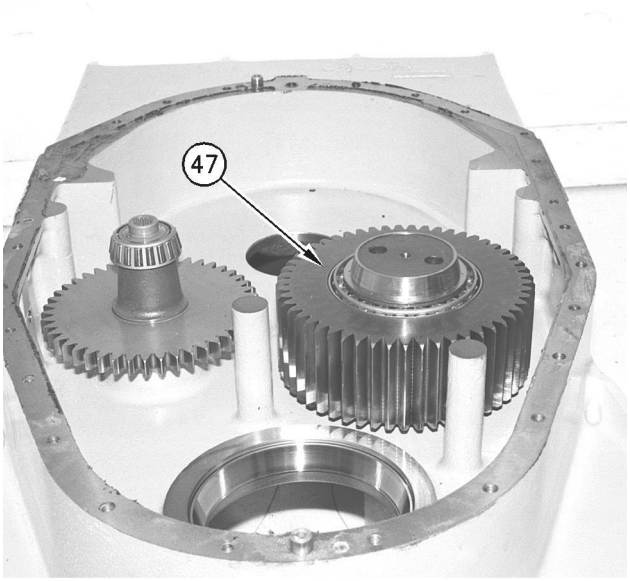


Illustration 373 g00865577

47. Use two people in order to remove idler gear (47) from transfer gear case assembly. The weight of idler gear (47) is approximately 32 kg (70 lb).

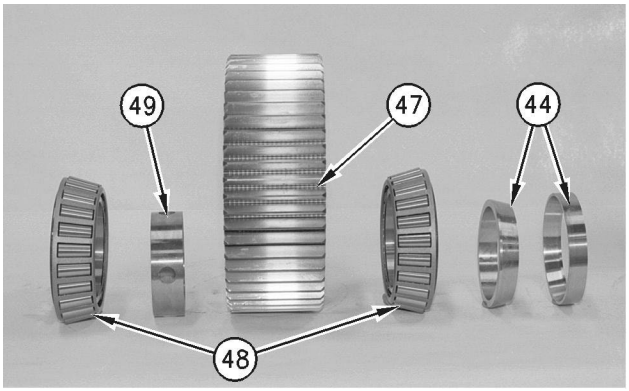


Illustration 374 g00865579

48. Remove lock assembly (44), bearing cones (48), and spacer (49) from idler gear (47).

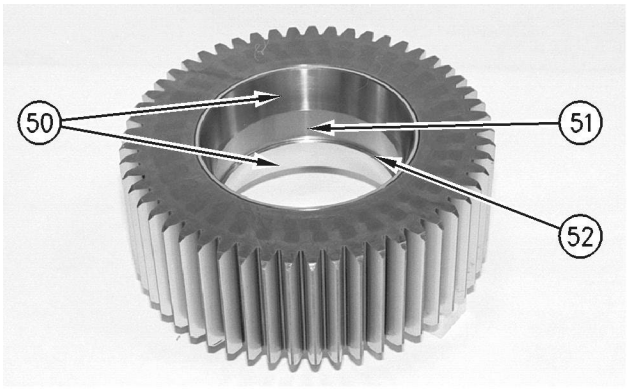


Illustration 375 g00865581

49. Remove bearing cups (50), spacer (51), and retainer ring (52) from idler gear (47).

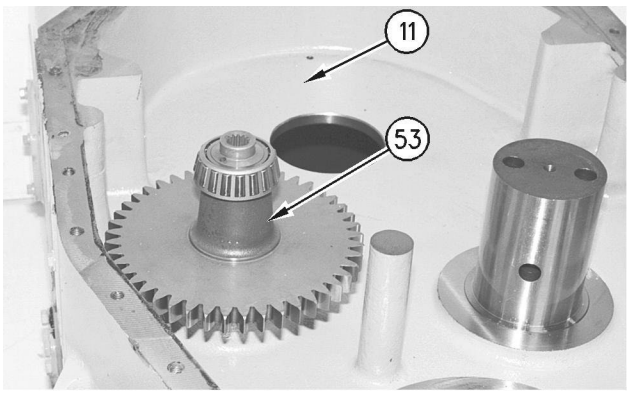


Illustration 376 g00865582

50. Remove pump gear (53) from transfer gear case assembly (11).

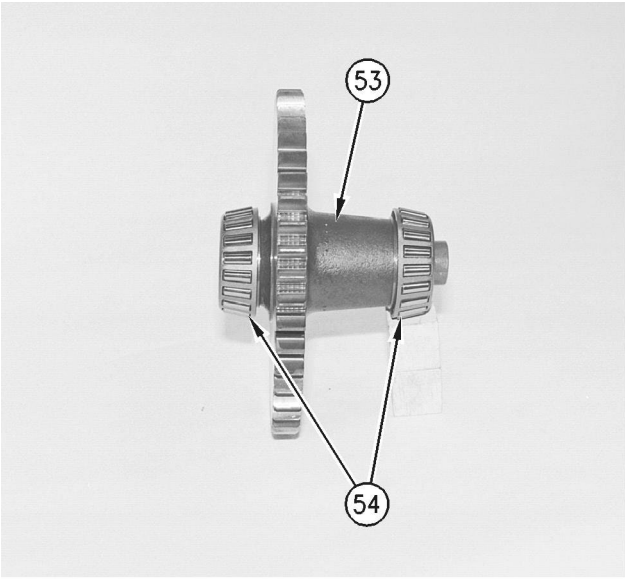


Illustration 377 g00865583

51. Remove bearing cones (54) from pump gear (53).

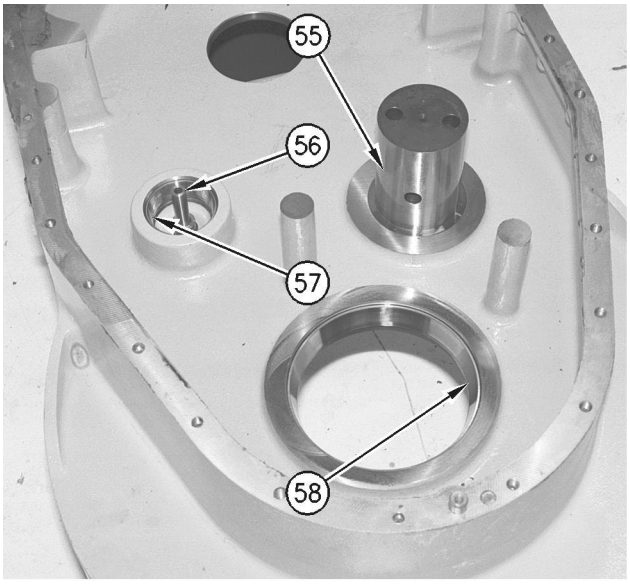


Illustration 378 g00865584

52. Remove idler shaft (55), tube (56), bearing cup (57), and bearing cup (58) from the transfer gear case assembly.

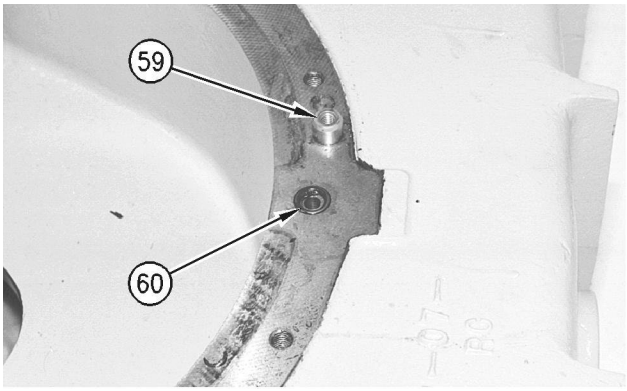


Illustration 379 g00865586

53. Remove dowels (59) and O-ring seal (60) from the transfer gear case assembly.

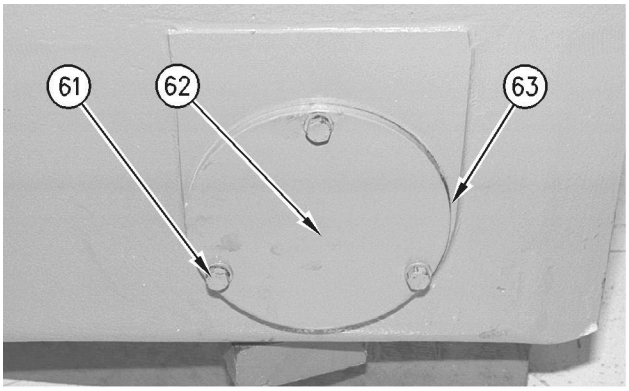


Illustration 380 g00865587

54. Remove bolts (61), cover (62), and O-ring seals (63) from the transfer gear case assembly.

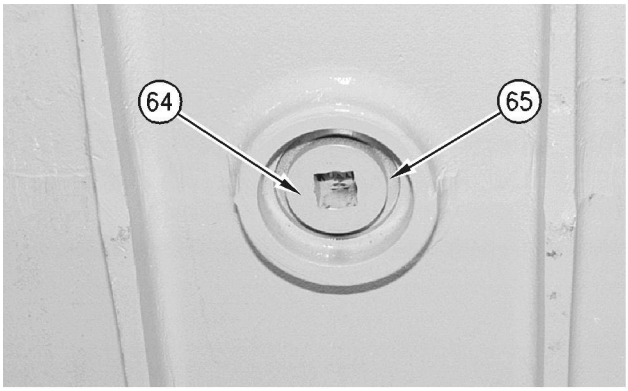


Illustration 381 g00865590

55. Remove drain plug (64) and gasket (65) from the bottom of the transfer gear case assembly.

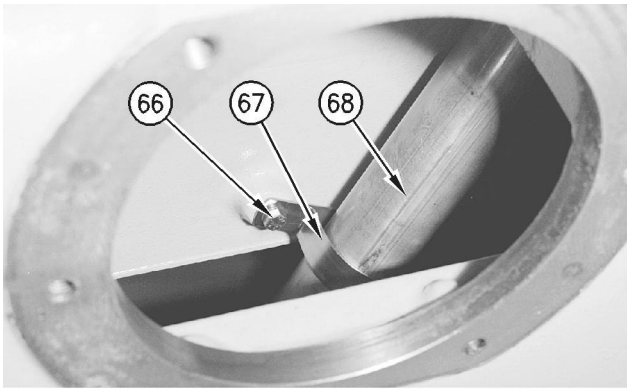


Illustration 382 g00865592

56. Remove bolt (66), clip (67), and tube (68) from the transfer gear case assembly.

i07418105

Output Transfer Gears - Assemble

SMCS Code: 3075-016-OJ

Assembly Procedure

Table 16

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-7409	Eyebolt	1
B	138-7575	Link Bracket	2
C	1P-0520	Driver Gp	1
E	6V-5765	Sealant	1
F	8H-8581	Feeler Gauge	1

1. 6V-5765

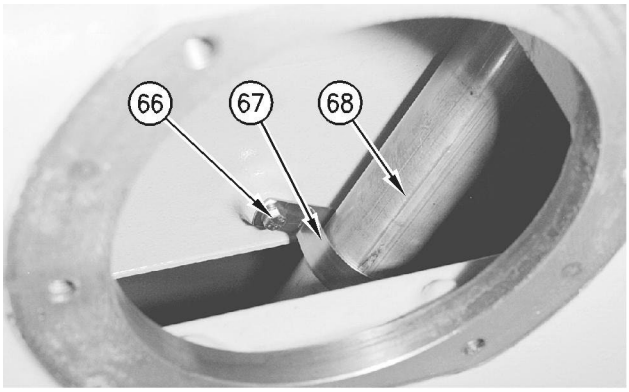


Illustration 383 g00865592

2. Install bolt (66), clip (67), and tube (68) in the transfer gear case assembly.

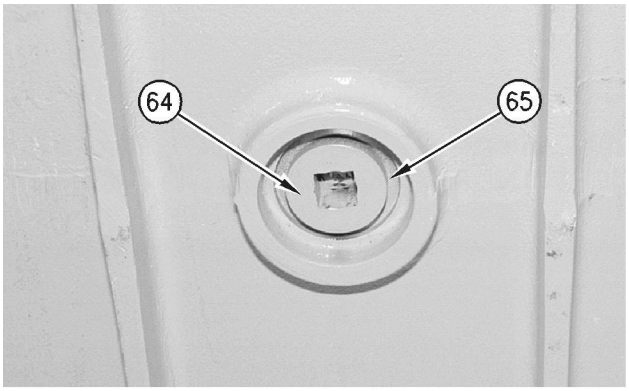


Illustration 384 g00865590

3. Install drain plug (64) and gasket (65) in the bottom of the transfer gear case assembly.

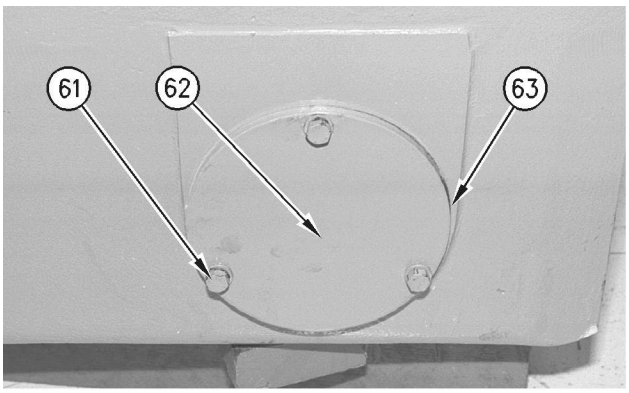


Illustration 385 g00865587

4. Install bolts (61), cover (62), and O-ring seals (63) in the transfer gear case assembly.

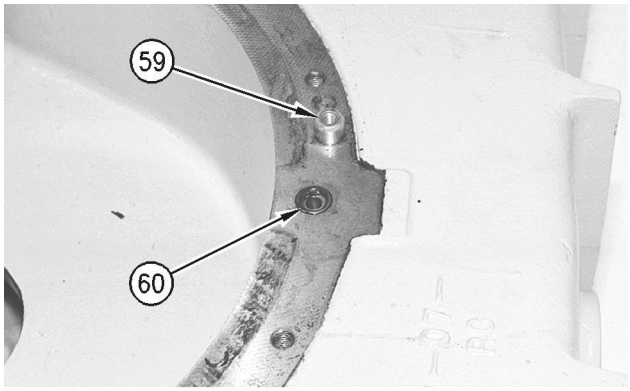


Illustration 386 g00865586

5. Install dowels (59) and O-ring seal (60) in the transfer gear case assembly.

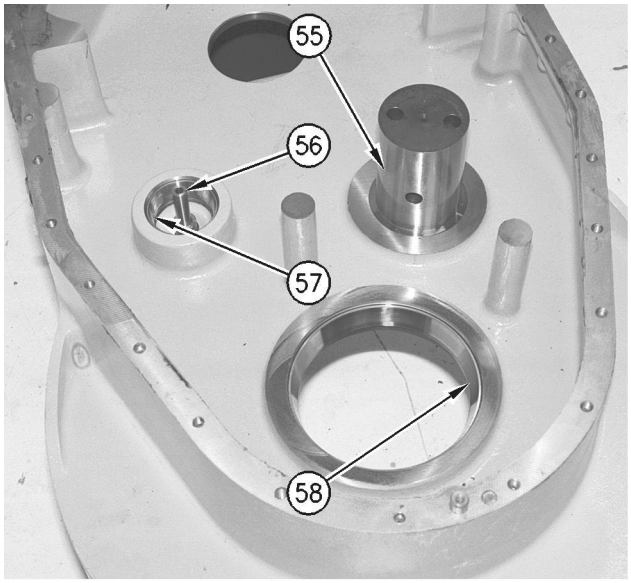


Illustration 387 g00865584

6. Lower the temperature of bearing cup (57) and bearing cup (58). Use appropriate equipment to handle the bearing cups.

7. Install the bearing cups in the transfer gear case assembly.

8. Install idler shaft (55) and tube (56) in the transfer gear case assembly.

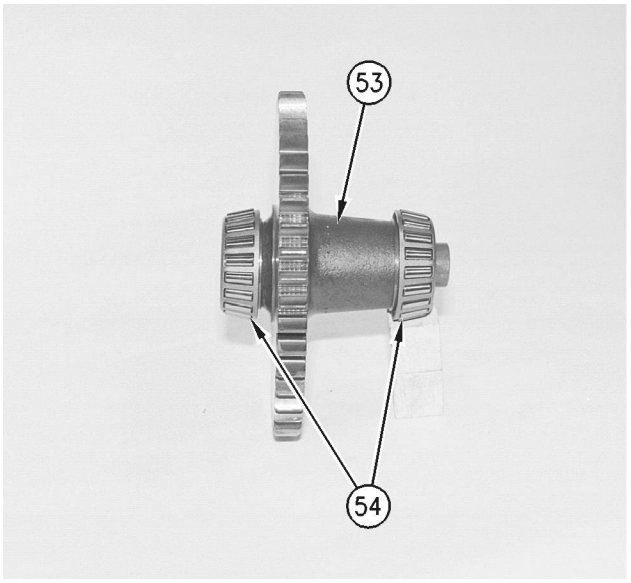


Illustration 388 g00865583

9. Raise the temperature of bearing cones (54) to a maximum temperature of 135 °C (275 °F).

10. Install bearing cones (54) on pump gear (53), as shown. The bearing cones must be seated on the gear properly.

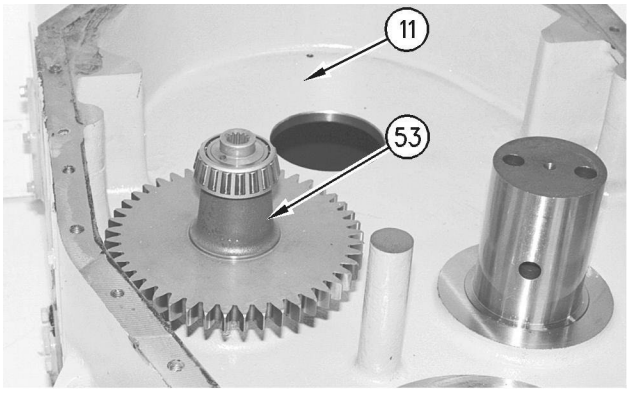


Illustration 389 g00865582

11. Install pump gear (53) in transfer gear case assembly (11).

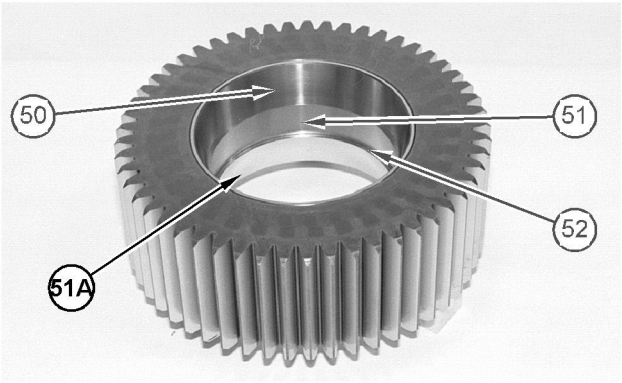


Illustration 390 g06315745

12. Install retainer ring (52) in the idler gear.

13. Lower the temperature of bearing cup (50), bearing cup (51A), and spacer (51).

14. Install the bearing cup(51A) in idler gear (47).

15. Install spacer (51) and bearing cup (50) in idler gear (47).

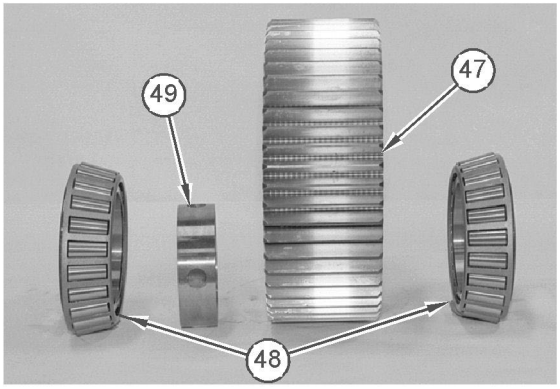


Illustration 391 g06315787

16. Install bearing cone (48) on the idler shaft.

17. Install idler gear (47), spacer (49), and bearing cone (48) on the idler shaft. The weight of idler gear (47) is approximately 32 kg (70 lb).

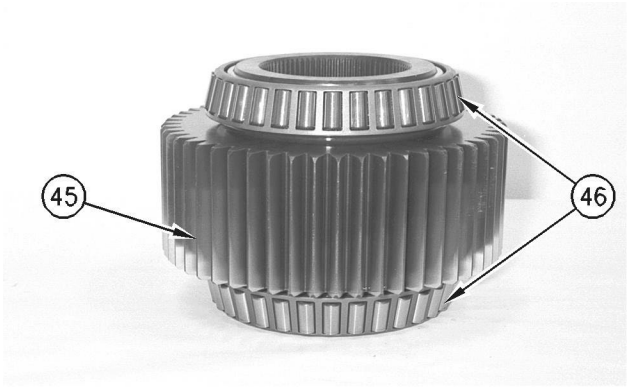


Illustration 392 g00865576

18. Raise the temperature of bearing cones (46) to a maximum temperature of 135 °C (275 °F).

19. Install bearing cones (46) to input gear (45).

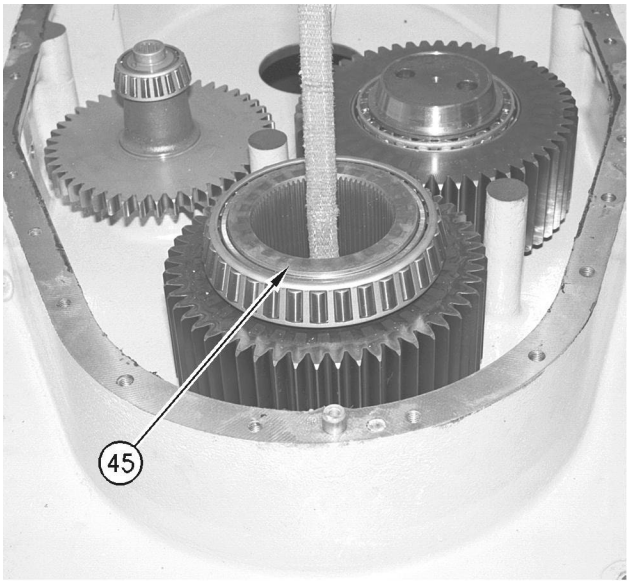


Illustration 393 g00865574

20. Attach a suitable lifting device to a flat piece of steel bar stock, and place the bar stock under the bottom of input gear (45).

21. Install input gear (45) into the transfer gear case assembly. The weight of input gear (45) is approximately 50 kg (110 lb).

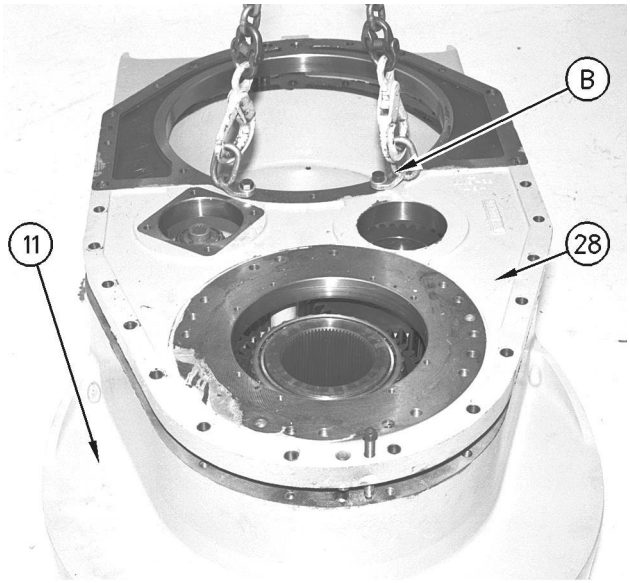


Illustration 394 g00865573

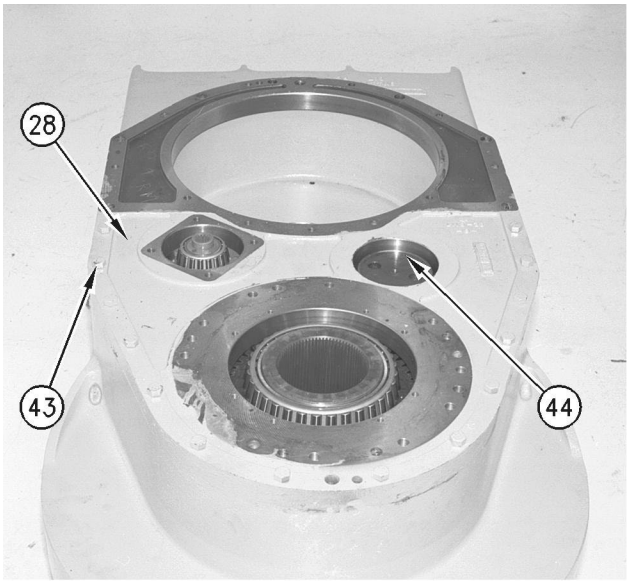


Illustration 395 g00865571

22. Apply Tooling (E) on the mating surface of the transfer case.

23. Install Tooling (B) to cover (28), as shown.

24. Use Tooling (B) to install cover (28) on the transfer gear case assembly. The weight of cover (28) is approximately 82 kg (180 lb).

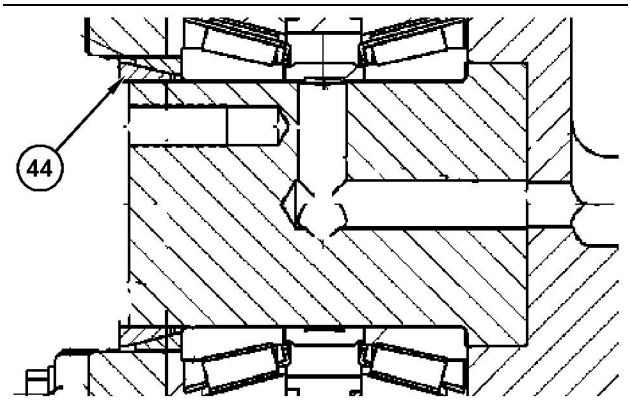


Illustration 396 g06315777

25. Install bolts (43).

26. Install lock assembly (44) to the idler shaft as shown.

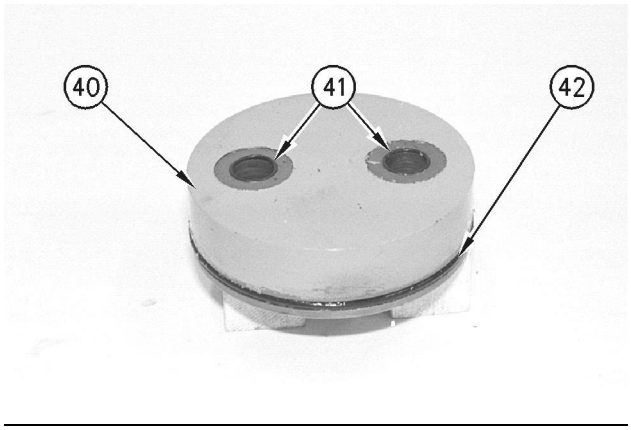


Illustration 397 g00865569

27. Install O-ring seals (41) and O-ring seal (42) on cover (40).

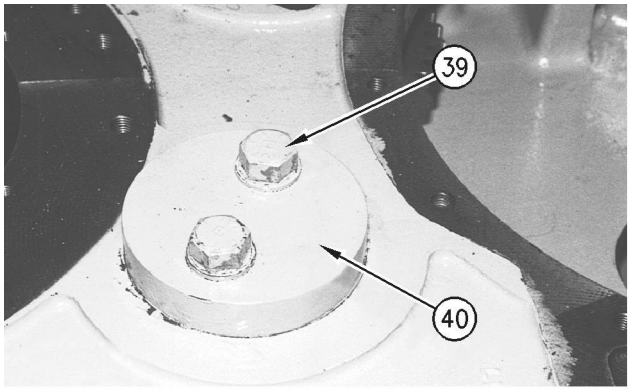


Illustration 398 g00865568

28. Lightly lubricate the bore with the lubricant that is being sealed.

29. Install cover (40) and bolts (39) on the transfer gear case assembly.

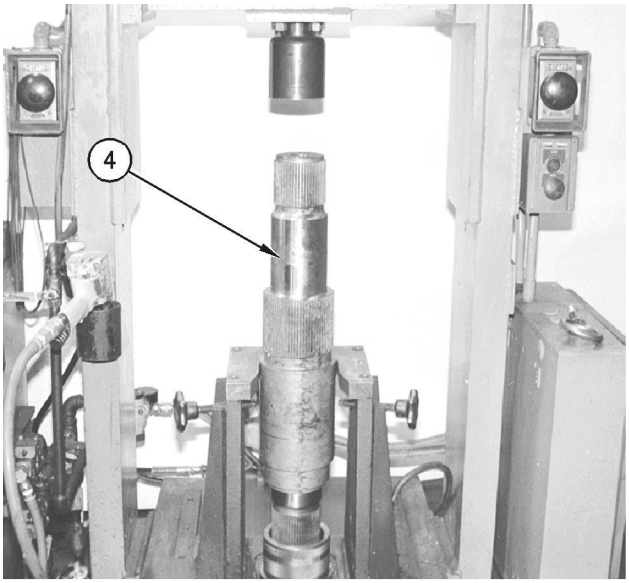


Illustration 399 g00866197

30. Place transfer shaft (4) into a suitable press, as shown. The weight of transfer shaft (4) is approximately 68 kg (150 lb).

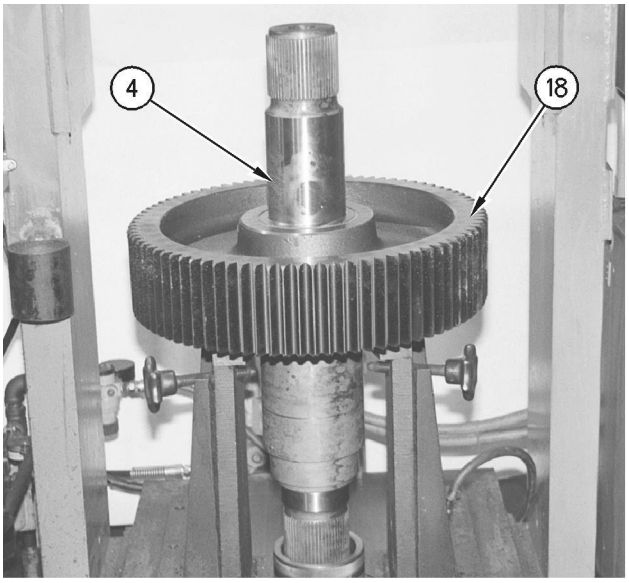


Illustration 400 g00866198

31. Install output gear (18) on transfer shaft (4). The weight of output gear (18) is approximately 79 kg (175 lb).

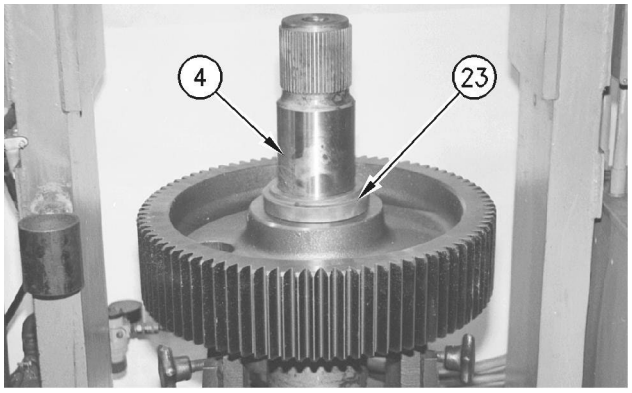


Illustration 401 g00866199

32. Install spacer (23) on transfer shaft (4).

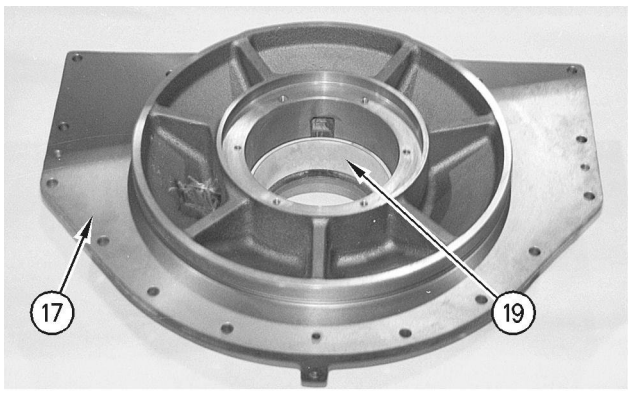


Illustration 402 g00866200

33. Lower the temperature of bearing cup (19).

34. Install bearing cup (19) into bearing cage assembly (17).

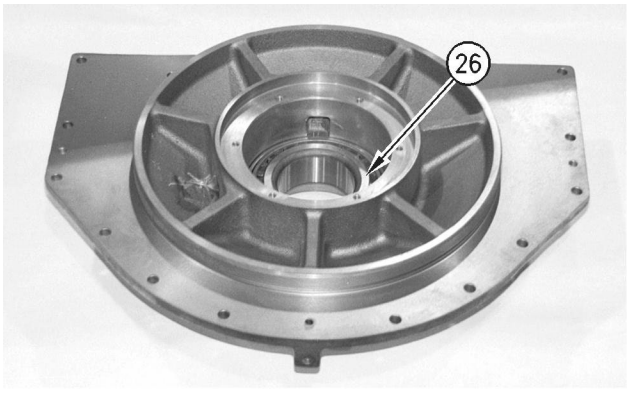


Illustration 403 g00866201

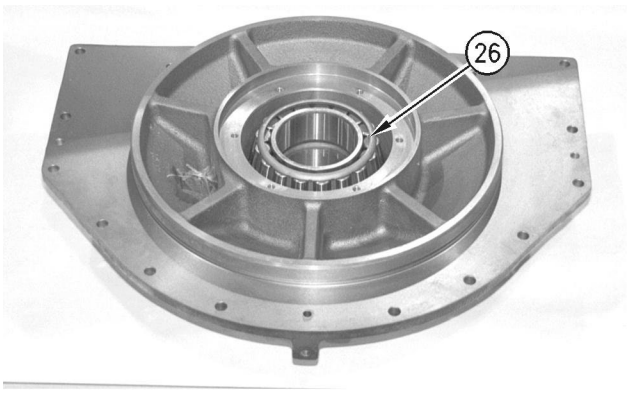


Illustration 404 g00866203

35. Install bearing cones (26) in the bearing cage assembly, as shown.

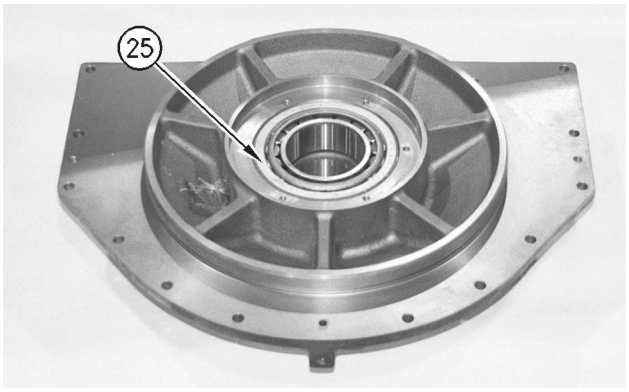


Illustration 405 g00866205

36. Lower the temperature of bearing cup (25). Use appropriate equipment to handle the bearing cup.

37. Install bearing cup (19) into the cage assembly.

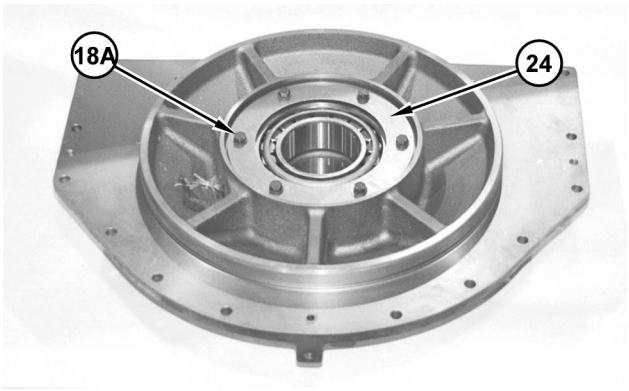


Illustration 406 g01252452

38. Install retainer (24) and bolts (18A) into the bearing cage.

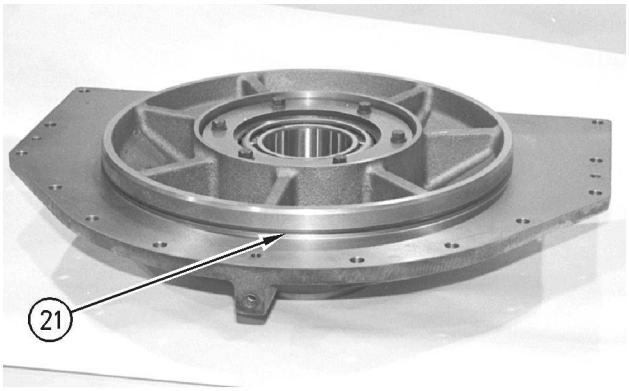


Illustration 407 g00866210

39. Install O-ring seal (21) on the bearing cage.

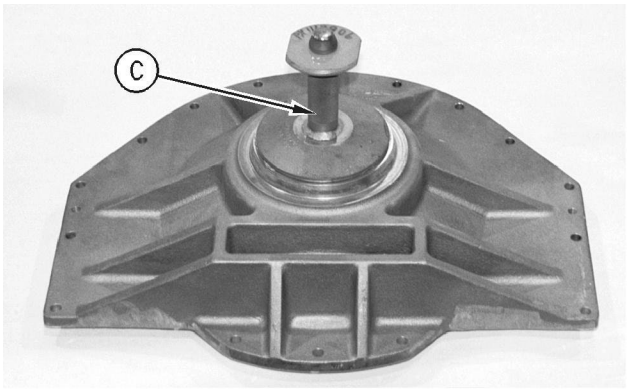


Illustration 408 g00866212

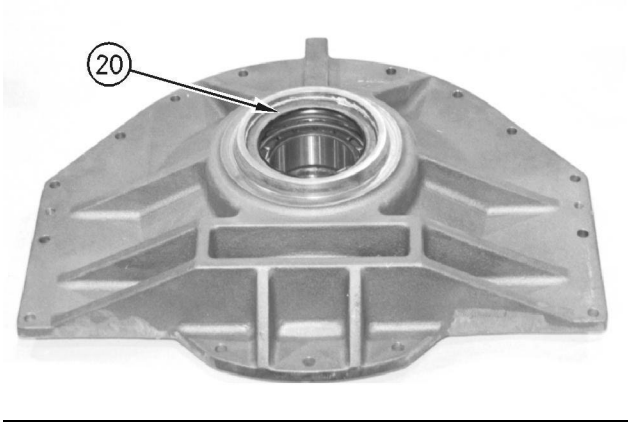


Illustration 409 g00866214

40. Use Tooling (C) to install lip seal (20) into the bearing cage. The lip of the seal must face toward the inside the bearing cage. The seal must make contact with the counterbore in the bearing cage.

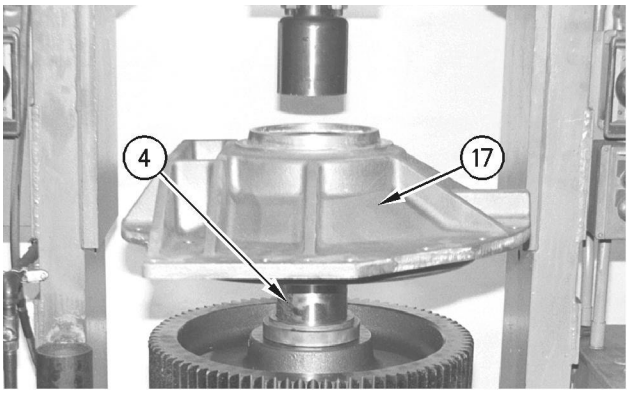


Illustration 410 g00866243

41. Put output bearing cage assembly (17) on transfer shaft (4).

42. Use a suitable press to install output bearing cage assembly (17) onto the transfer shaft. The weight of output bearing cage assembly (17) is approximately 82 kg (180 lb).

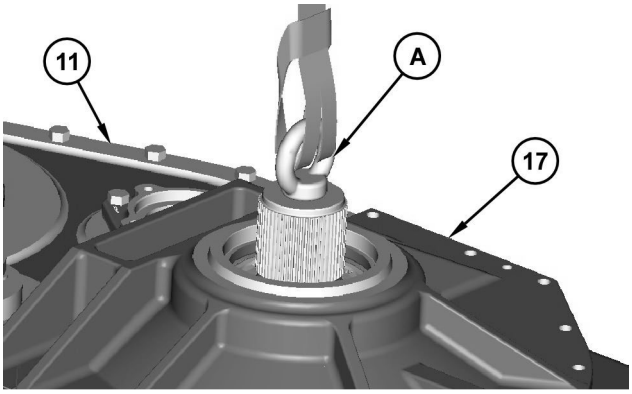


Illustration 411 g01249746

43. Lubricate the bore of the transfer gear case assembly with the lubricant that is being sealed.

44. Use Tooling (A) and a suitable lifting device to install output bearing cage assembly (17) on transfer case assembly (11). The weight of output bearing cage assembly (17) is approximately 254 kg (560 lb).

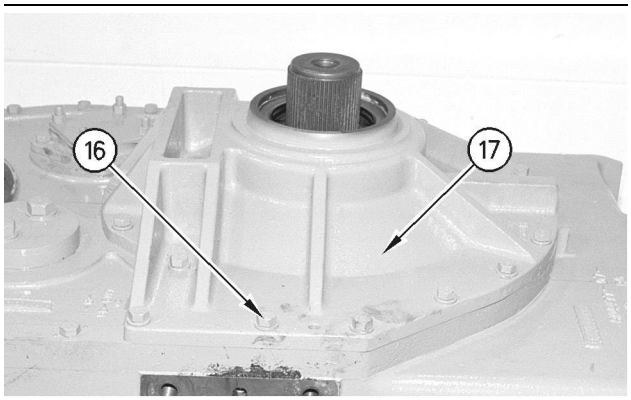


Illustration 412 g00865531

45. Install bolts (16) to output bearing cage assembly (17).

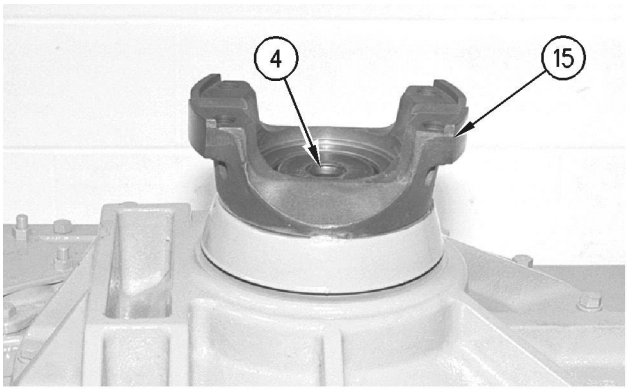


Illustration 413 g00865530

46. Lubricate lip seal (20) with clean oil before installation of the yoke.

47. Install yoke (15) on transfer shaft (4).

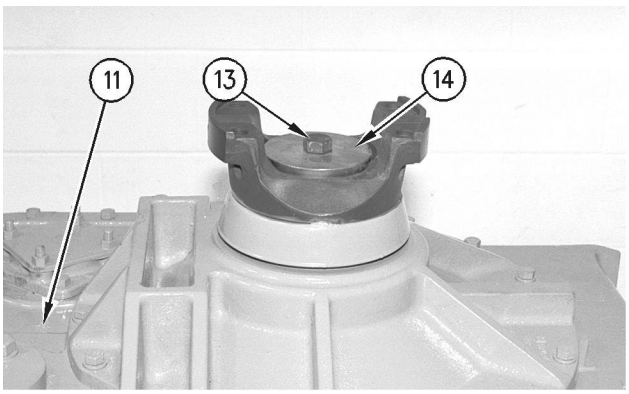


Illustration 414 g00865529

48. Install bolt (13), retainer (14), and the seal on the transfer shaft. Tighten bolt (13) to a torque of 475 ± 50 N·m (350 ± 37 lb ft).

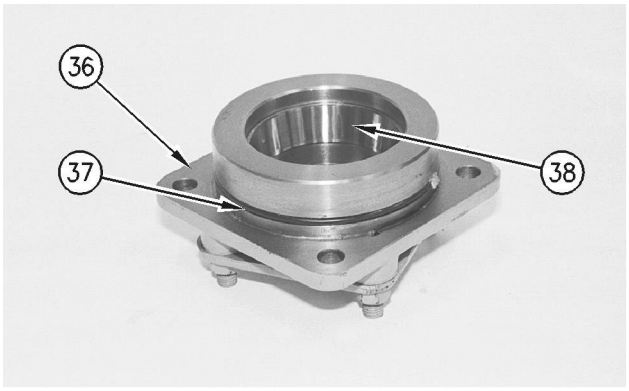


Illustration 415 g00865567

49. Lower the temperature of bearing cup (38). Do not install the O-ring seal at this time. Install bearing cup (38) into bearing cage assembly (36).

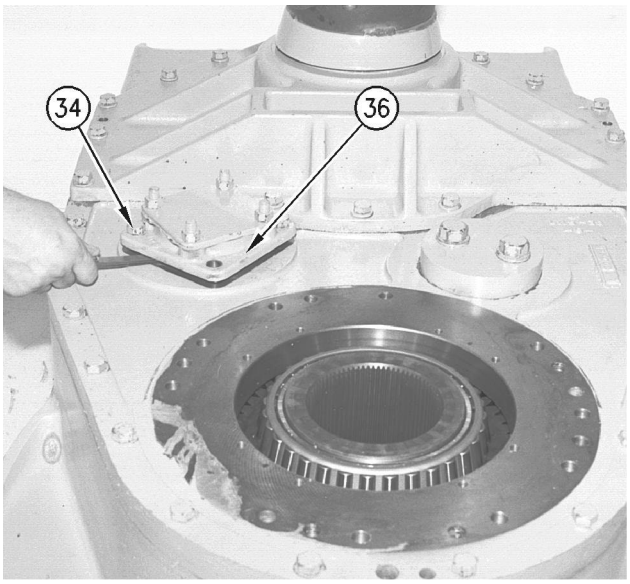


Illustration 416 g00866244

50. Install bearing cage assembly (36) in the transfer case. DO NOT install the O-ring seal or the shims at this time.

51. Install bolts (34) at a 180° interval in bearing cage (36). Tighten bolts (34) to a torque of 14 N·m (10 lb ft).

52. Rotate the transfer shaft three times.

53. Tighten bolts (34) in bearing cage assembly (36) to a torque of 14 N·m (10 lb ft).

54. Repeat Steps 52 and 53 until 14 N·m (10 lb ft) torque will not advance bolts (34).

55. Loosen bolts (34) evenly and reset the bolts finger tight.

56. Use Tooling (F) to measure the gaps between the housing and the bearing cage. Measure the gap in four places.

57. Add the four measurements for the bearing cage. Divide the sum by four. This is the average gap for each bearing cage. Add 0.08 mm (0.003 inch) to 0.15 mm (0.006 inch) to the average gap measurement to determine the thickness of the shims.

58. Remove bolts (34) and bearing cage assembly (36) from the transfer gear case assembly.

59. Install the O-ring, bearing cage assembly (36), the correct shim pack, and bolts (34). Tighten bolts (34) to a torque of 105 ± 20 N·m (77 ± 15 lb ft).

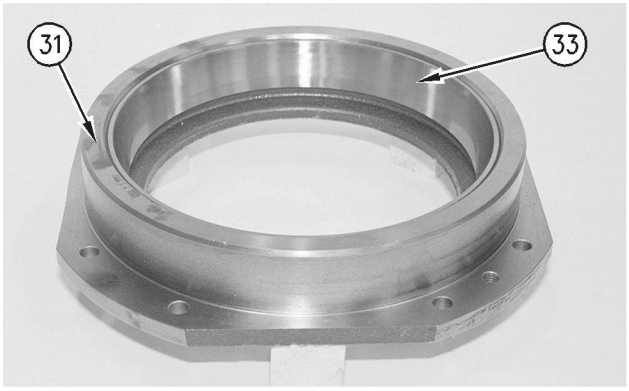


Illustration 417 g00865565

60. Lower the temperature of bearing cup (33). Use appropriate equipment to handle the bearing cup.

61. Install the bearing cup into input bearing cage (31).

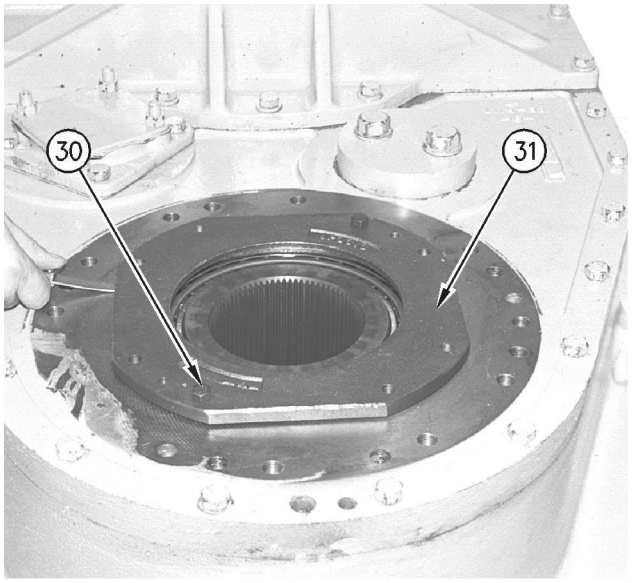


Illustration 418 g00866245

62. Install input bearing cage (31) in the transfer case. DO NOT install the O-ring seal or the shims at this time.

63. Install bolts (30) at a 180° interval in input bearing cage (31). Tighten bolts (30) to a torque of 28 N·m (21 lb ft).

64. Rotate the transfer shaft three times.

65. Tighten bolts (30) in input bearing cage (31) to a torque of 28 N·m (21 lb ft).

66. Repeat Steps 64 and 65 until 28 N·m (21 lb ft) torque will not advance bolts (30).

67. Loosen bolts (30) evenly and reset the bolts finger tight.

68. Use Tooling (D) to measure the gaps between the housing and the input bearing cage. Measure the gap in four places.

69. Add the four measurements for the bearing cage. Divide the sum by four. This is the average gap for each bearing cage. Add 0.08 mm (0.003 inch) to 0.15 mm (0.006 inch) to the average gap measurement to determine the thickness of the shims.

70. Remove bolts (30) and input bearing cage (31) from the transfer gear case assembly.

71. Install input bearing cage (31), the correct shim pack, locks (29), and bolts (30).

72. Tighten bolts (30) to a torque of 47 ± 9 N·m (35 ± 7 lb ft).

73. Fold the end of locks (29) onto bolts (30).

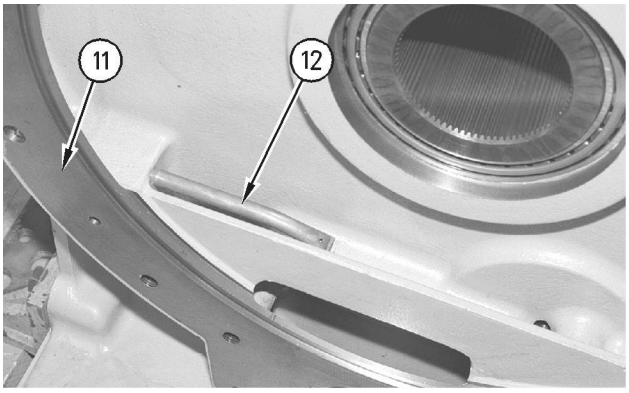


Illustration 419 g00865527

74. Install tube (12) to transfer gear case assembly (11).

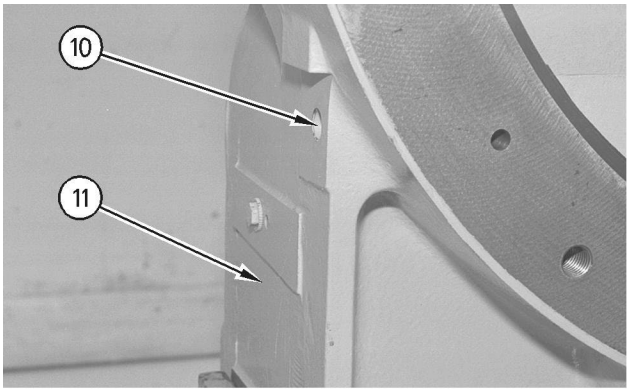


Illustration 420 g00865526

75. Install cup plug (10) in transfer gear case assembly (11).

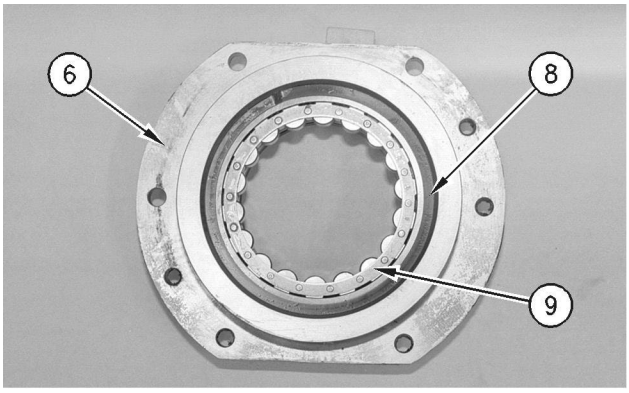


Illustration 421 g00865525

76. Install the race, and roller assembly (9) in bearing cage (6).

77. Install ring (8) in bearing cage (6).

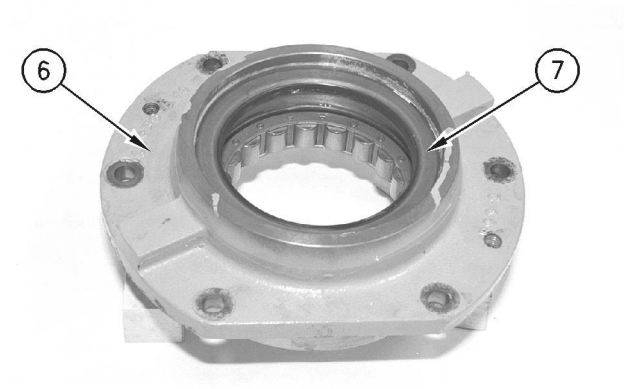


Illustration 422 g00865524

78. Turn over bearing cage (6).

79. Use Tooling (C) to install lip seal (7) in bearing cage (6). The lip of the seal must face toward the inside the bearing cage. The seal must make contact with the counterbore in the bearing cage.

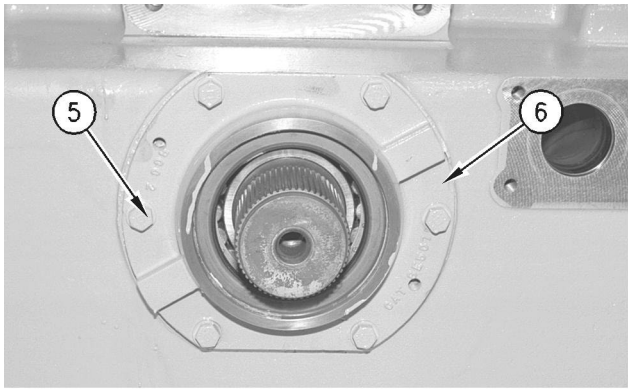


Illustration 423 g00865522

80. Apply Tooling (E) on the mating surface of the transfer case.

81. Install bearing cage (6) and bolts (5) to the transfer gear case assembly.

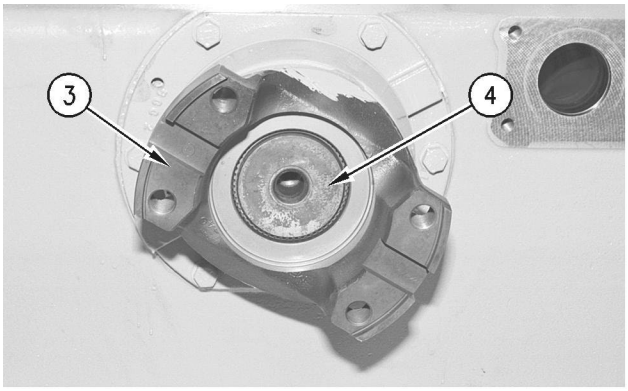


Illustration 424 g00865520

82. Use clean oil to lubricate the lip seal before installation of the yoke. Install yoke (3) to transfer shaft (4).

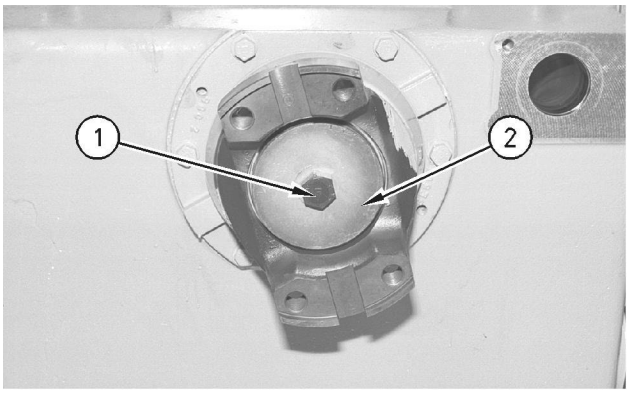


Illustration 425 g00865519

83. Install the O-ring seal, retainer (2), and bolt (1) to the transfer shaft. Tighten bolt (1) to a torque of 475 ± 50 N·m (350 ± 37 lb ft).

End By:

a. Connect the transfer gears. Refer to Disassembly and Assembly, “Transmission to Transfer Gears - Connect”.

b. Install the magnetic filter screen tube assembly. Refer to Disassembly and Assembly, “Magnetic Filter Screen and Housing - Install”.

i02473483

Transmission Planetary - Disassemble

SMCS Code: 3160-015

Disassembly Procedure

Table 17

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2420	Transmission Repair Stand	1
B	138-7575	Link Bracket	2
C	138-7573	Link Bracket	2
D	1P-1863	Pliers	1
E	1P-0520	Driver Group	1
F	FT-0833	Clamp	1
G	1P-1861	Pliers	1
H	6L-7283	Bolt	3

Start By:

a. Separate the transfer gears from the transmission. Refer to Disassembly and Assembly, “Transmission from Transfer Gears - Separate”.

b. Remove the transmission hydraulic control relief valve. Refer to Disassembly and Assembly, “Relief Valve (Transmission Hydraulic Control) - Remove”.

NOTICE
When the transmission is disassembled, keep the clutch plates and the friction discs in the original sequence. The clutch plates and the friction discs may be reused only if these items are kept in the original location. Failure to follow this note will cause excessive wear in the transmission. The wear may result in a failure of the transmission.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

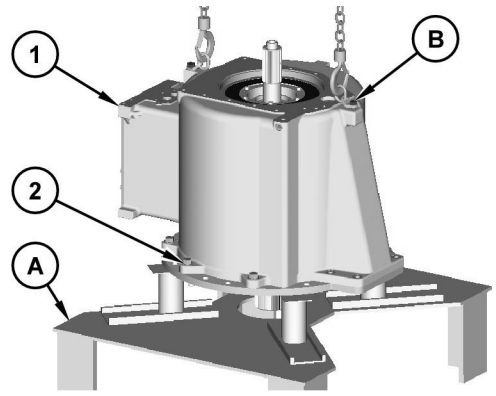


Illustration 426 g01234101

1. Place the transmission assembly on Tooling (A), as shown.

2. Remove bolts (2).

3. Use Tooling (B) and a suitable lifting device in order to remove transmission case (1). The weight of transmission case (1) is approximately 211 kg (465 lb).

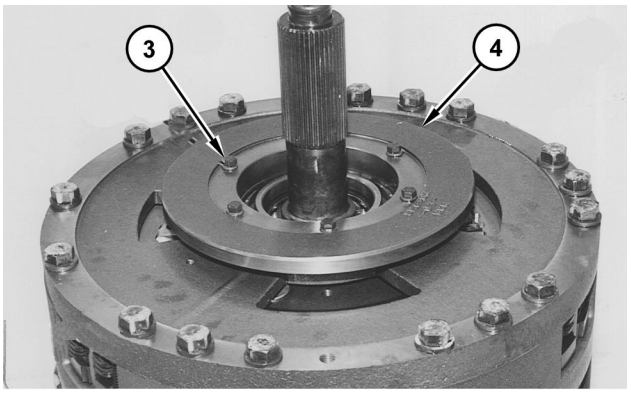


Illustration 427 g01234384

4. Remove bolts (3) and remove pilot plate (4).

5. In order to support the transmission main shaft, place suitable blocking under the transmission main shaft.

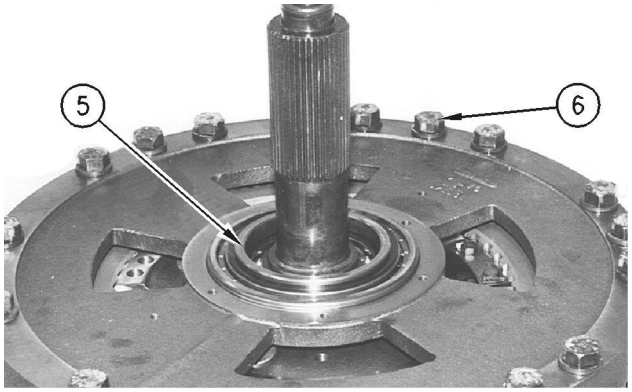


Illustration 428 g01239399

6. Remove retaining ring (5).

7. Remove bolts (6).

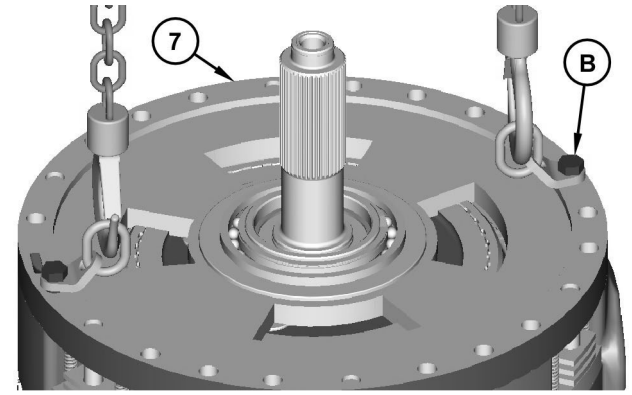


Illustration 429 g01234103

8. Use Tooling (B) and a suitable lifting device in order to remove end plate (7). The weight of end plate (7) is approximately 57 kg (125 lb).

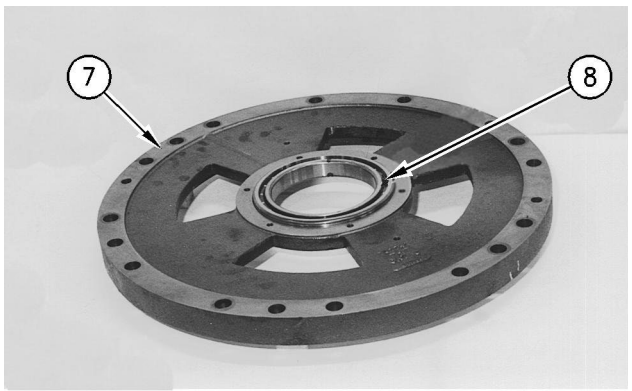


Illustration 430 g00850984

9. Remove bearing assembly (8) from end plate (7).

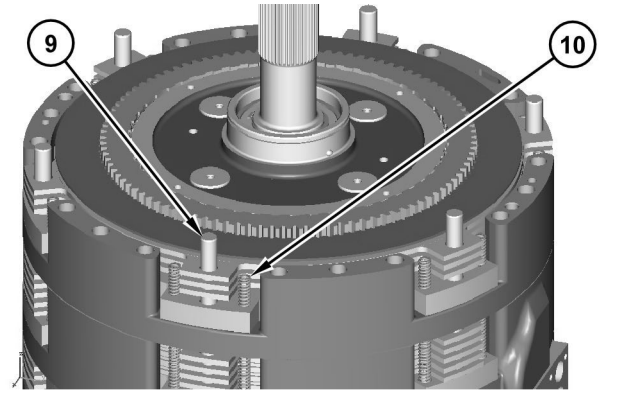


Illustration 431 g01234394

10. Remove pins (9) and springs (10).

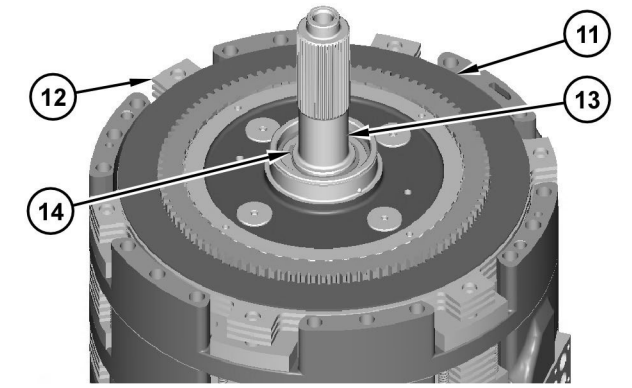


Illustration 432 g01234396

11. Remove clutch discs (11) and clutch plates (12) from the clutch housing.

12. Use Tooling (D) in order to remove retaining ring (14) from input shaft (13).

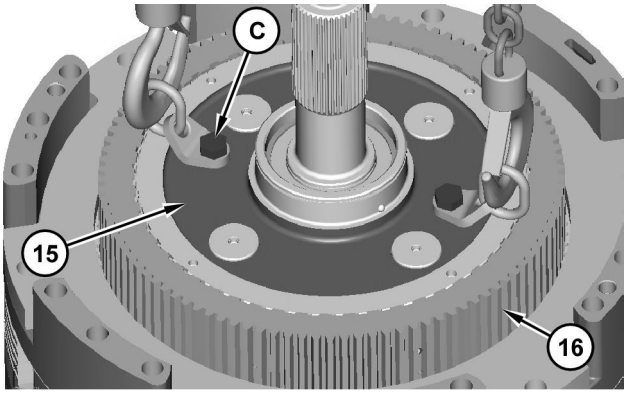


Illustration 433 g01234111

13. Use Tooling (C) and a suitable lifting device in order to remove planetary carrier assembly (15) and ring gear (16) as a unit. The combined weight of planetary carrier assembly (15) and ring gear (16) is approximately 68 kg (150 lb).

14. Compress the retaining ring in order to remove ring gear (16) from planetary carrier assembly (15). Remove the retaining ring from planetary carrier assembly (15).

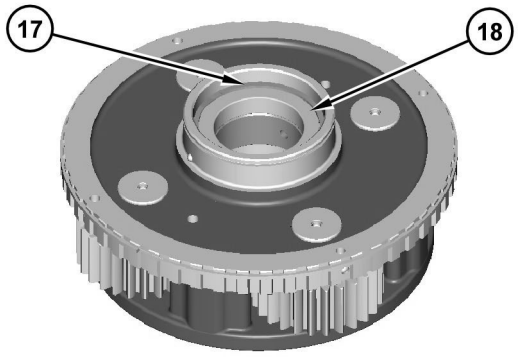


Illustration 434 g01234403

15. Remove retaining ring (17) and bearing assembly (18).

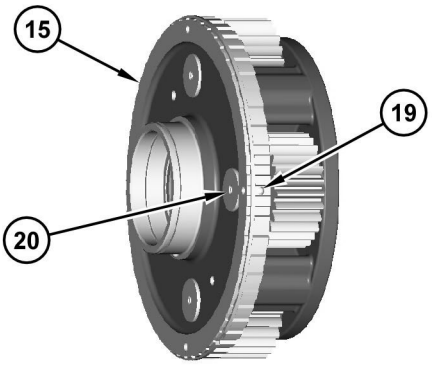


Illustration 435 g01234411

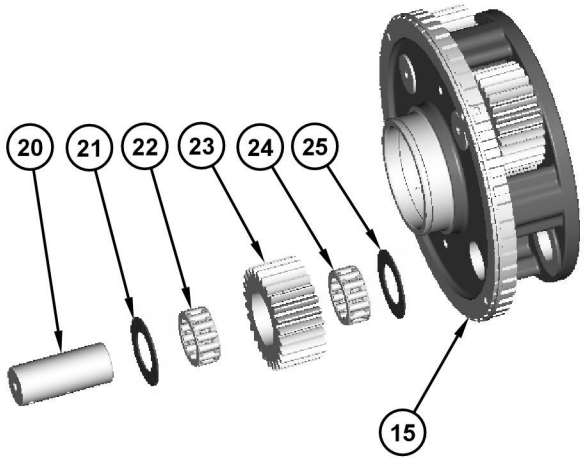


Illustration 436 g01234414

16. Drive spring pin (19) into shaft (20).

17. Remove shaft (20) from planetary carrier assembly (15).

18. Remove washer (21), bearing assembly (22), planetary gear (23), bearing assembly (24), and washer (25) from planetary carrier assembly (15). Repeat this procedure in order to remove the remaining planetary gears from planetary carrier assembly (15).

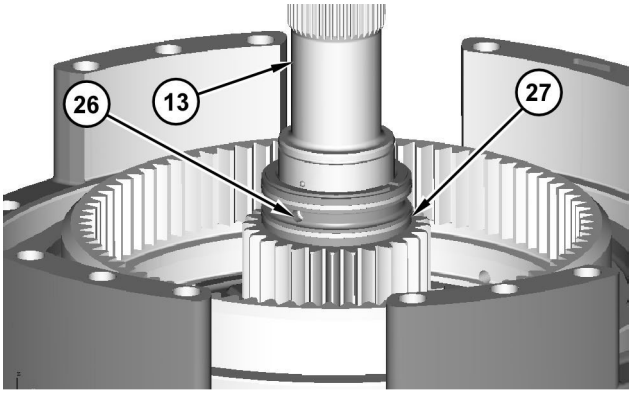


Illustration 437 g01234431

19. Remove spring pin (26) and remove carrier ring (27) from input shaft (13).

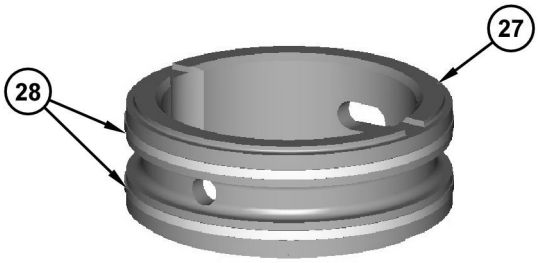


Illustration 438 g01234724

20. Remove seal rings (28) from carrier ring (27).

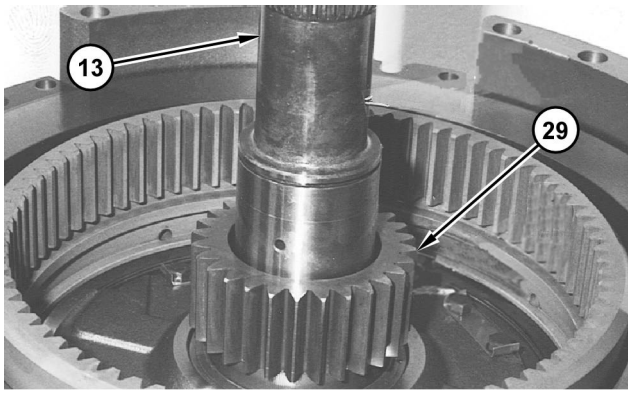


Illustration 439 g01234905

21. Remove sun gear (29) from input shaft assembly (13).

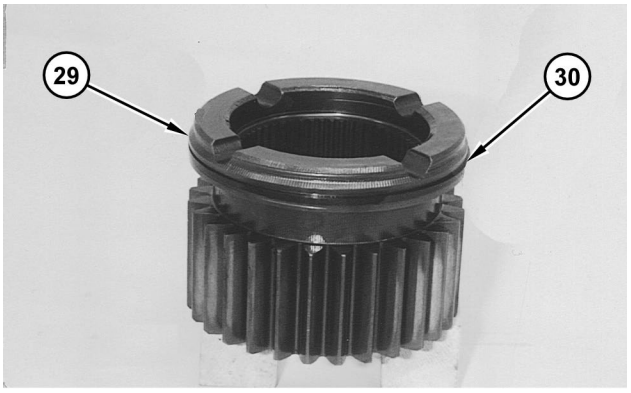


Illustration 440 g01234911

22. Remove seal ring (30) from sun gear (29).

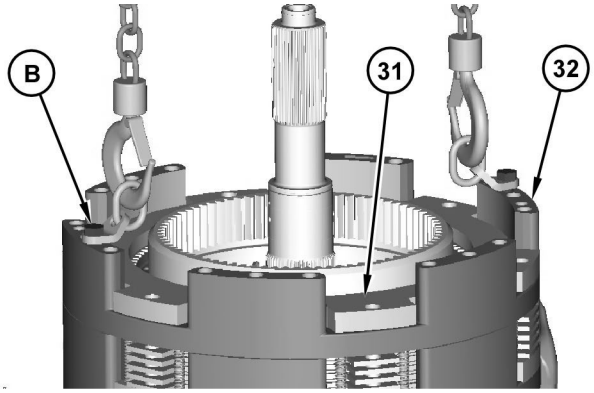


Illustration 441 g01234901

23. Use Tooling (B) and a suitable lifting device in order to remove clutch housing (32) and clutch piston (31) as a unit. The combined weight of clutch housing (32) and clutch piston (31) is approximately 77 kg (170 lb).

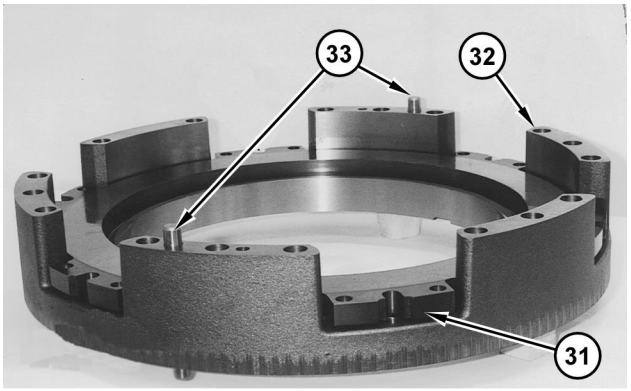


Illustration 442 g01234921

24. Remove clutch piston (31) from clutch housing (32).

25. Remove dowels (33) from clutch housing (32).

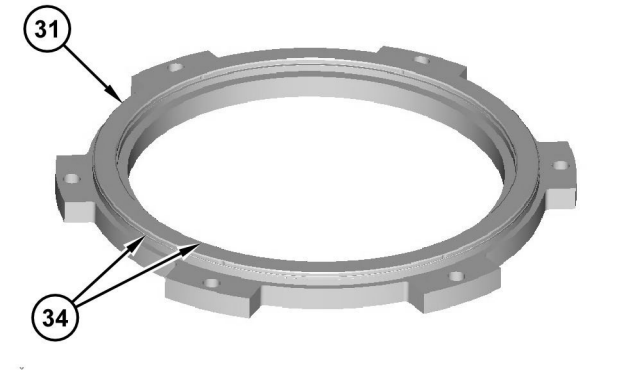


Illustration 443 g01234932

26. Remove seal rings (34) from clutch piston (31).

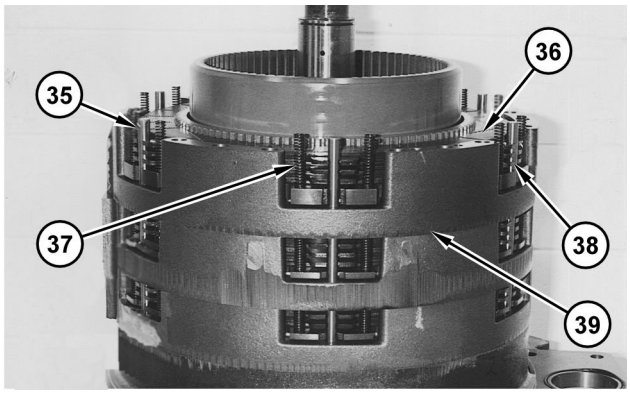


Illustration 444 g01235224

27. Remove pins (35), springs (37), clutch discs (36), and clutch plates (38) from clutch housing (39).

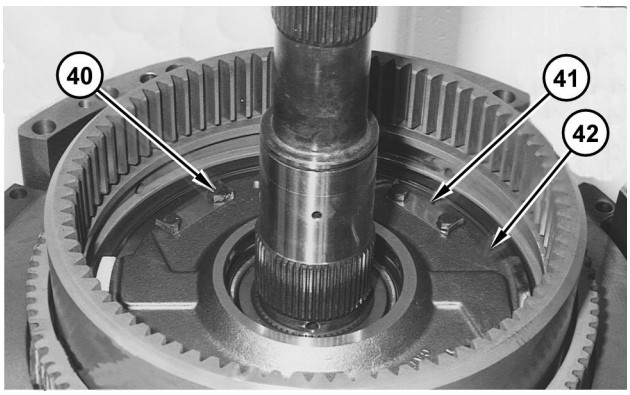


Illustration 445 g01235268

28. Remove bolts (40). Remove locks (41). Remove bearing cage (42).

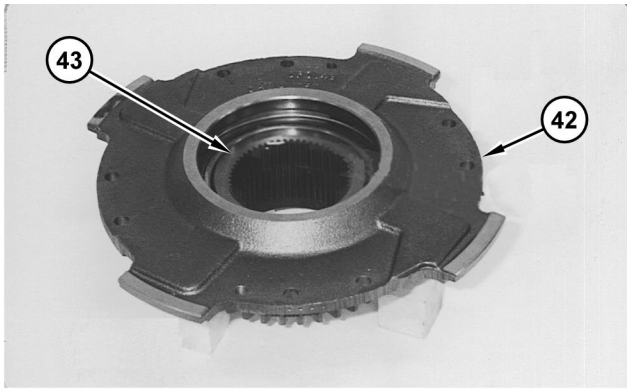


Illustration 446 g01235272

29. Remove sun gear assembly (43) from bearing cage (42).

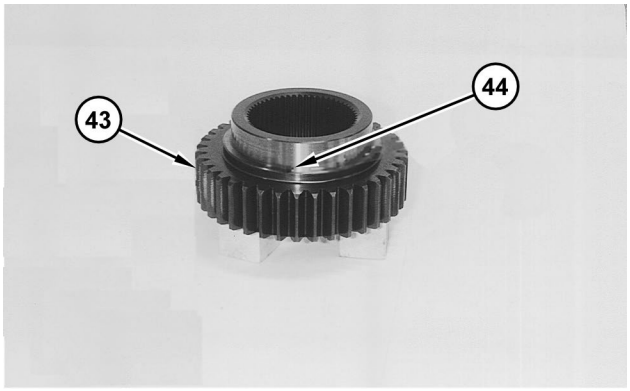


Illustration 447 g01235276

30. Inspect dowel (44). Replace sun gear assembly (43) if dowel (44) is worn or damaged.

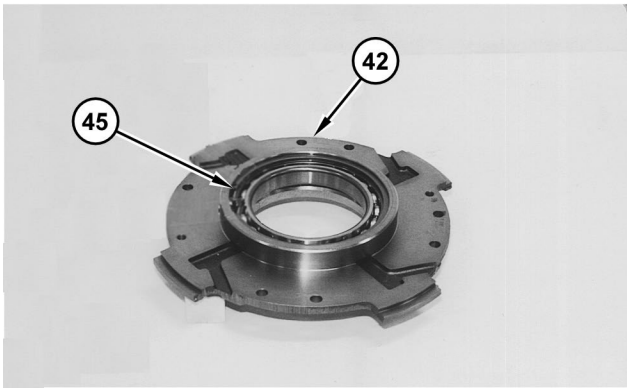


Illustration 448 g01235280

31. Remove retaining ring (45) from bearing cage (42).

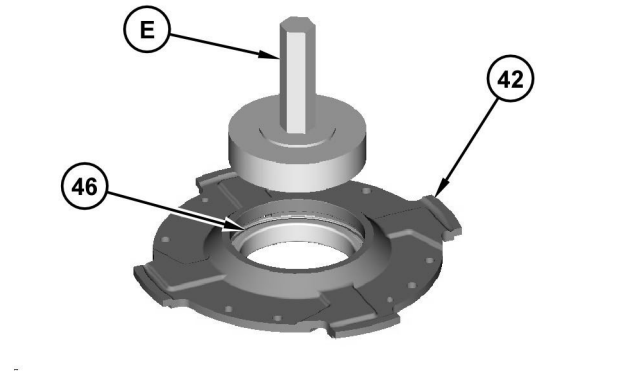


Illustration 449 g01235282

32. Place bearing cage (42) on suitable blocking.

33. Use Tooling (E) in order to remove bearing (46).

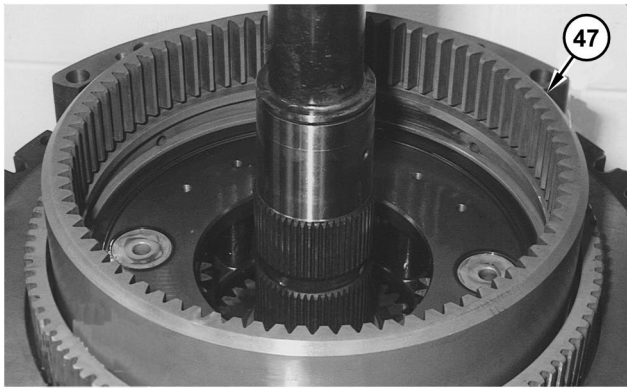


Illustration 450 g01235286

34. Remove coupling gear (47).

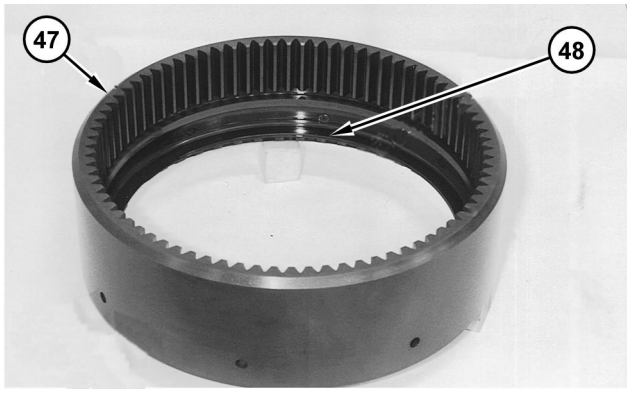


Illustration 451 g01235292

35. Remove retaining ring (48) from coupling gear (47).

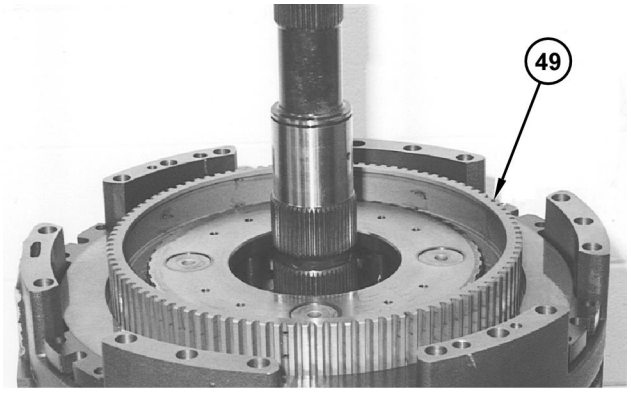


Illustration 452 g01235293

36. Remove ring gear (49).

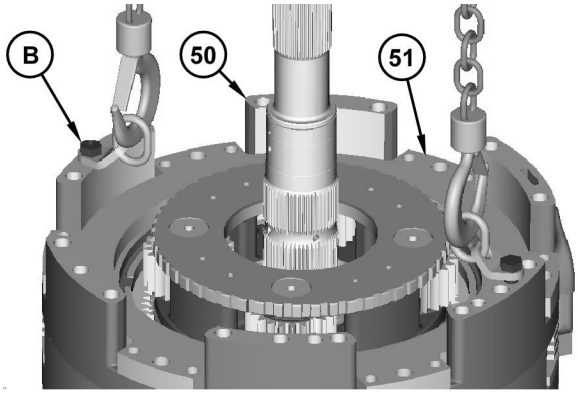


Illustration 453 g01234899

37. Use Tooling (B) and a suitable lifting device in order to remove clutch housing (50) and clutch piston (51) as a unit. The combined weight of clutch piston (51) and clutch housing (50) is approximately 77 kg (170 lb).

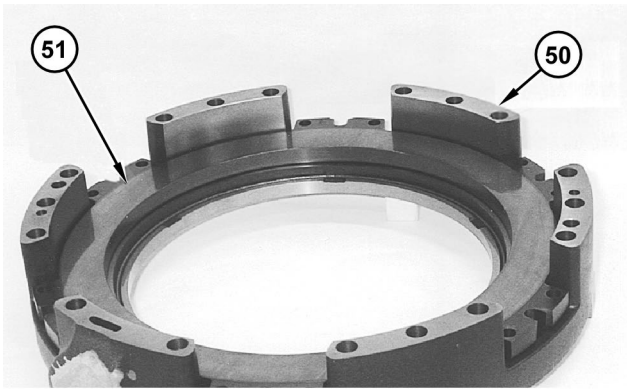


Illustration 454 g01235305

38. Remove clutch piston (51) from clutch housing (50). The weight of clutch piston (51) is approximately 21 kg (47 lb).

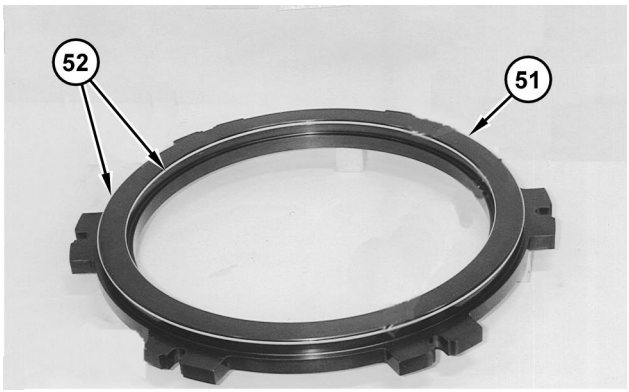


Illustration 455 g01235308

39. Remove seal rings (52) from clutch piston (51).

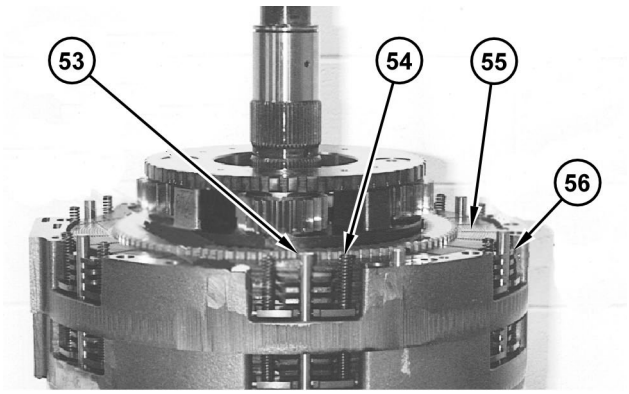


Illustration 456 g01235315

40. Remove pins (53), springs (54), clutch discs (55), and clutch plates (56).

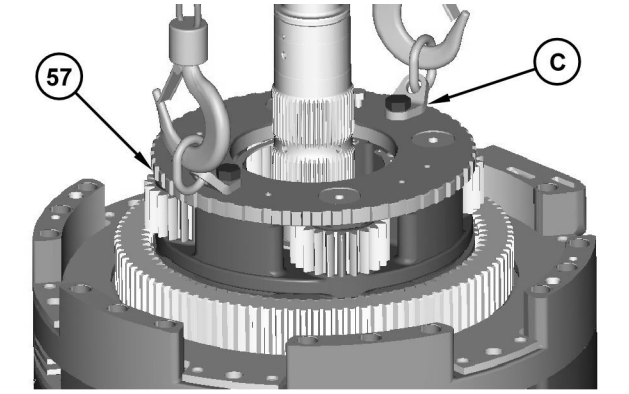


Illustration 457 g01235317

41. Use Tooling (C) and a suitable lifting device in order to remove planetary carrier assembly (57). The weight of planetary carrier assembly (57) is approximately 59 kg (130 lb).

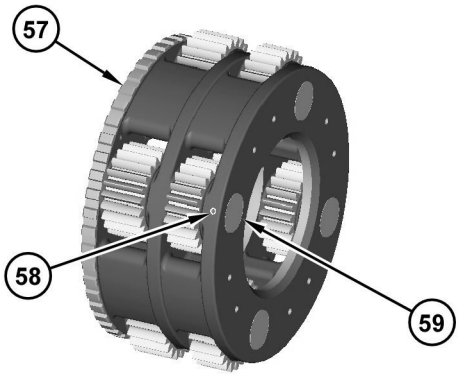


Illustration 458 g01235672

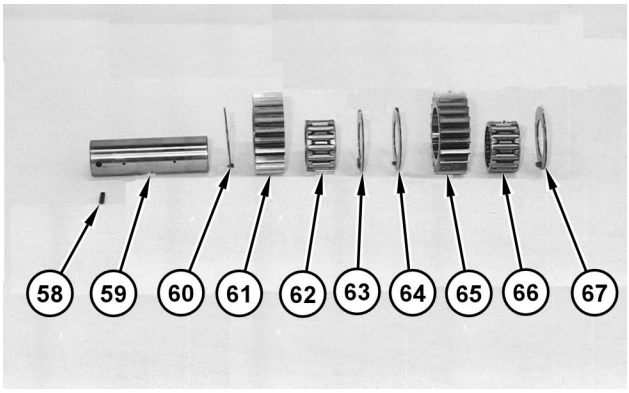


Illustration 459 g01235675

42. Drive spring pin (58) into shaft (59).

43. Remove shaft (59) from planetary carrier assembly (57).

44. Remove washer (60), planetary gear (61), bearing assembly (62), washer (63), washer (64), planetary gear (65), bearing assembly (66), and washer (67). Repeat this procedure in order to remove the remaining planetary gears from planetary carrier assembly (57).

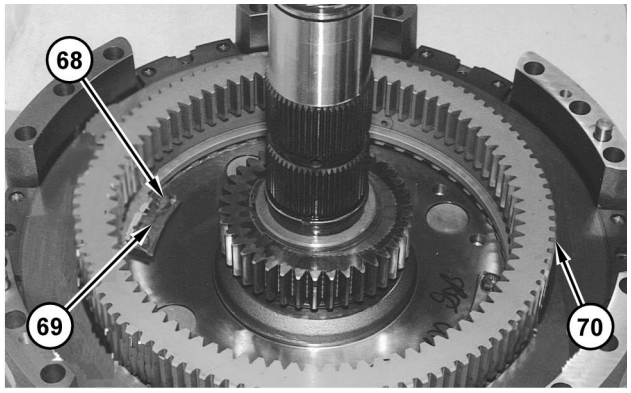


Illustration 460 g01235680

45. Remove bolts (68), locks (69), and ring gear (70).

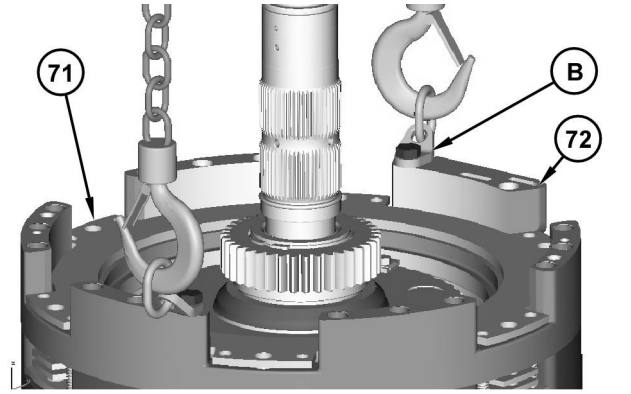


Illustration 461 g01235684

46. Use Tooling (B) and a suitable lifting device in order to remove clutch housing (72) and clutch piston (71) as a unit. The combined weight of clutch housing (72) and clutch piston (71) is approximately 86 kg (190 lb).

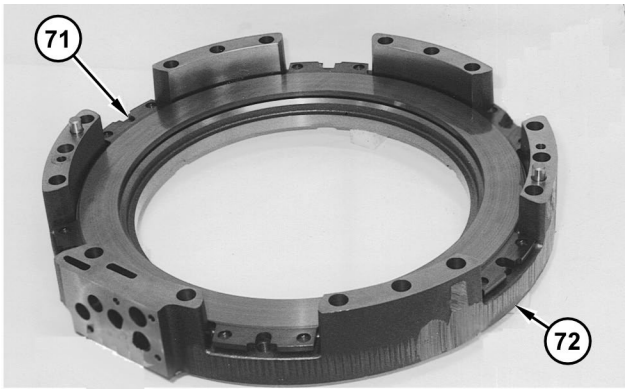


Illustration 462 g01235688

47. Remove clutch piston (71) from clutch housing (72). The weight of clutch housing (72) is approximately 64 kg (140 lb).

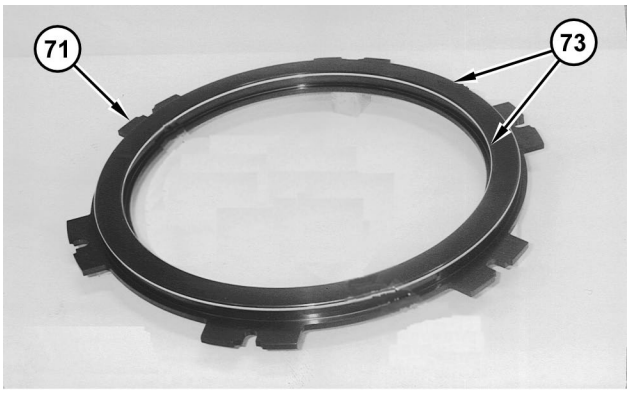


Illustration 463 g01235691

48. Remove seal rings (73) from clutch piston (71).

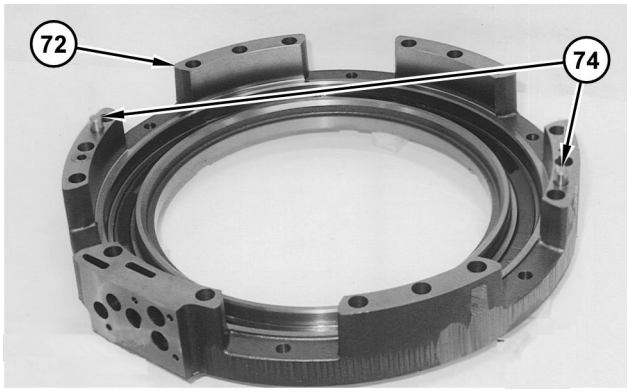


Illustration 464 g01235704

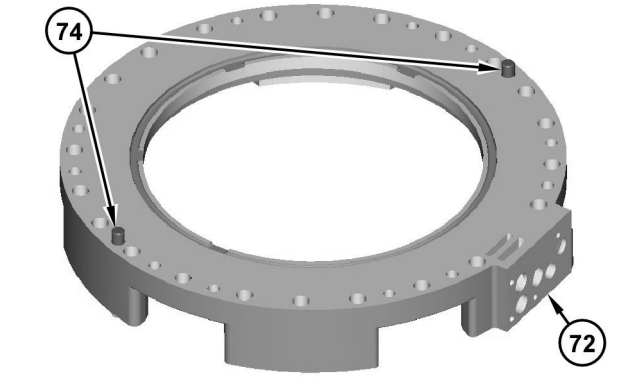


Illustration 465 g01235708

49. Remove dowels (74) from clutch housing (72).

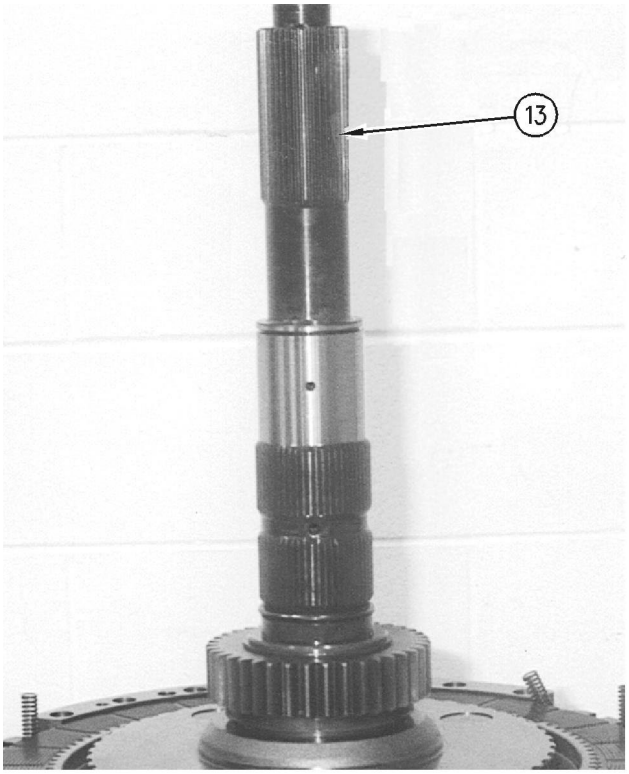


Illustration 466 g00852929

50. Use two people in order to remove input shaft (13). The weight of input shaft (13) is approximately 32 kg (70 lb).

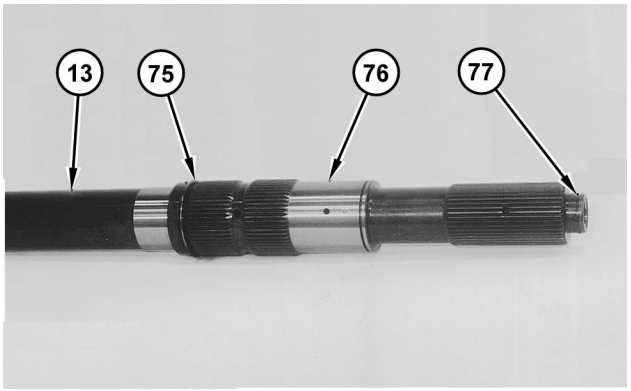


Illustration 467 g01235711

51. Remove dowel (76), ring (75), and seal ring (77) from input shaft (13).

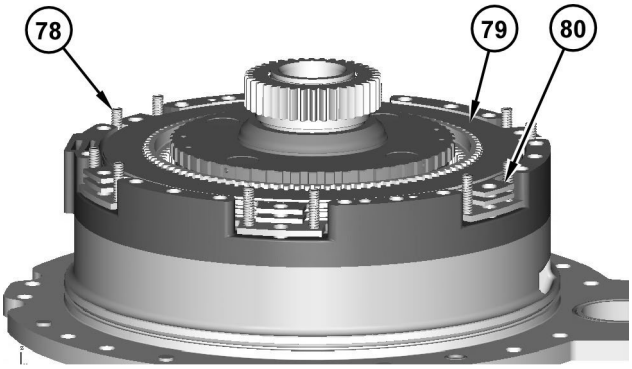


Illustration 468 g01235728

52. Remove springs (78), clutch discs (79), and clutch plates (80).

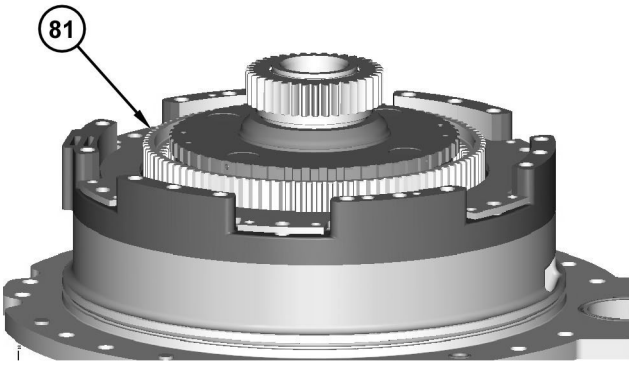


Illustration 469 g01235735

53. Remove ring gear (81).

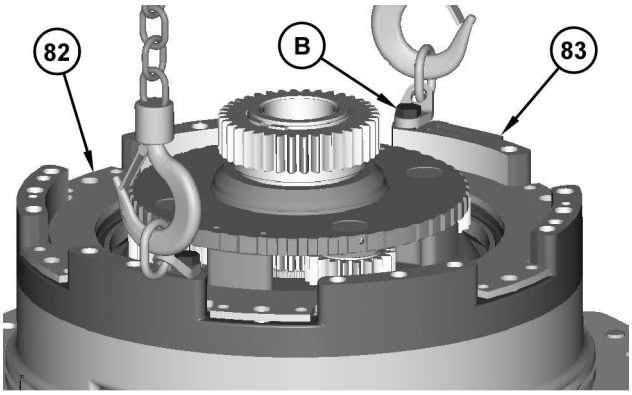


Illustration 470 g01235779

54. Use Tooling (B) in order to remove clutch housing (83) and clutch piston (82) as a unit. The combined weight of clutch piston (82) and clutch housing (83) is approximately 54 kg (120 lb).

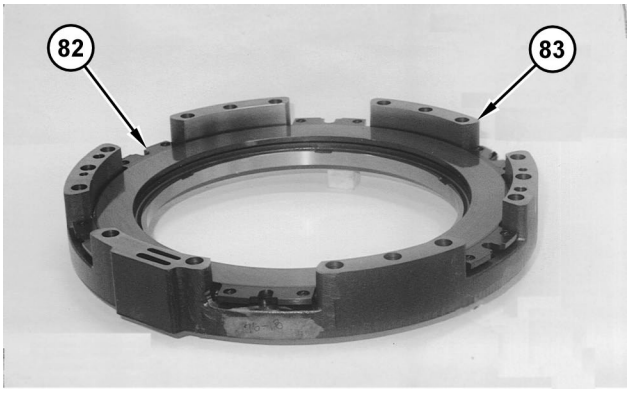


Illustration 471 g01235789

55. Remove clutch piston (82) from clutch housing (83). The weight of clutch piston (82) is approximately 41 kg (90 lb).

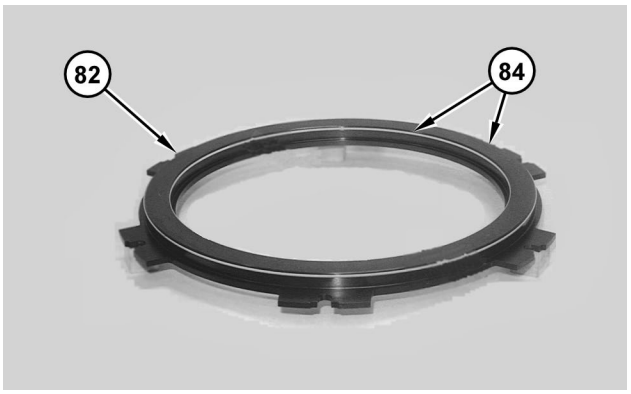


Illustration 472 g01235791

56. Remove seal rings (84) from clutch piston (82).



Illustration 473 g01236970

57. Remove retaining ring (85).

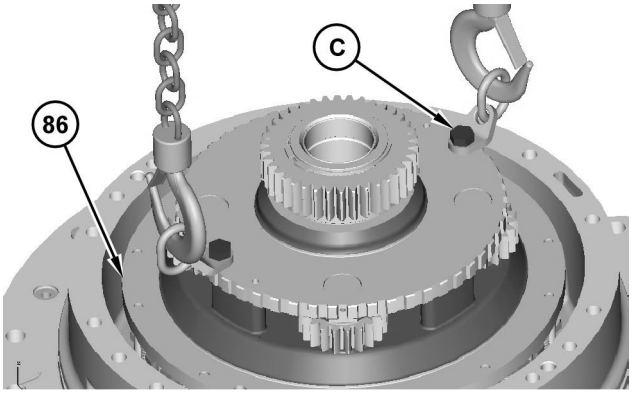


Illustration 474 g01236972

58. Use Tooling (C) and a suitable lifting device in order to remove planetary carrier assembly (86). The weight of planetary carrier assembly (86) is approximately 186 kg (410 lb).

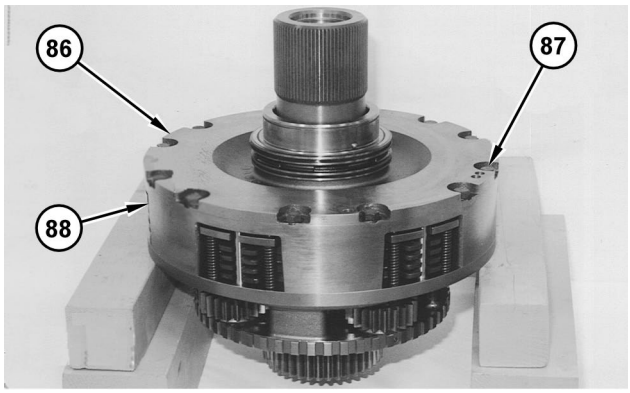


Illustration 475 g01236977

59. Turn over planetary carrier assembly (86).

60. Place planetary carrier assembly (86) on suitable blocking, as shown.

61. Remove bolts (87) from clutch housing (88).

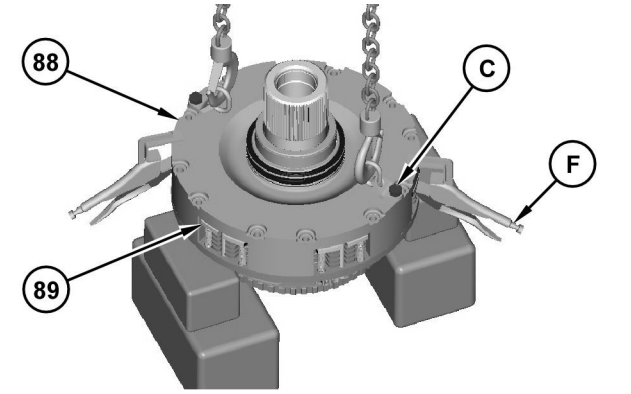


Illustration 476 g01236981

62. Use Tooling (F) in order to hold clutch piston (89) in clutch housing (88).

63. Use Tooling (C) and a suitable lifting device in order to remove clutch housing (88) and clutch piston (89) as a unit. The combined weight of clutch housing (88) and clutch piston (89) is approximately 61 kg (135 lb).

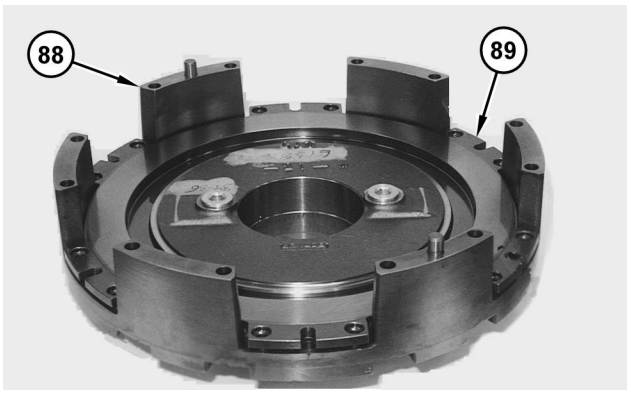


Illustration 477 g01236995

64. Remove clutch piston (89) from clutch housing (88). The weight of clutch housing (88) is approximately 41 kg (90 lb).

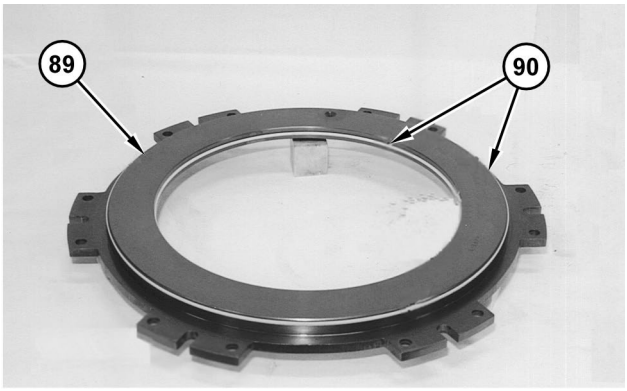


Illustration 478 g01236997

65. Remove seal rings (90) from clutch piston (89).

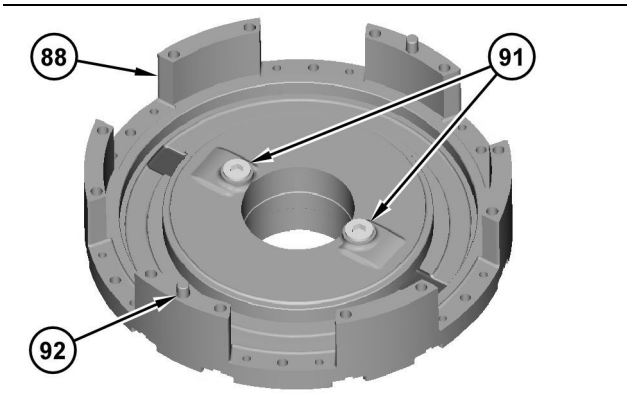


Illustration 479 g01237002

66. Remove plugs (91) and remove dowels (92) from clutch housing (88).

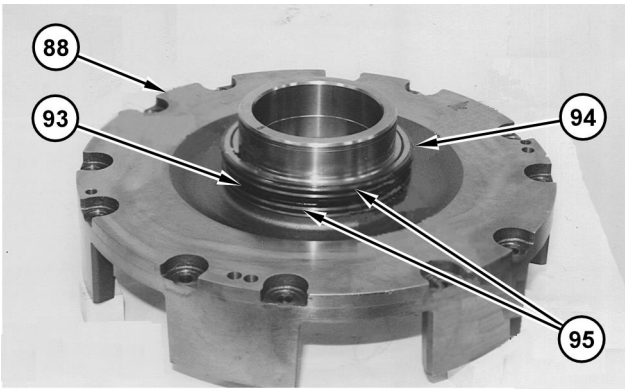


Illustration 480 g01237004

67. Turn over clutch housing (88).

68. Remove dowel (93) from clutch housing (88).

69. Remove seal rings (95) from carrier ring (94).

70. Remove carrier ring (94) from clutch housing (88).

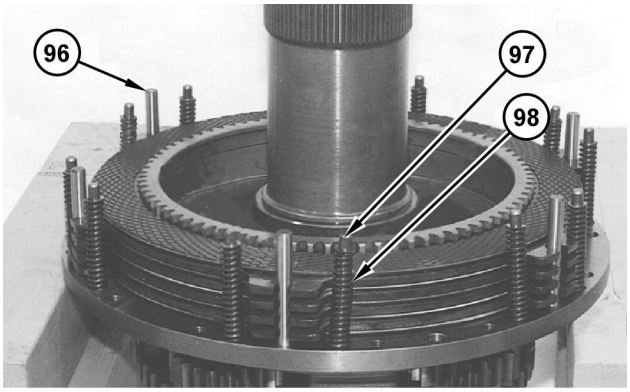


Illustration 481 g01237011

71. Remove pins (96).

72. Remove springs (98) and remove pins (97).

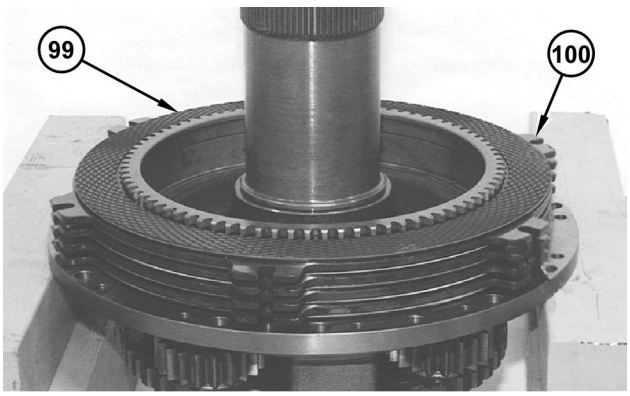


Illustration 482 g01239177

73. Remove clutch discs (99) and remove clutch plates (100).

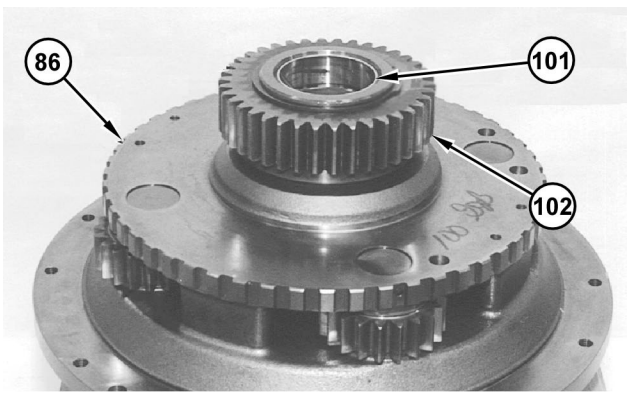


Illustration 483 g01237038

74. Turn over planetary carrier assembly (86).

75. Use Tooling (D) in order to remove retaining ring (101) from the output shaft.

76. Remove sun gear (102) from the output shaft.

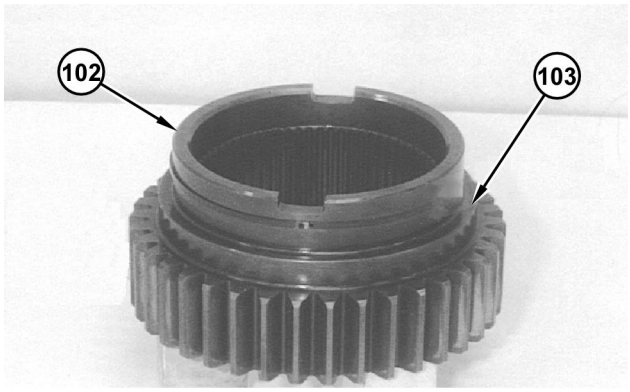


Illustration 484 g01237045

77. Remove seal ring (103) from sun gear (102).

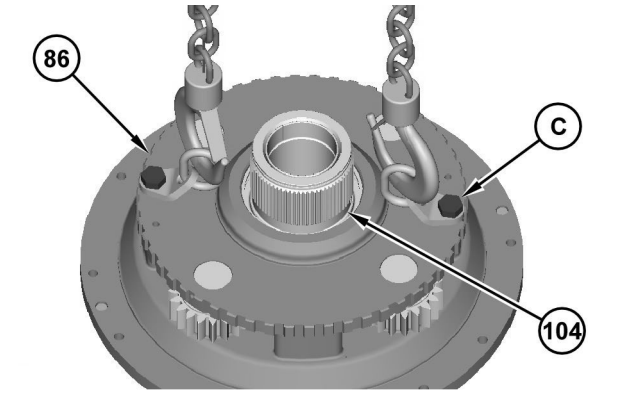


Illustration 485 g01237047

78. Use Tooling (C) and a suitable lifting device in order to remove planetary carrier assembly (86) from output shaft assembly (104). The weight of planetary carrier assembly (86) is approximately 52 kg (115 lb).

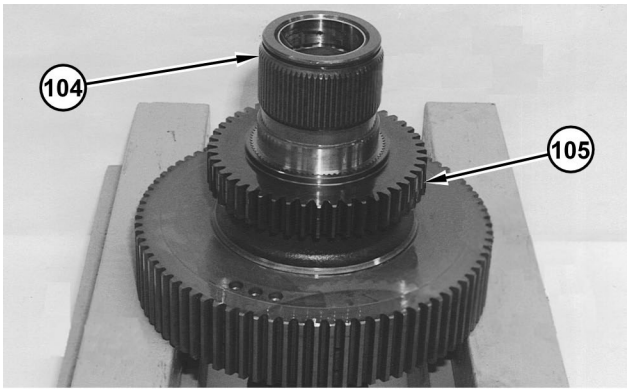


Illustration 486 g01237061

79. Remove sun gear (105) from output shaft (104).

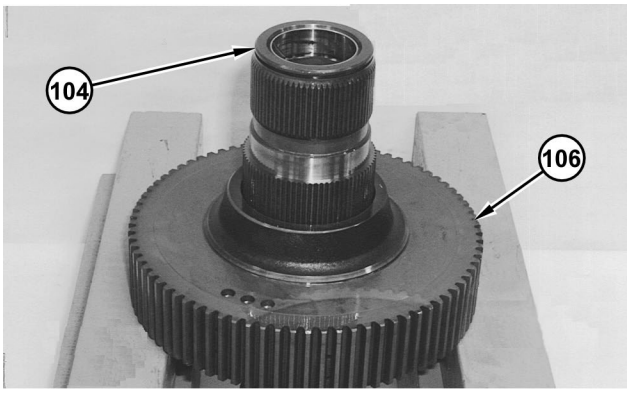


Illustration 487 g01237066

80. Remove rotating hub (106) from output shaft assembly (104). The weight of rotating hub (106) is approximately 20 kg (45 lb).

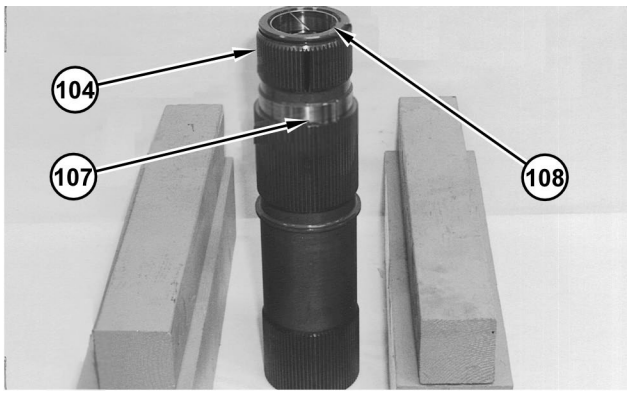


Illustration 488 g01237074

81. Inspect dowel (107). Replace output shaft assembly (104) if dowel (107) is worn or damaged.

82. Remove bearing sleeve (108) from each end of output shaft assembly (104). The weight of output shaft assembly (104) is approximately 27 kg (60 lb).

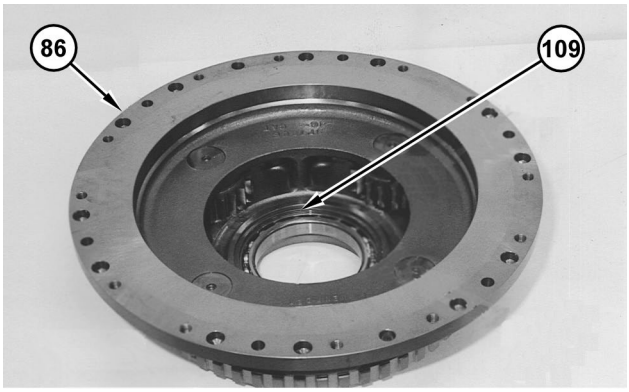


Illustration 489 g01237089

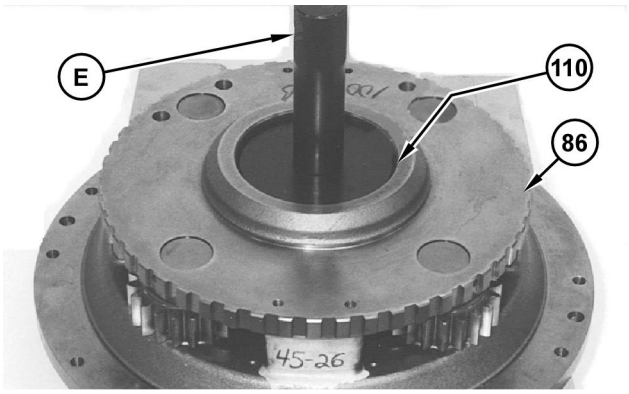


Illustration 490 g01237092

83. Use Tooling (G) in order to remove retaining ring (109) from planetary carrier assembly (86).

84. Use Tooling (E) in order to remove bearing assembly (110) from planetary carrier assembly (86).

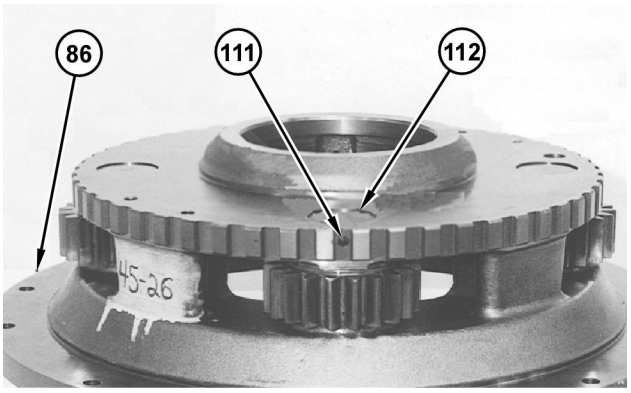


Illustration 491 g01237095

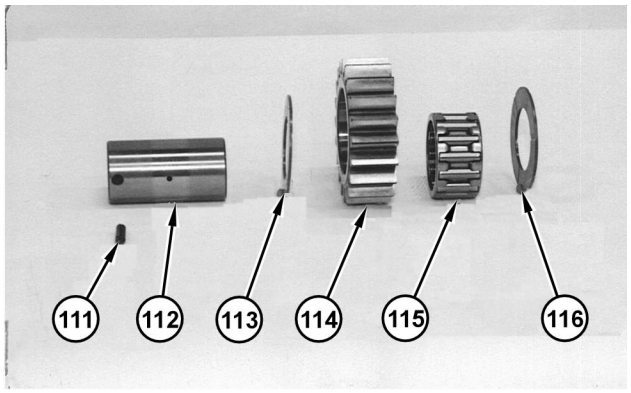


Illustration 492 g01237122

85. Drive spring pin (111) into shaft (112).

86. Remove shaft (112) from planetary carrier assembly (86).

87. Remove washer (113), planetary gear (114), bearing assembly (115), and washer (116). Repeat this procedure in order to remove the remaining planetary gears from planetary carrier assembly (86).

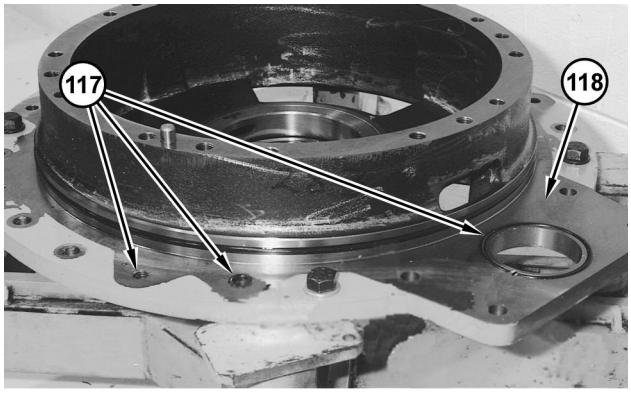


Illustration 493 g01237130

88. Remove O-ring seals (117) from support housing (118).

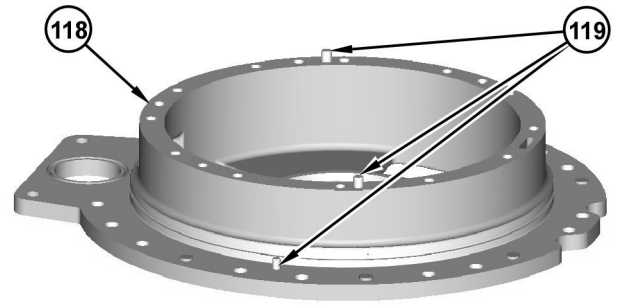


Illustration 494 g01237143

89. Remove dowels (119) from support housing assembly (118).

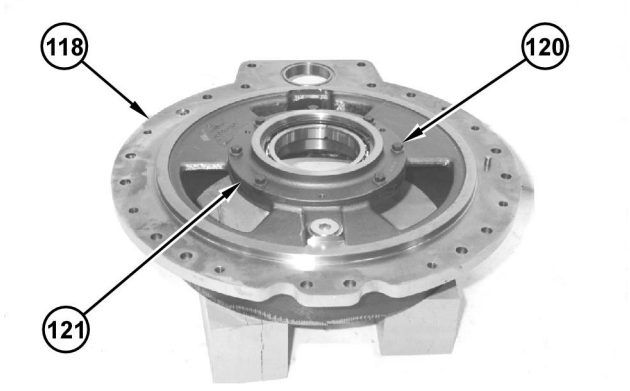


Illustration 495 g01237163

90. Turn over support assembly (118), as shown.

91. Remove bolts (120) from bearing cage (121).

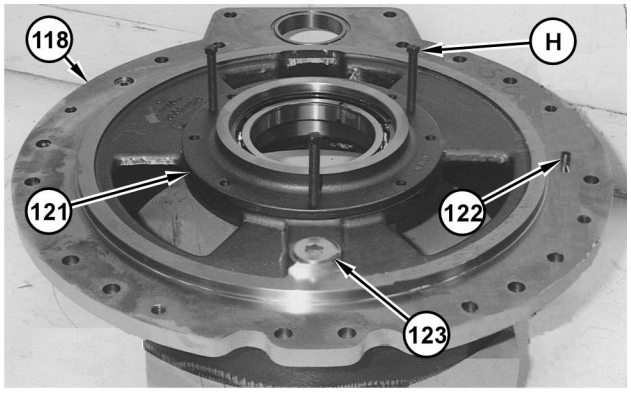


Illustration 496 g01237170

92. Install Tooling (H) in order to separate bearing cage (121) from support housing assembly (118).

93. Remove dowel (122) and remove plug (123).

94. Remove bearing cage (121) from support housing assembly (118).

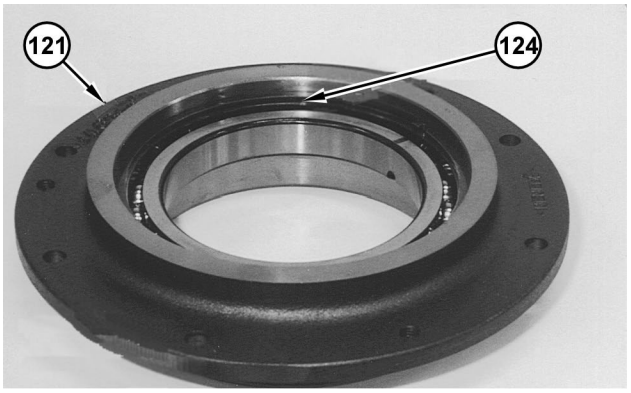


Illustration 497 g01237173

95. Remove retaining ring (124) from bearing cage (121).

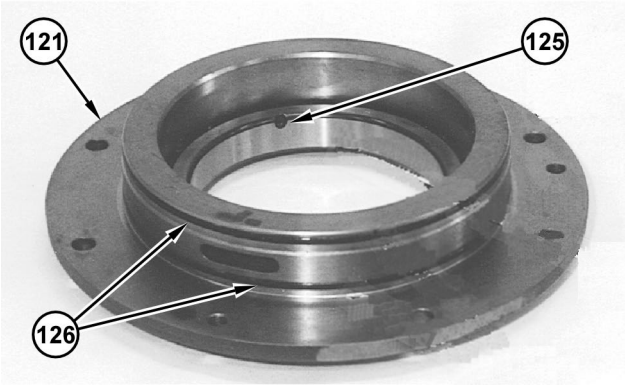


Illustration 498 g01237175

96. Remove bearing assembly (125) from bearing cage (121).

97. Remove O-ring seals (126) from bearing cage (121).

i02473484

Transmission Planetary - Assemble

SMCS Code: 3160-016

Assembly Procedure

Table 18

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2420	Transmission Repair Stand	1
B	138-7575	Link Bracket	2
C	138-7573	Link Bracket	2
D	1P-1863	Pliers	1
E	1P-0520	Driver Group	1
F	FT-0833	Clamp	1
G	1P-1861	Pliers	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

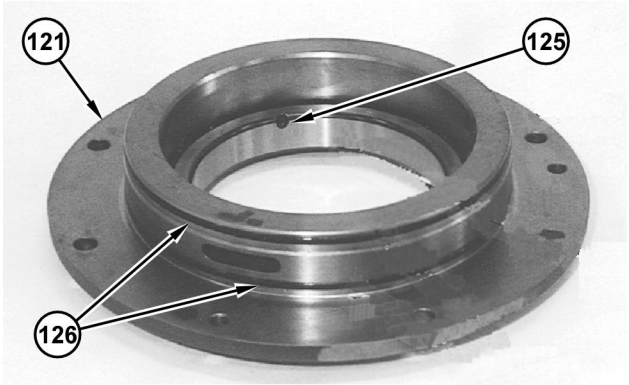


Illustration 499 g01237175

1. Install O-ring seals (126) onto bearing cage (121).

2. Install bearing assembly (125) into bearing cage (121).

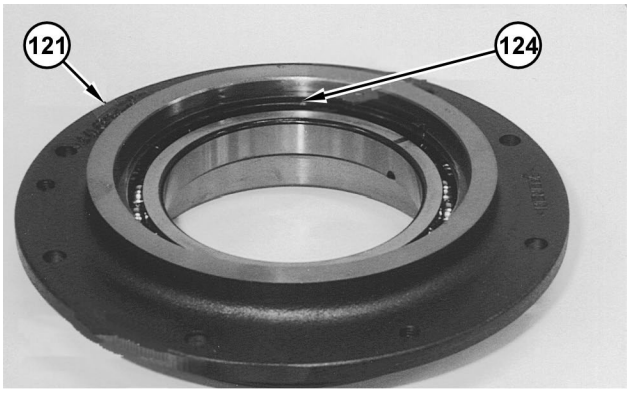


Illustration 500 g01237173

3. Install retaining ring (124) into bearing cage (121).

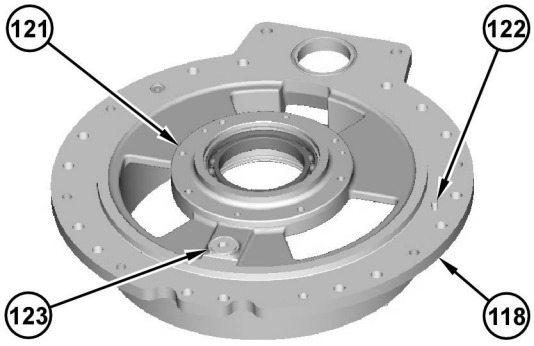


Illustration 501 g01239216

4. Install bearing cage (121) into support housing assembly (118).

5. Install dowel (122) and install plug (123) into support housing assembly (118).

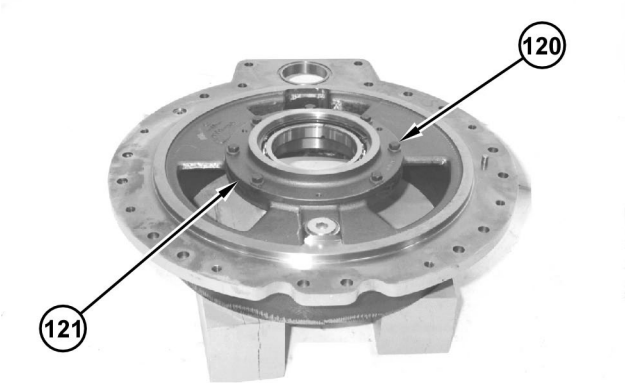


Illustration 502 g01239225

6. Install bolts (120) onto bearing cage (121).

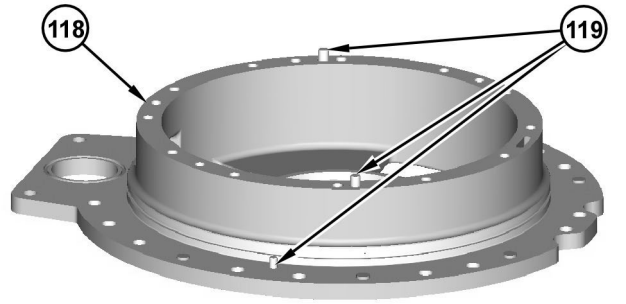


Illustration 503 g01237143

7. Turn over support housing assembly (118).

8. Install dowels (119) onto support housing assembly (118).

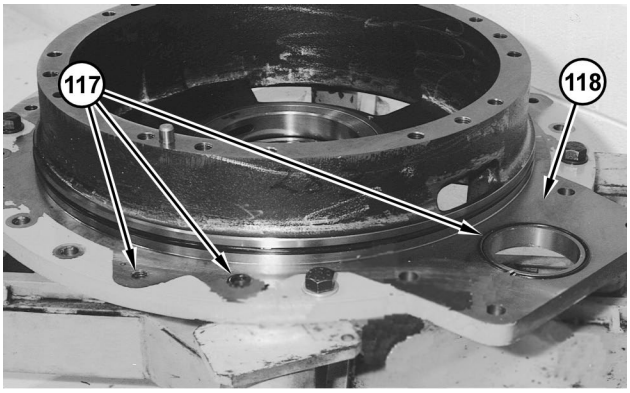


Illustration 504 g01237130

9. Install O-ring seals (117) onto support housing (118).

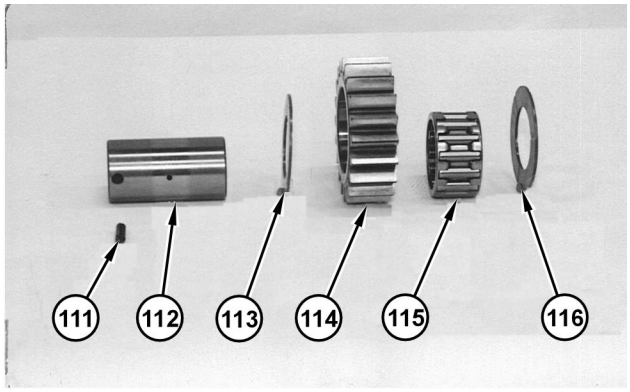


Illustration 505 g01237122

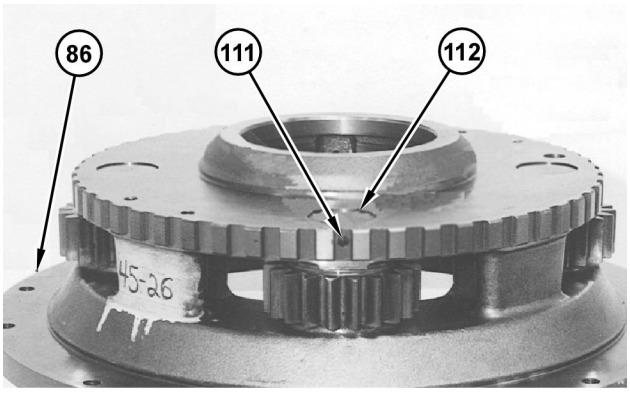


Illustration 506 g01237095

10. Apply clean oil onto bearing assembly (115).

11. Install bearing assembly (115) into planetary gear (114).

12. Install washer (116) and install washer (113), as shown.

13. Install planetary gear (114) into planetary carrier assembly (86).

14. Install shaft (112).

15. Align the spring pin hole in shaft (112) with the spring pin hole in planetary carrier assembly (86).

16. Install spring pin (111).

Note: The outer edge of the spring pin must be even with the outer edge of the planetary carrier.

17. Repeat Steps 10 through 16 in order to install the remaining planetary gears.

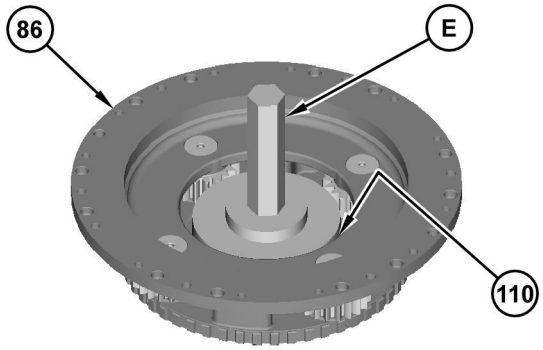


Illustration 507 g01237260

18. Turn over planetary carrier assembly (86), as shown.

19. Use Tooling (E) in order to install bearing assembly (110) into planetary carrier assembly (86).

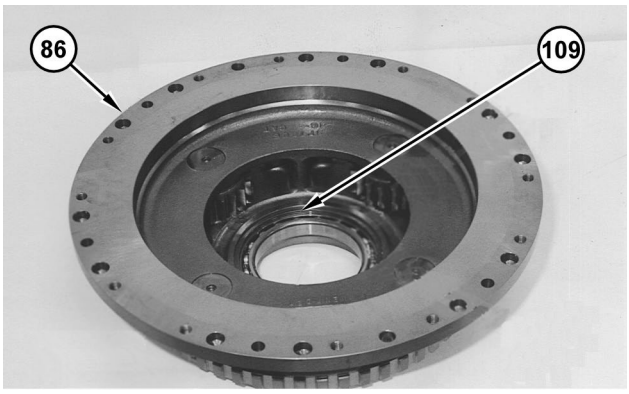


Illustration 508 g01237089

20. Use Tooling (G) in order to install retaining ring (109) into planetary carrier assembly (86).

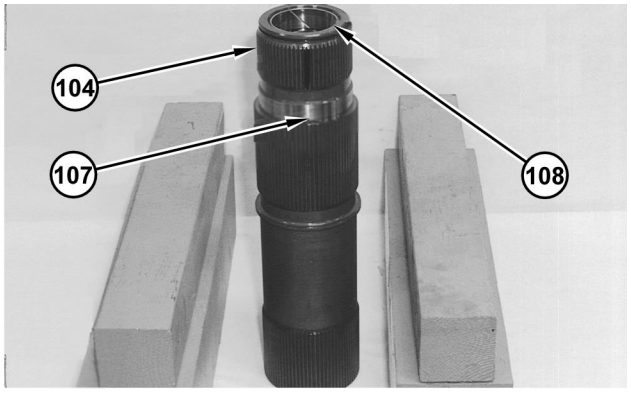


Illustration 509 g01237074

21. Use Tooling (E) in order to install bearing sleeve (108) into each end of output shaft assembly (104).

22. Inspect dowel (107). Replace output shaft assembly (104) if dowel (107) is worn or damaged.

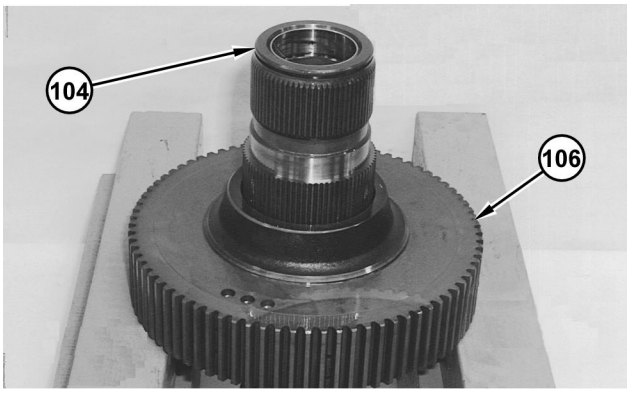


Illustration 510 g01237066

23. Install rotating hub (106) onto output shaft assembly (104). The weight of rotating hub (106) is 20 kg (45 lb).

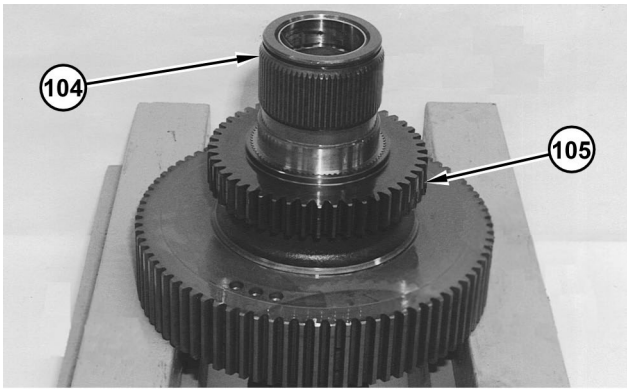


Illustration 511 g01237061

24. Install sun gear (105) onto output shaft (104).

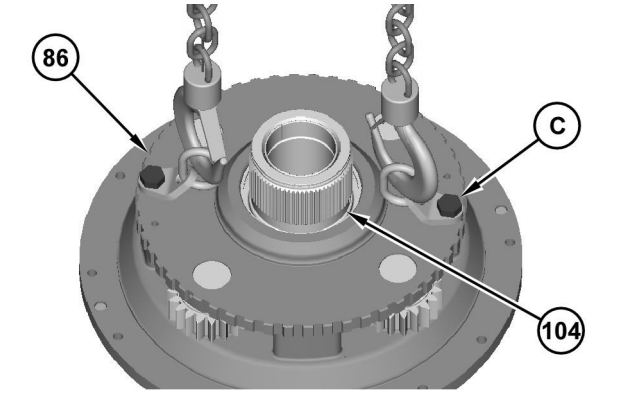


Illustration 512 g01237047

25. Use Tooling (C) and a suitable lifting device in order to install planetary carrier assembly (86) onto output shaft assembly (104). The weight of planetary carrier assembly (86) is approximately 52 kg (115 lb).

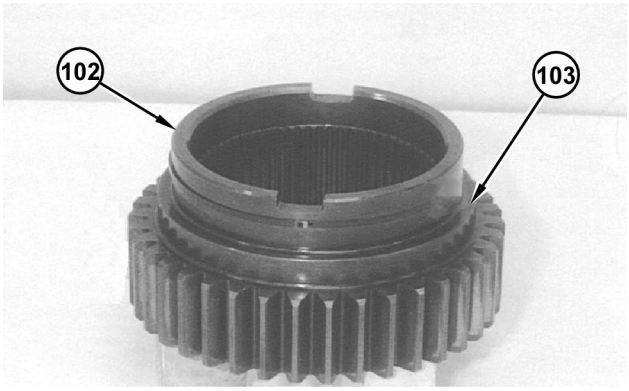


Illustration 513 g01237045

26. Install seal ring (103) onto sun gear (102).

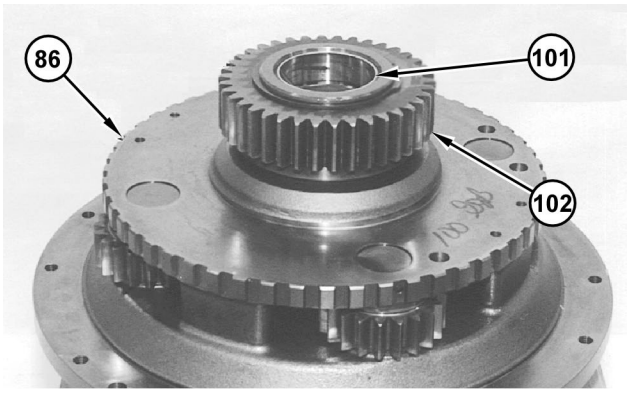


Illustration 514 g01237038

27. Install sun gear (102).

28. Use Tooling (D) in order to install retaining ring (101).

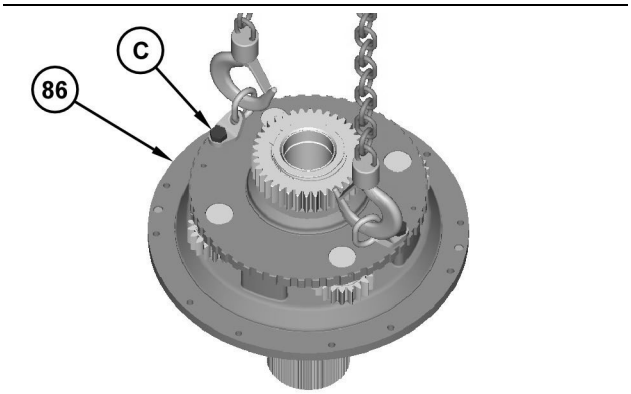


Illustration 515 g01239477

29. Use Tooling (C) and a suitable lifting device in order to turn over planetary carrier assembly. The weight of planetary carrier assembly (86) is approximately 110 kg (243 lb).

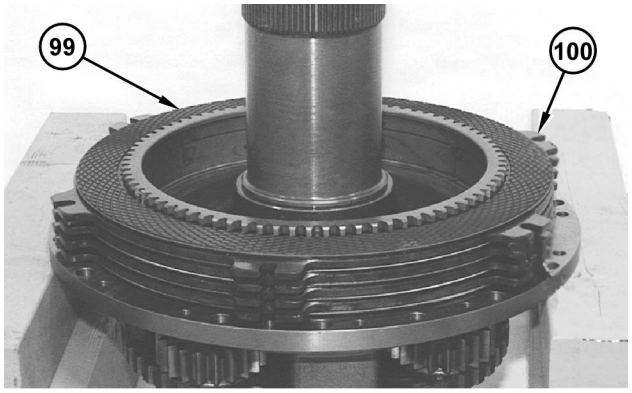


Illustration 516 g01239177

30. Apply clean oil onto clutch discs (99) and clutch plates (100). Install clutch discs (99) and install clutch plates (100).

Note: Install clutch discs (99) and install clutch plates (100) in an alternating order. Start with a clutch disc and end with a clutch disc.

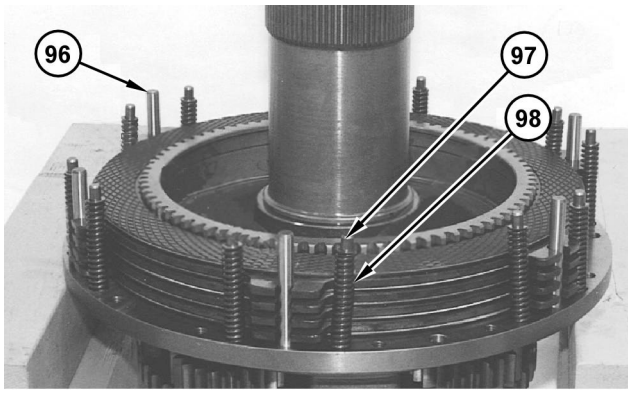


Illustration 517 g01237011

31. Install pins (96).

32. Install pins (98) and install springs (97).

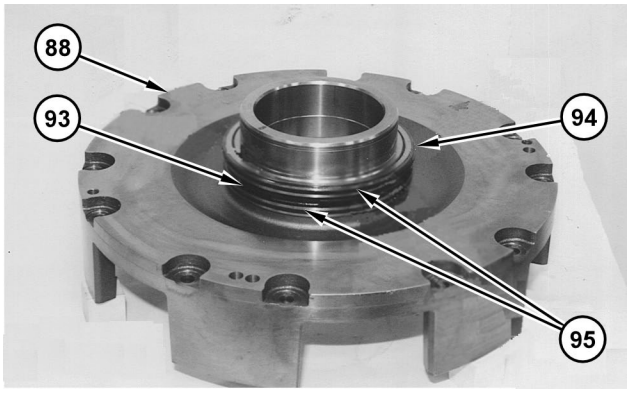


Illustration 518 g01237004

33. Raise the temperature of carrier ring (94) to 135 °C (275 °F).

34. Install carrier ring (94) onto clutch housing (88).

35. Install seal rings (95) onto carrier ring (94).

36. Install dowel (93) into clutch housing (88).

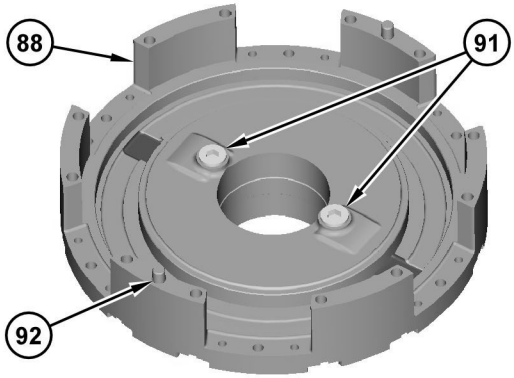


Illustration 519 g01237002

37. Install plugs (91) and install dowels (92) into clutch housing (88).

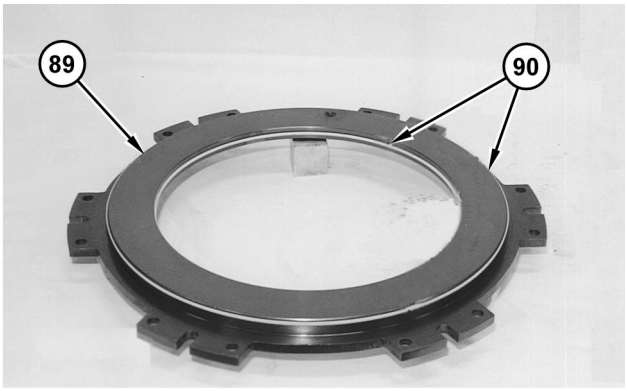


Illustration 520 g01236997

38. Apply clean oil onto seal rings (90).

39. Install seal rings (90) onto clutch piston (89).

Note: Install the seal rings so that the oil groove and the sealing edge are toward the inside of the clutch housing.

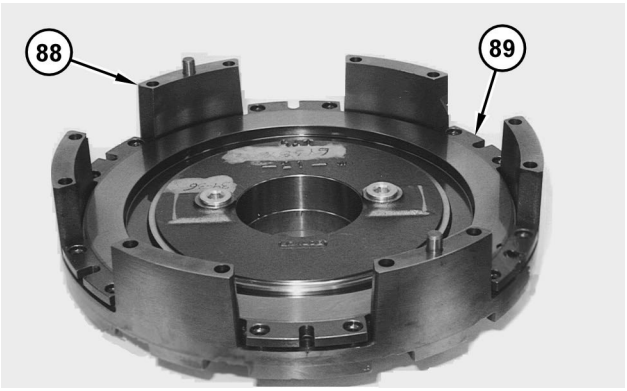


Illustration 521 g01236995

40. Install clutch piston (89) into clutch housing (88). The weight of clutch housing (88) is approximately 41 kg (90 lb).

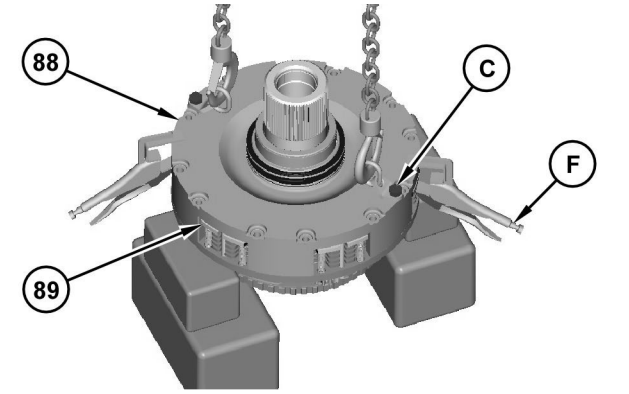


Illustration 522 g01236981

41. Attach Tooling (F) in order to hold clutch piston (89) into clutch housing (88).

42. Use Tooling (C) and a suitable lifting device in order to install clutch housing (88) and clutch piston (89) as a unit. The combined weight of clutch housing (88) and clutch piston (89) is approximately 61 kg (135 lb).

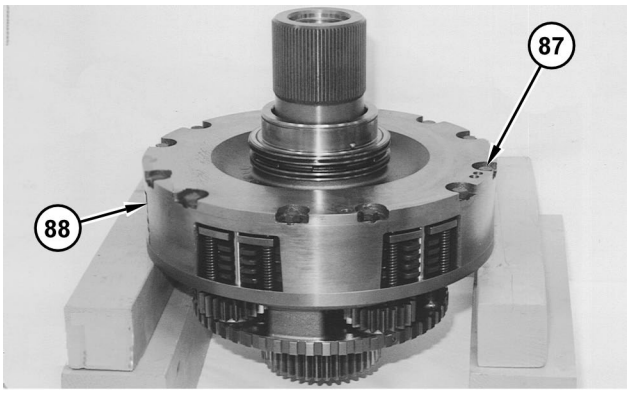


Illustration 523 g01239253

43. Install bolts (87) onto clutch housing (88). Tighten bolts (87) to a torque of 115 ± 7 N·m (85 ± 5 lb ft).

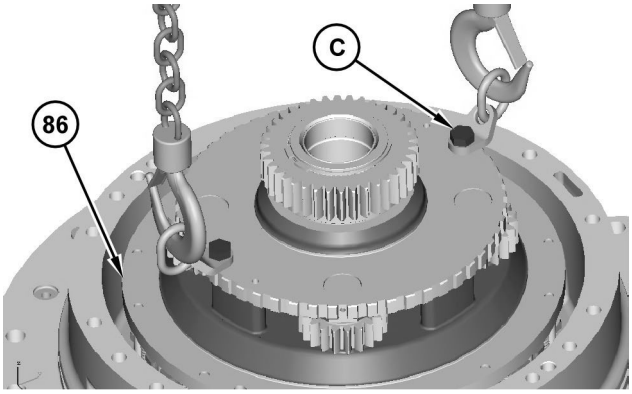


Illustration 524 g01236972

44. Use Tooling (C) and a suitable lifting device in order to turn over planetary carrier assembly (86). The weight of planetary carrier assembly (86) is approximately 186 kg (410 lb).

45. Use Tooling (C) and a suitable lifting device in order to install planetary carrier assembly (86).

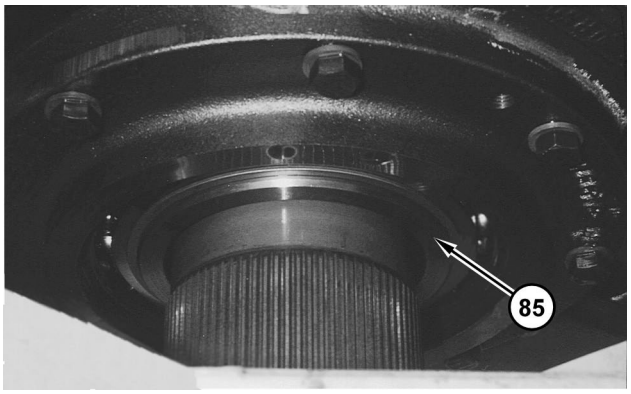


Illustration 525 g01236970

46. Install retaining ring (85).

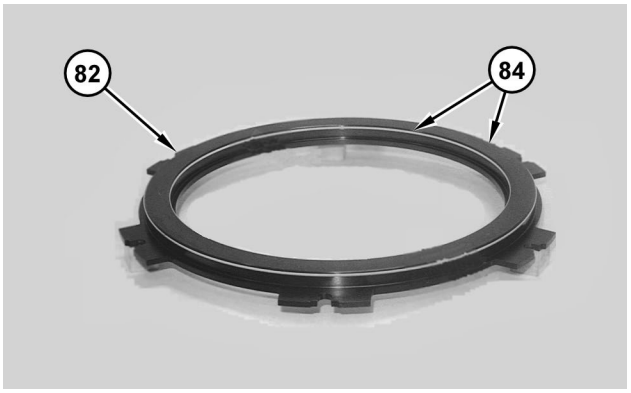


Illustration 526 g01235791

47. Apply clean oil onto seal rings (84).

48. Install seal rings (84) onto clutch piston (82).

Note: Install the seal rings so that the oil groove and the sealing edge are toward the inside of the clutch housing.

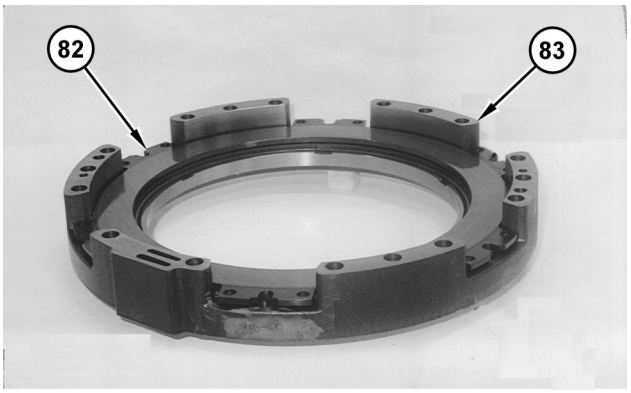


Illustration 527 g01235789

49. Install clutch piston (82) in clutch housing (83). The weight of clutch piston (82) is approximately 41 kg (90 lb).

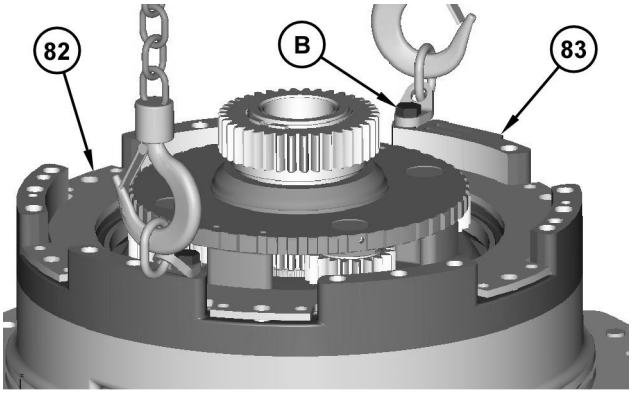


Illustration 528 g01235779

50. Use Tooling (B) in order to install clutch housing (83) and clutch piston (82) as a unit. The combined weight of clutch piston (82) and clutch housing (83) is approximately 54 kg (120 lb).

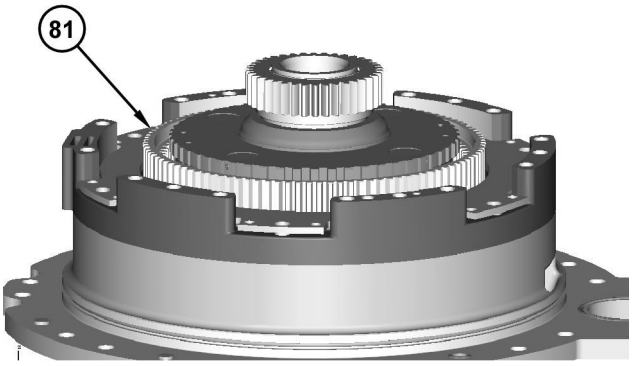


Illustration 529 g01235735

51. Install ring gear (81).

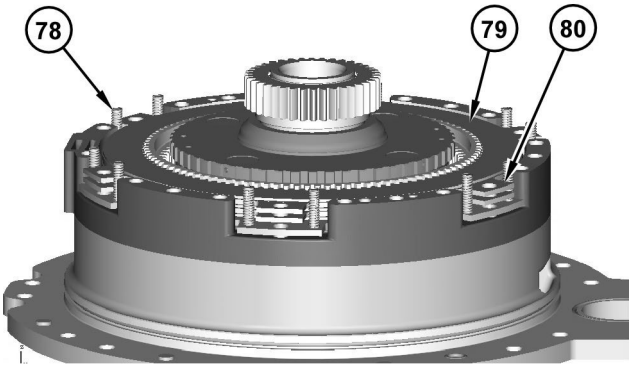


Illustration 530 g01235728

52. Apply clean oil onto clutch discs (79) and clutch plates (80). Install springs (78), clutch discs (79), and clutch plates (80).

Note: Install clutch discs (79) and clutch plates (80) in an alternating order. Start with a clutch disc and end with a clutch disc.

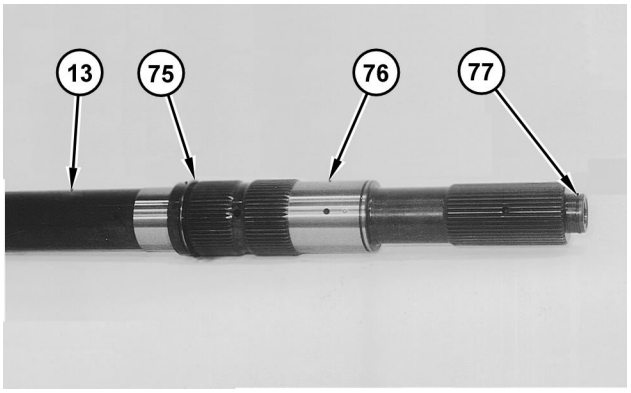


Illustration 531 g01235711

53. Apply clean oil onto seal ring (75).

54. Install dowel (76), ring (75), and seal ring (77) onto input shaft (13).

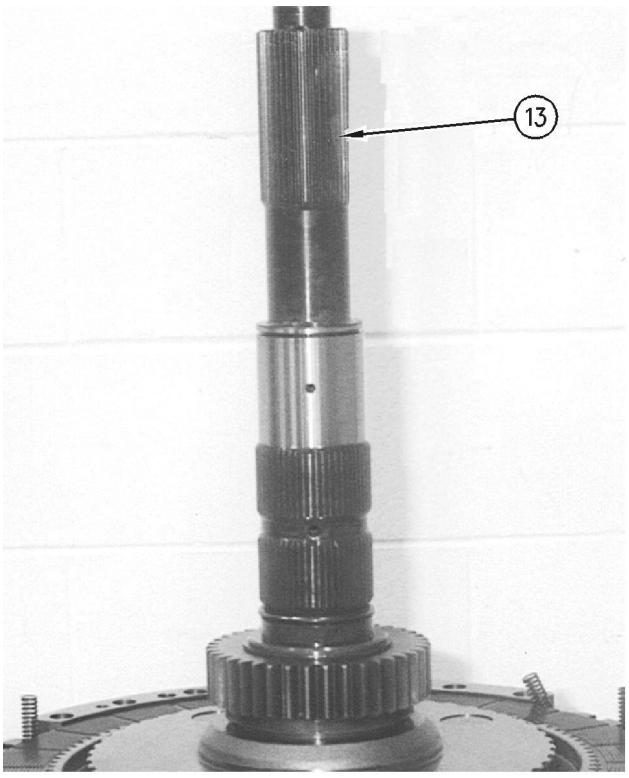


Illustration 532 g00852929

55. Use two people in order to install input shaft (13). The weight of input shaft (13) is approximately 32 kg (70 lb).

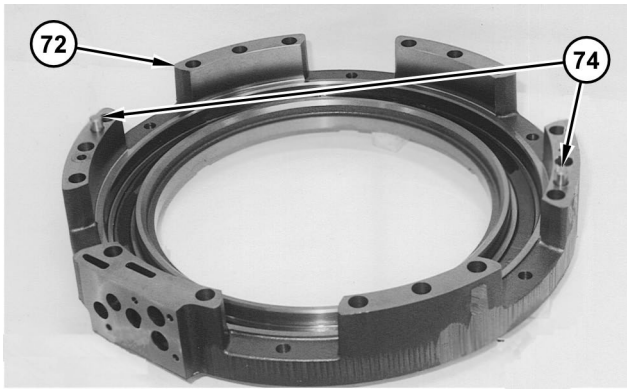


Illustration 533 g01235704

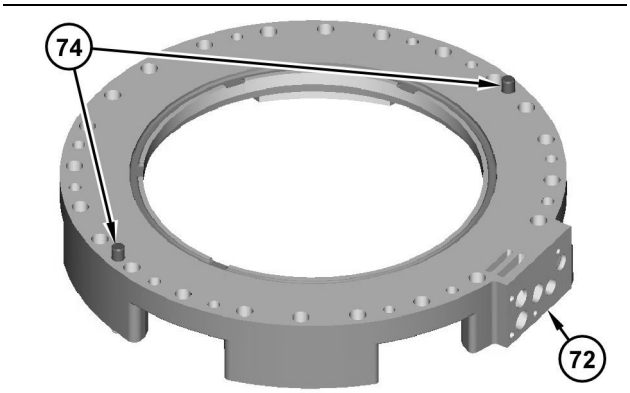


Illustration 534 g01235708

56. Install dowels (74) into clutch housing (72).

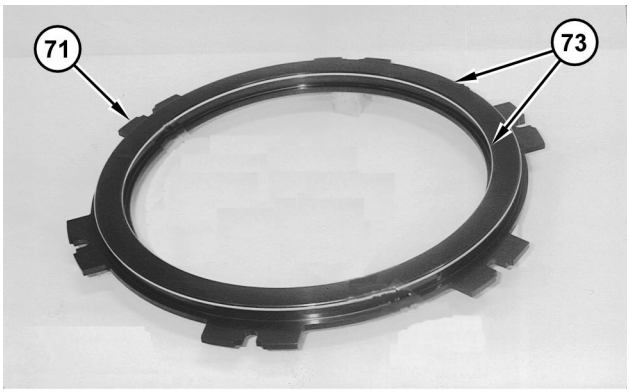


Illustration 535 g01235691

57. Apply clean oil onto seal rings (73).

58. Install seal rings (73) onto clutch piston (71).

Note: Install the seal rings so that the oil groove and the sealing edge will be toward the inside of the clutch housing.

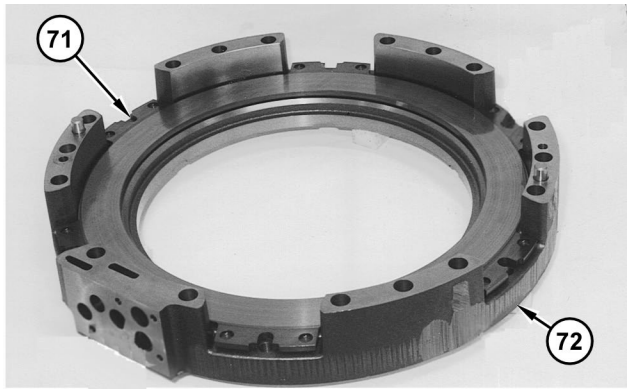


Illustration 536 g01235688

59. Install clutch piston (71) into clutch housing (72). The weight of clutch housing (72) is approximately 64 kg (140 lb).

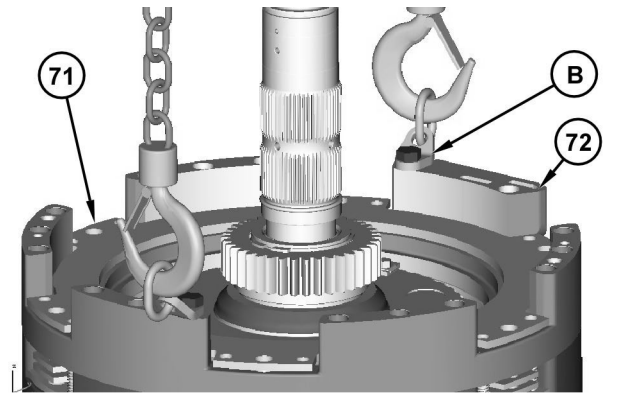


Illustration 537 g01235684

60. Use Tooling (B) and a suitable lifting device in order to install clutch housing (72) and clutch piston (71) as a unit. The combined weight of clutch housing (72) and clutch piston (71) is approximately 86 kg (190 lb).

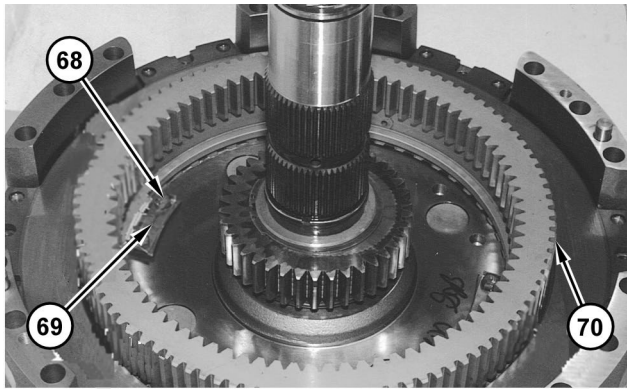


Illustration 538 g01235680

61. Install ring gear (70), locks (69), and bolts (68).

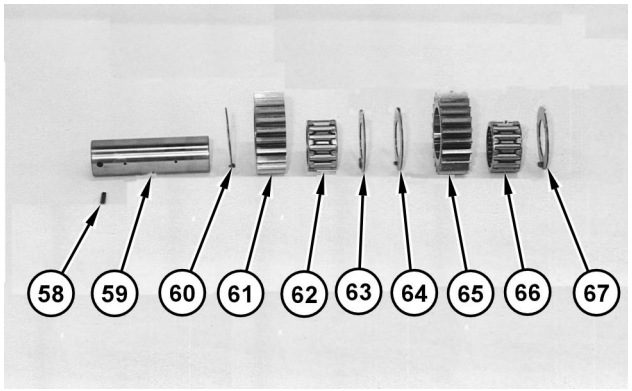


Illustration 539 g01235675

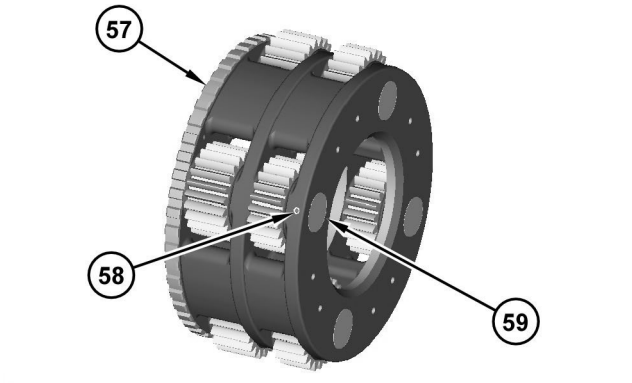


Illustration 540 g01235672

62. Apply clean oil onto bearing assembly (62) and bearing assembly (66).

63. Install bearing assembly (62) into planetary gear (61).

64. Install bearing assembly (66) into planetary gear (65).

65. Install washer (60) and install washer (63) onto planetary gear (61), as shown.

66. Install washer (64) and install washer (67) onto planetary gear (65), as shown.

67. Install planetary gear (61) and planetary gear (65) into planetary carrier assembly (57).

68. Install shaft (59).

69. Align the spring pin hole in shaft (59) with the spring pin hole in planetary carrier assembly (57).

70. Install spring pin (58). The outer edge of the spring pin must be even with the outer edge of the planetary carrier assembly.

71. Repeat Steps 62 through 70 in order to install the remaining planetary gears.

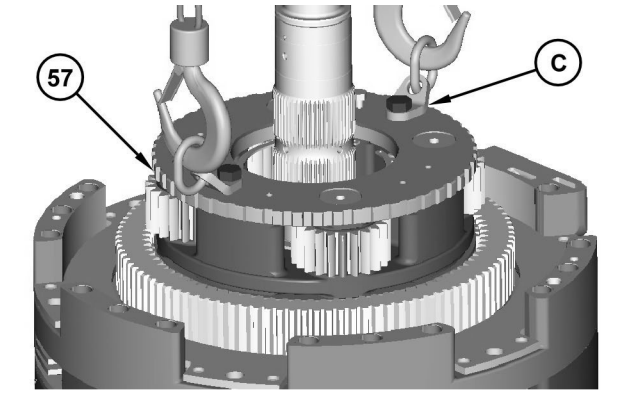


Illustration 541 g01235317

72. Use Tooling (C) and a suitable lifting device in order to install planetary carrier assembly (57). The weight of planetary carrier assembly (57) is approximately 59 kg (130 lb).

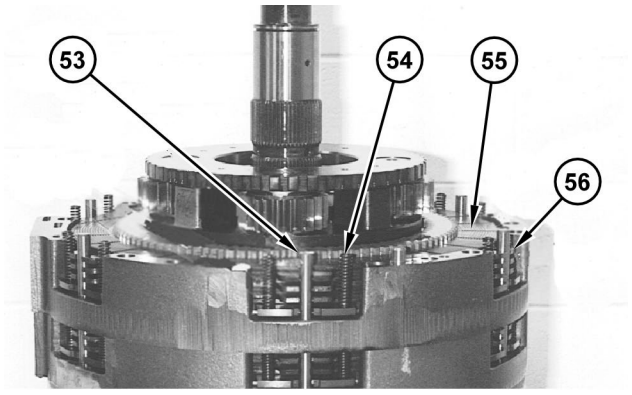


Illustration 542 g01235315

73. Apply clean oil onto clutch discs (55) and clutch plates (56).

74. Install pins (53), springs (54), clutch discs (55), and clutch plates (56).

Note: Install clutch discs (55) and clutch plates (56) in an alternating order. Start with a clutch disc and end with a clutch disc.

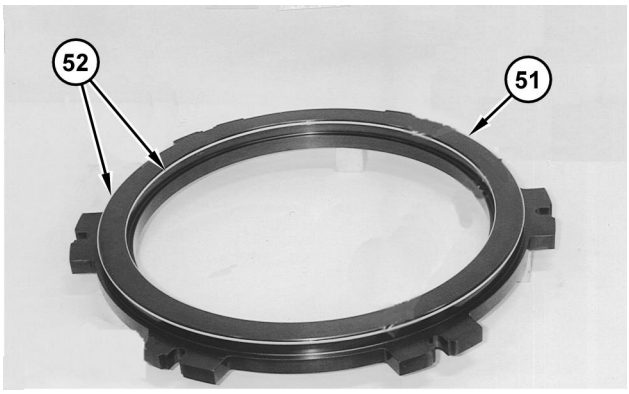


Illustration 543 g01235308

75. Apply clean oil onto seal rings (52).

76. Install seal rings (52) onto clutch piston (51).

Note: Install the seal rings so that the oil groove and the sealing edge will be toward the inside of the clutch housing.

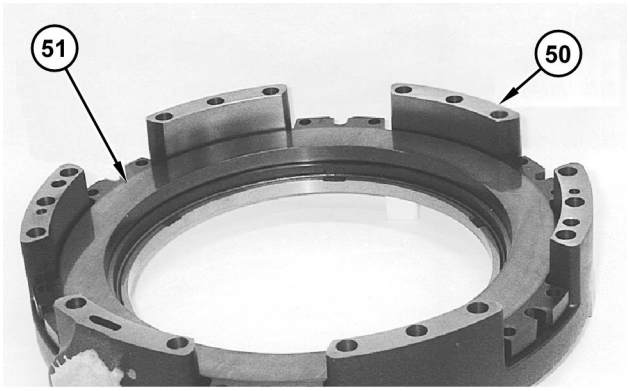


Illustration 544 g01235305

77. Install clutch piston (51) into clutch housing (50). The weight of clutch piston (51) is approximately 23 kg (50 lb).

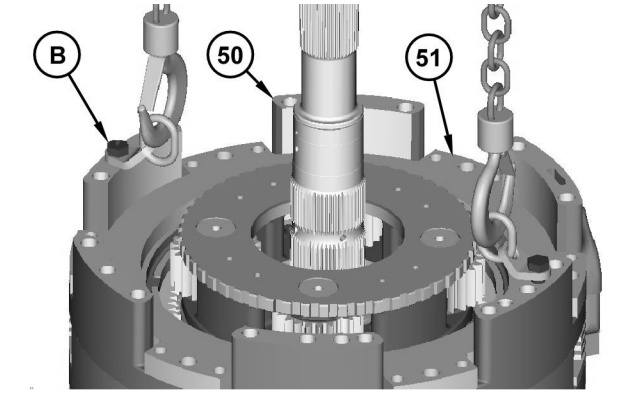


Illustration 545 g01234899

78. Use Tooling (B) and a suitable lifting device in order to install clutch housing (50) and clutch piston (51) as a unit. The combined weight of clutch piston (51) and clutch housing (50) is approximately 77 kg (170 lb).

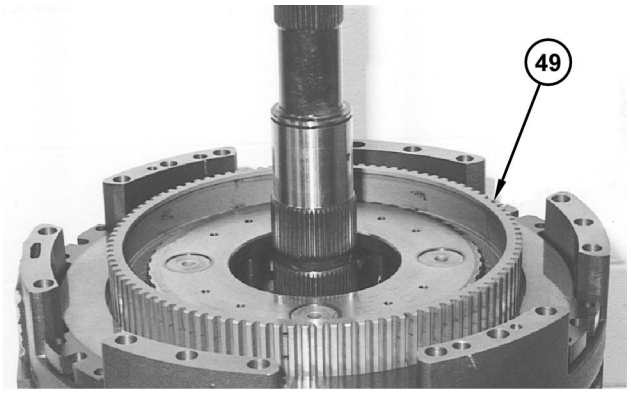


Illustration 546 g01235293

79. Install ring gear (49).

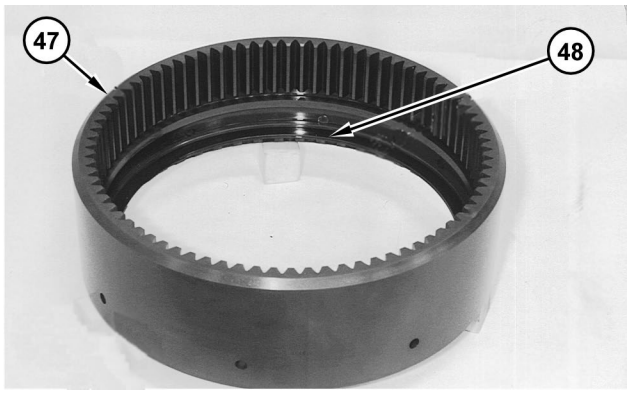


Illustration 547 g01235292

80. Install retaining ring (48) into coupling gear (47).

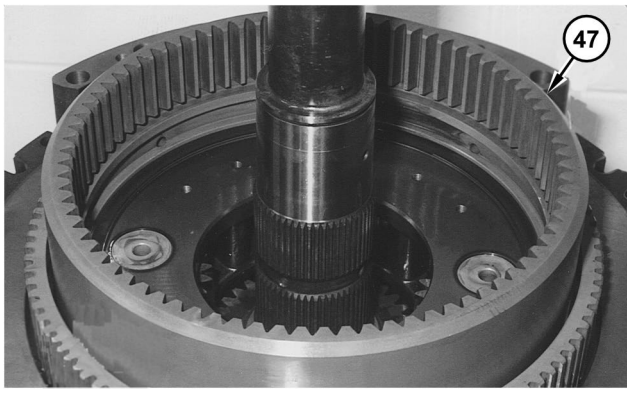


Illustration 548 g01235286

81. Install coupling gear (47).

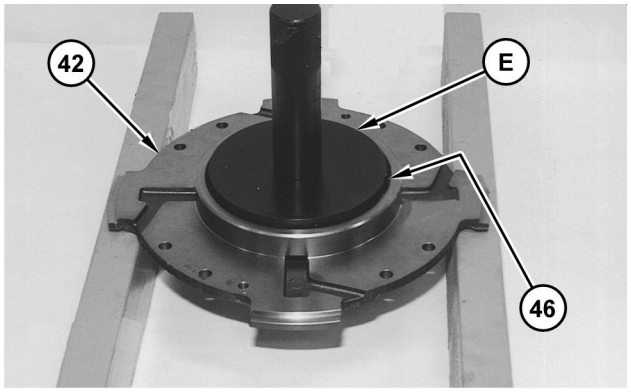


Illustration 549 g01237323

82. Place bearing cage (42) on suitable blocking.

83. Use Tooling (E) in order to install bearing (46), as shown.

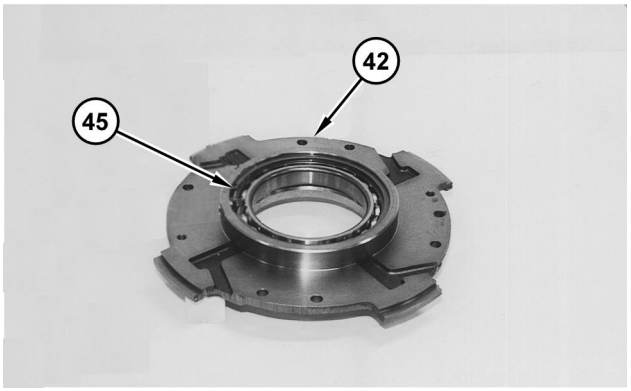


Illustration 550 g01235280

84. Install retaining ring (45) into bearing cage (42).

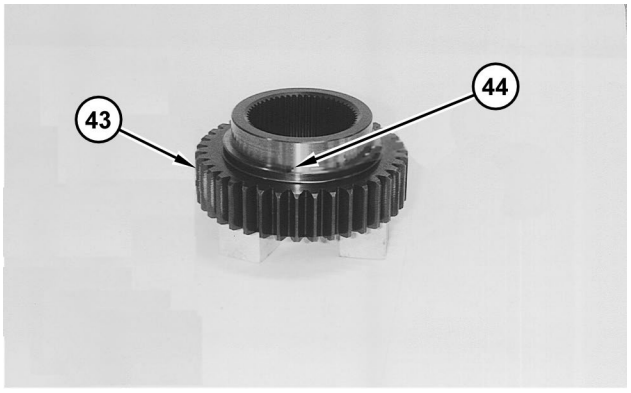


Illustration 551 g01235276

85. Inspect dowel (44). Replace sun gear assembly (43) if dowel (44) is worn or damaged.

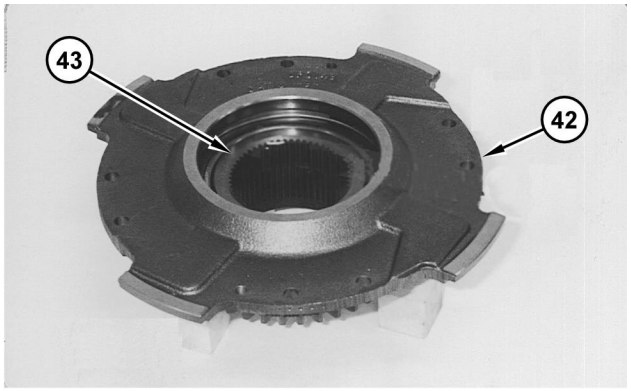


Illustration 552 g01235272

86. Install sun gear assembly (43) into bearing cage (42).

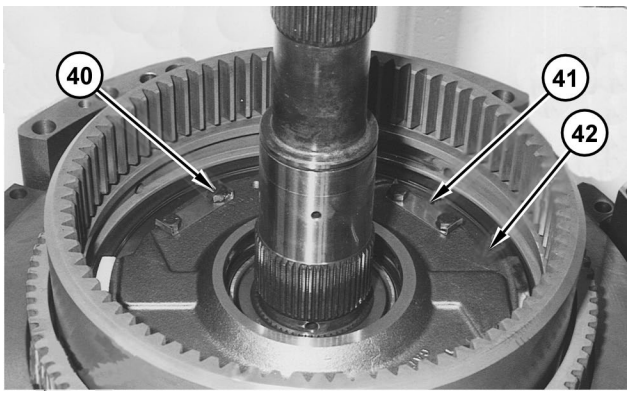


Illustration 553 g01235268

87. Install bearing cage (42), locks (41), and bolts (40).

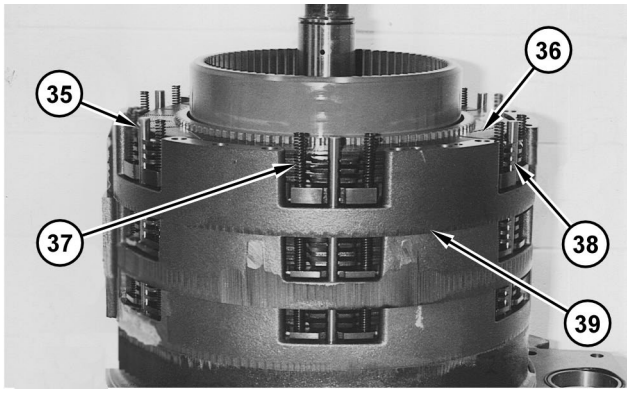


Illustration 554 g01235224

88. Apply clean oil onto clutch discs (36) and clutch plates (38).

89. Install pins (35), springs (37), clutch discs (36), and clutch plates (38) into clutch housing (39).

Note: Install clutch discs (36) and clutch plates (38) in an alternating order. Start with a clutch disc and end with a clutch disc.

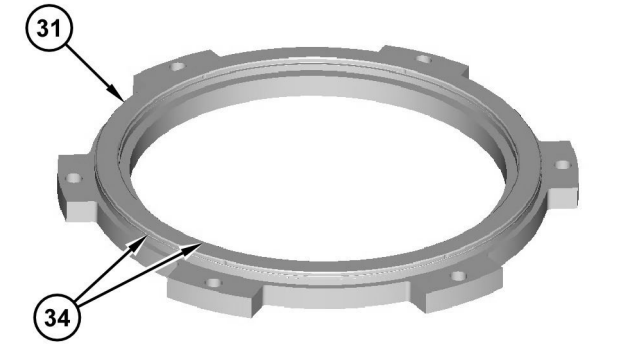


Illustration 555 g01234932

90. Apply clean oil onto seal rings (34).

91. Install seal rings (34) on clutch piston (31).

Note: Install the seal rings so that the oil groove and the sealing edge are toward the inside of the clutch housing.

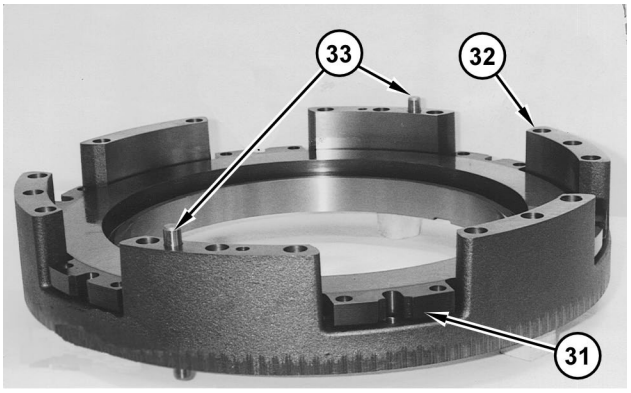


Illustration 556 g01234921

92. Install dowels (33) into clutch housing (32). The weight of clutch housing (32) is approximately 55 kg (120 lb).

93. Install clutch piston (31) into clutch housing (32).

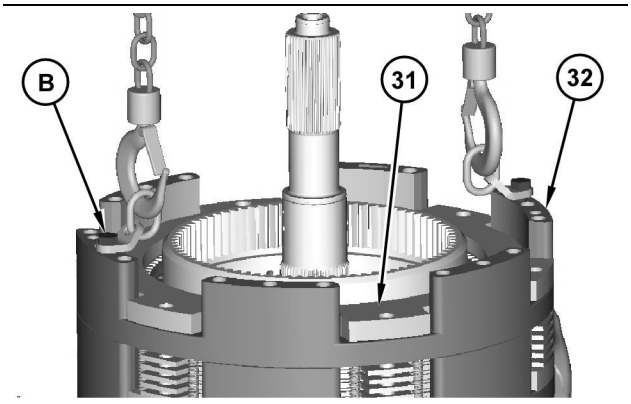


Illustration 557 g01234901

94. Use Tooling (B) and a suitable lifting device in order to install clutch housing (32) and clutch piston (31) as a unit. The combined weight of clutch housing (32) and clutch piston (31) is approximately 77 kg (170 lb).

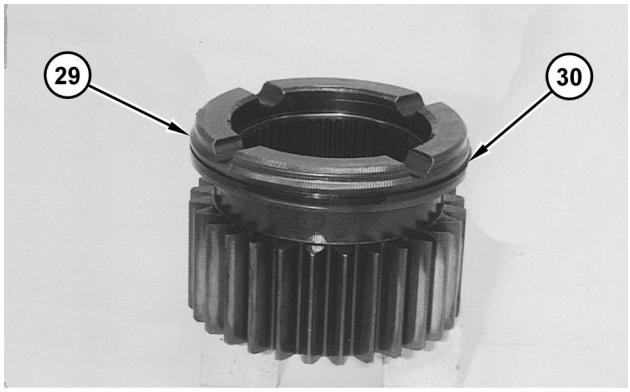


Illustration 558 g01234911

95. Install seal ring (30) onto sun gear (29).

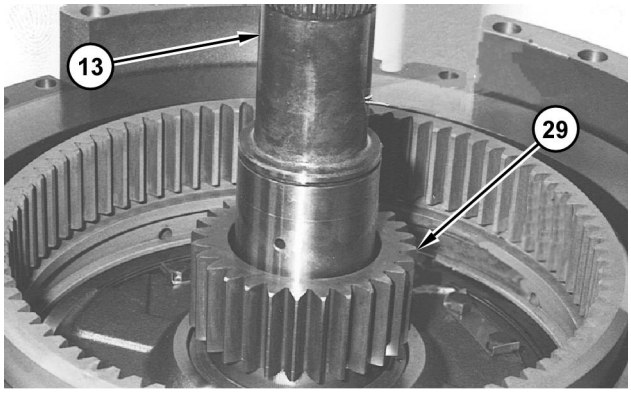


Illustration 559 g01234905

96. Install sun gear (29) onto input shaft assembly (13).

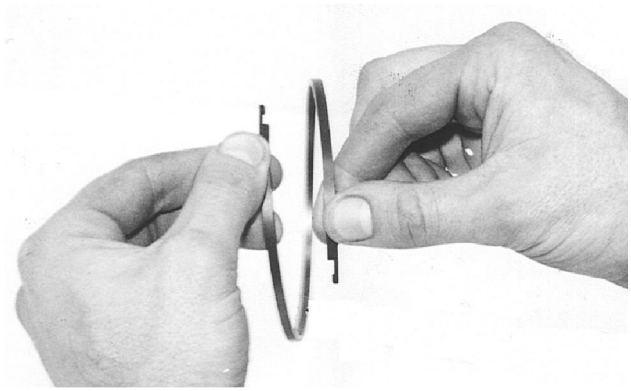


Illustration 560 g01237338

Typical example of the correct method of preparing new rings for installation

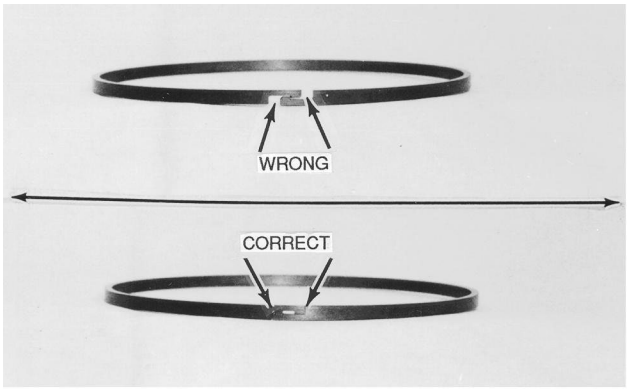


Illustration 561 g00854370

Typical example of the correct end gap

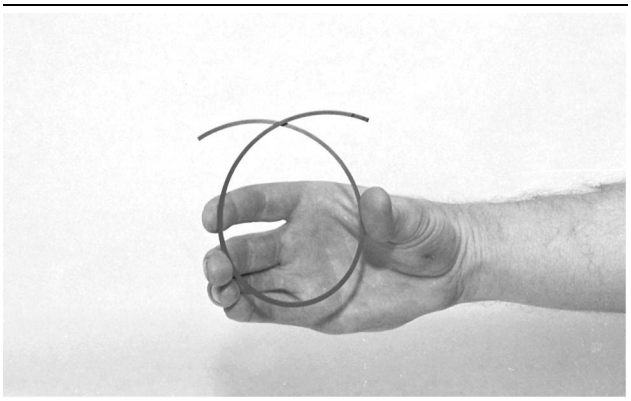


Illustration 562 g00854371

Typical example of the incorrect method of preparing new rings for installation

97. Prepare the new rings for installation.

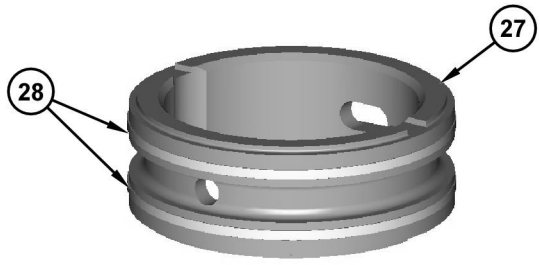


Illustration 563 g01234724

98. Install seal rings (28) onto carrier ring (27).

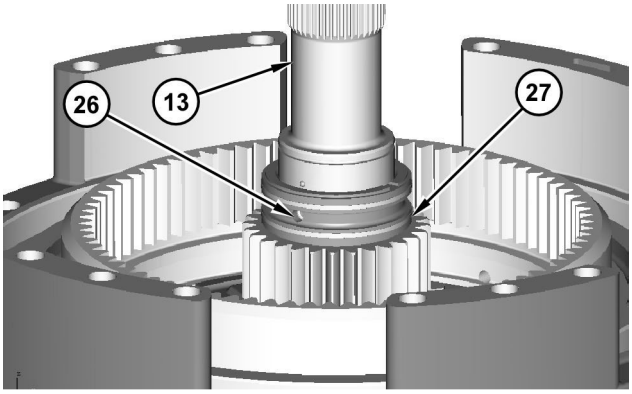


Illustration 564 g01234431

99. Install carrier ring (27) onto input shaft (13).

100. Install spring pin (26) into carrier ring (27).

Note: Rotate carrier ring (27) by 90 degrees after the installation.

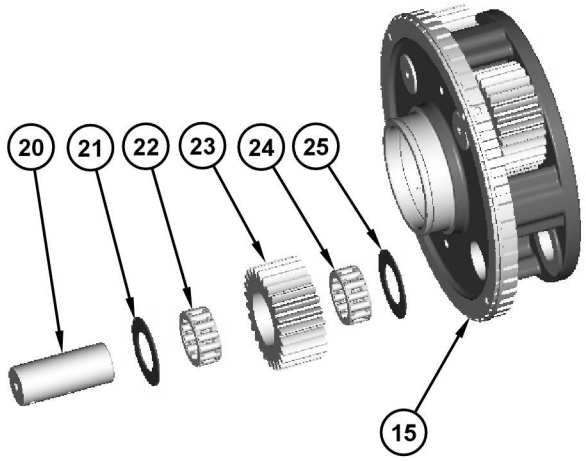


Illustration 565 g01234414

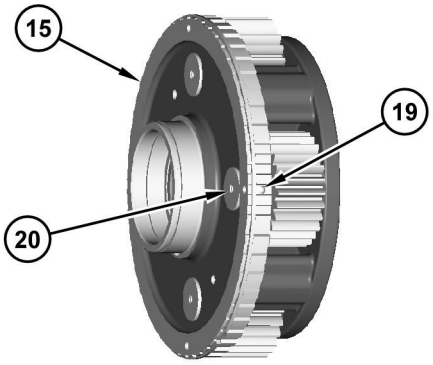


Illustration 566 g01234411

101. Apply clean oil onto bearing assembly (22) and bearing assembly (24).

102. Install bearing assembly (24) and install bearing assembly (22) into planetary gear (23).

103. Install washer (25) and install washer (21) onto planetary gear (23), as shown.

104. Install planetary gear (23) into planetary carrier assembly (15).

105. Install shaft (20).

106. Align the spring pin hole in shaft (20) with the spring pin hole in planetary carrier assembly (15).

107. Install spring pin (19).

Note: The outer edge of the spring pin must be even with the outer edge of the planetary carrier.

108. Repeat Steps 101 through 107 in order to install the remaining planetary gears.

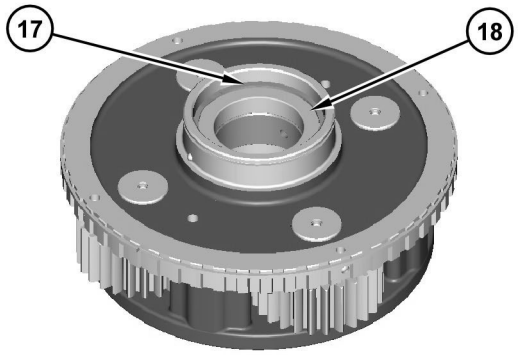


Illustration 567 g01234403

109. Install bearing assembly (18) and install retaining ring (17).

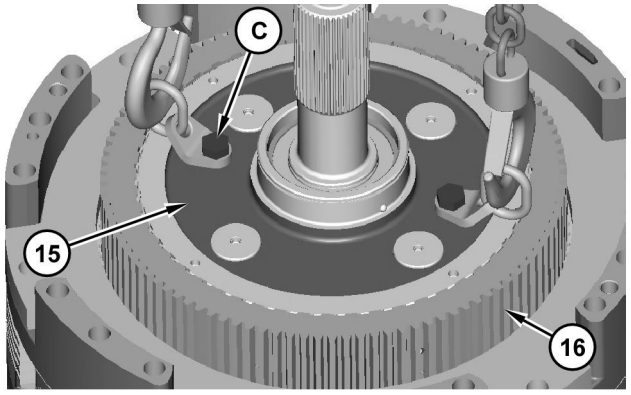


Illustration 568 g01234111

110. Install the retaining ring onto planetary carrier assembly (15). Compress the retaining ring in order to install ring gear (16) onto planetary carrier assembly (15).

111. Use Tooling (C) and a suitable lifting device in order to install planetary carrier assembly (15) and ring gear (16) as a unit. The combined weight of planetary carrier assembly (15) and ring gear (16) is approximately 68 kg (150 lb).

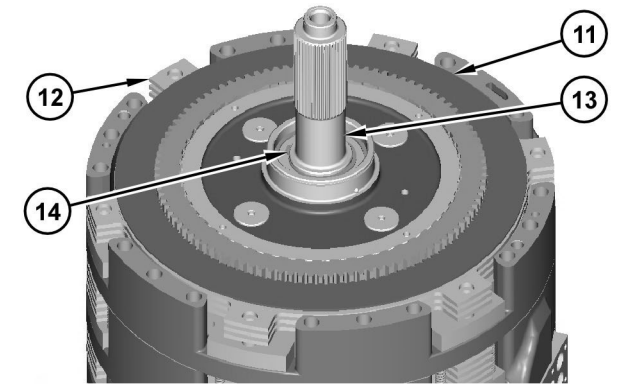


Illustration 569 g01234396

112. Install retaining ring (14) on input shaft (13).

113. Put clean oil on clutch discs (11) and clutch plates (12).

114. Install clutch discs (11) and install clutch plates (12) into the clutch housing.

Note: Install clutch discs (11) and clutch plates (12) in an alternating order. Start with a clutch disc and end with a clutch disc.

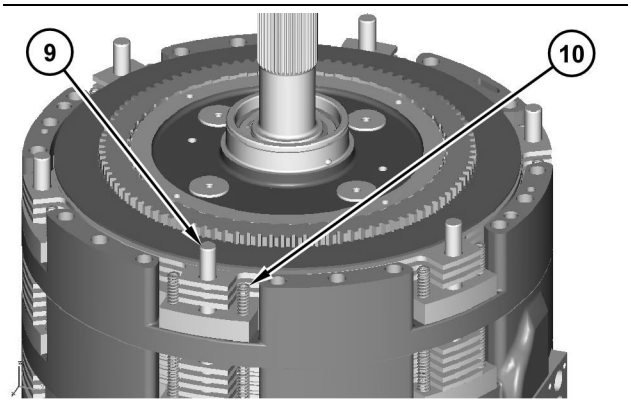


Illustration 570 g01234394

115. Install pins (9) and install springs (10).

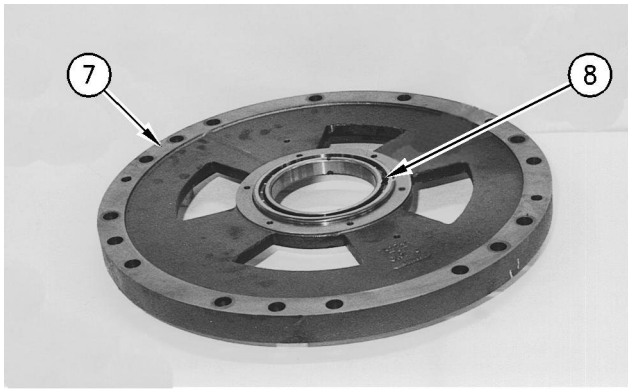


Illustration 571 g00850984

116. Install bearing assembly (8) into end plate (7).

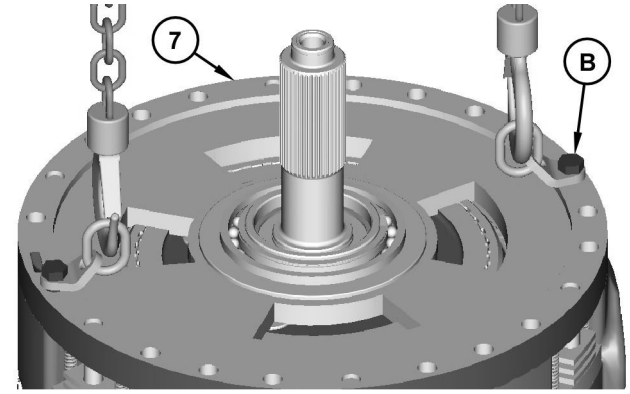


Illustration 572 g01234103

117. Use Tooling (B) and a suitable lifting device in order to install end plate (7). The weight of end plate (7) is approximately 57 kg (125 lb).

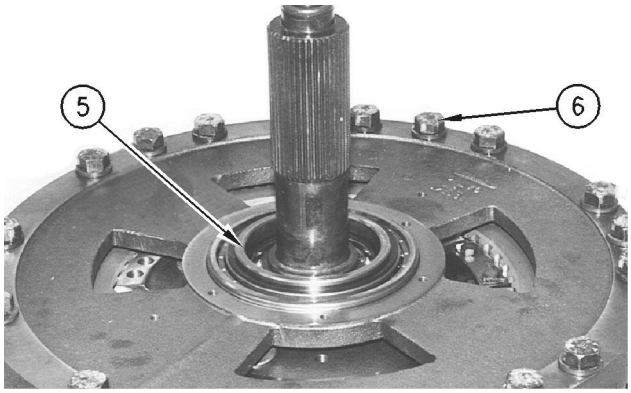


Illustration 573 g01239399

118. Install bolts (6). Tighten bolts (6) to a torque of 408 ± 48 N·m (300 ± 35 lb ft).

119. Install retaining ring (5).

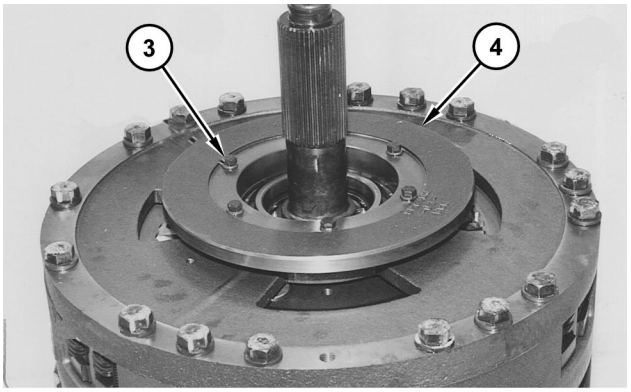


Illustration 574 g01234384

120. Install pilot plate (4) and install bolts (3).

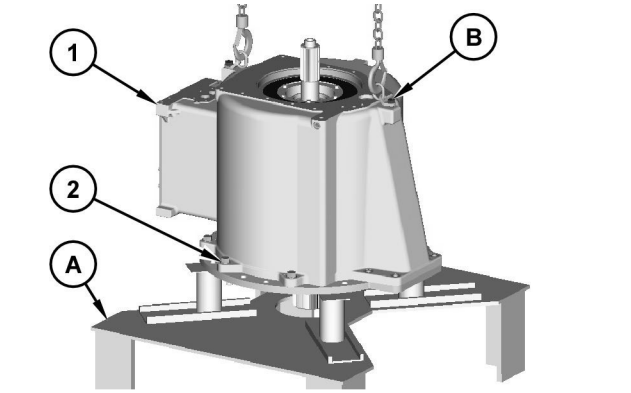


Illustration 575 g01234101

121. Use Tooling (B) and a suitable lifting device in order to install transmission case (1) onto the transmission assembly. The weight of transmission case (1) is approximately 211 kg (465 lb).

122. Install bolts (2).

End By:

a. Install the transmission hydraulic control valve. Refer to Disassembly and Assembly, “Transmission Hydraulic Control Valve - Install”.

b. Connect the transfer gears to the transmission. Refer to Disassembly and Assembly, “Transmission toTransfer Gears - Connect”.

i02505318

Transmission to Transfer Gears - Connect

SMCS Code: 3002-077-IV; 3002-077-OJ

Connecting Procedure

Table 19

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	4

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

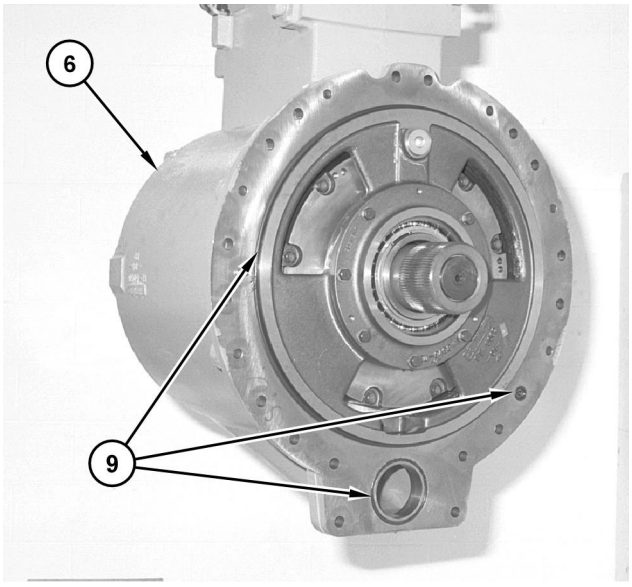


Illustration 576 g01254271

1. Install O-ring seals (9) into transmission (6).

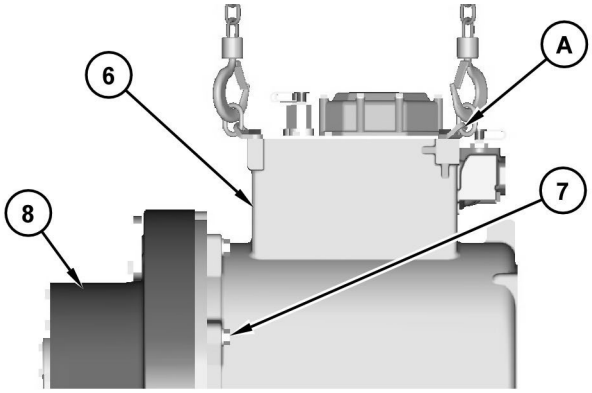


Illustration 577 g01254270

2. Use Tooling (A) and a suitable lifting device in order to install transmission (6) to output transfer gears (8). The weight of transmission (6) is approximately 1226 kg (2700 lb). The weight of output transfer gears (8) is approximately 908 kg (2000 lb).

3. Install bolts (7).

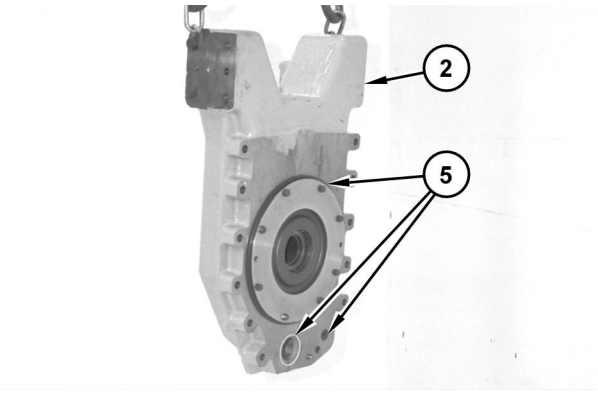


Illustration 578 g01254285

4. Install O-ring seals (5) to input transfer gears (2).

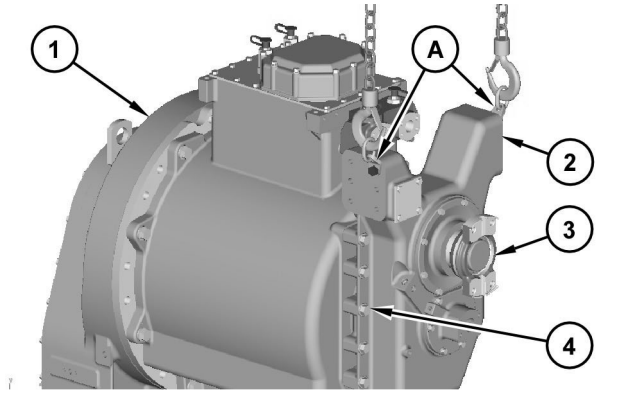


Illustration 579 g01254250

5. Use Tooling (A) and a suitable lifting device in order to install input transfer gears (2) onto transmission and transfer gears (1). The weight of input transfer gears (3) is approximately 173 kg (380 lb).

6. Install bolts (4).

7. Install yoke assembly (3) onto input transfer gears (2).

End By:

a. Install the transmission and transfer gears. Refer to Disassembly and Assembly Manual, "Transmission and Transfer Gears - Install".

i02496584

Transmission and Transfer Gears - Install

SMCS Code: 3002-012-IV; 3002-012-OJ

Installation Procedure

Table 20

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	138-7575	Link Bracket	2
C	1U-9204	Lever Puller Hoist	1
D	140-7742	Sleeve	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

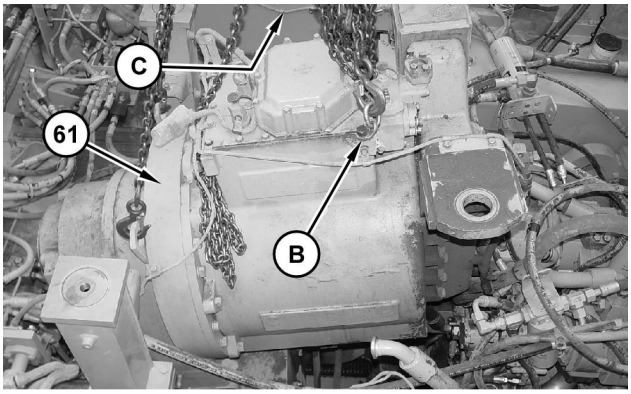


Illustration 580 g01249211

1. Use Tooling (B), Tooling (C), and a suitable lifting device in order to position transmission and transfer gears (61). The weight of transmission and transfer gears (61) is approximately 2631 kg (5800 lb).

Note: Position the transmission and transfer gears at an angle with the rear of the transmission upward.

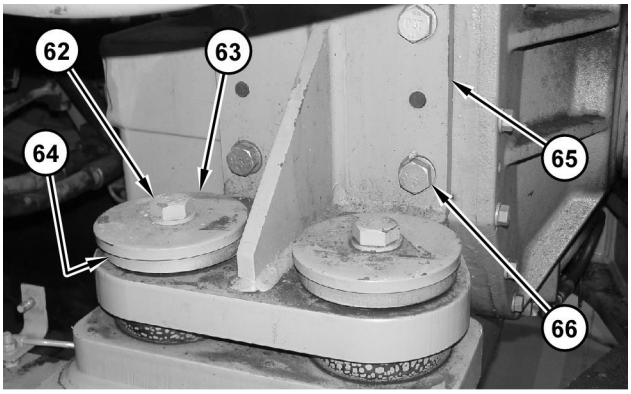


Illustration 581 g01249203

2. Install mount assemblies (64) onto transmission mounting bracket (65). Use two people in order to position transmission mounting bracket (65) onto the transmission. Install bolts (66). Tighten bolts (66) to a torque of 570 ± 80 N·m (420 ± 60 lb ft). The weight of transmission mounting bracket (65) is approximately 32 kg (70 lb). Repeat for the opposite side.

3. Lower the transmission onto the machine frame.

4. Install washers (63) and install bolts (62). Tighten bolts (62) to a torque of 800 ± 100 N·m (590 ± 75 lb ft). Repeat for the opposite side.

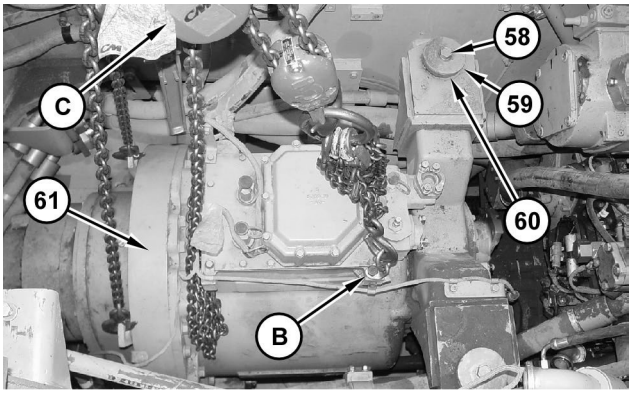


Illustration 582 g01249146

5. Install mount assemblies (60), washers (59), and bolts (58). Tighten bolts (58) to a torque of 460 ± 60 N·m (340 ± 44 lb ft).

6. Remove Tooling (B), Tooling (C), and the suitable lifting device from transmission and transfer gears (61).



Illustration 583 g01249142

7. Install sight gauge (57).

8. Install tube assembly (56).

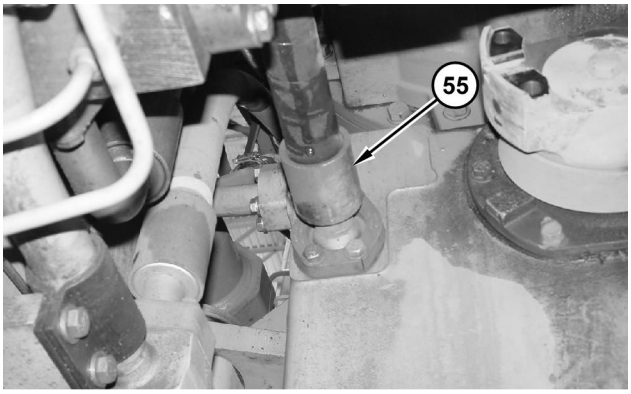


Illustration 584 g01249133

9. Connect hose assembly (55).

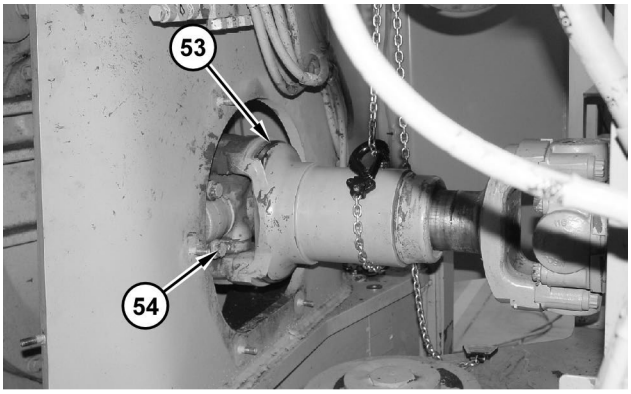


Illustration 585 g01248810

10. Attach a suitable lifting device onto center drive shaft (53). The weight of center drive shaft (53) is approximately 82 kg (180 lb). Position center drive shaft (53) and install bolts (54) in order to connect center drive shaft (53) to the transmission.

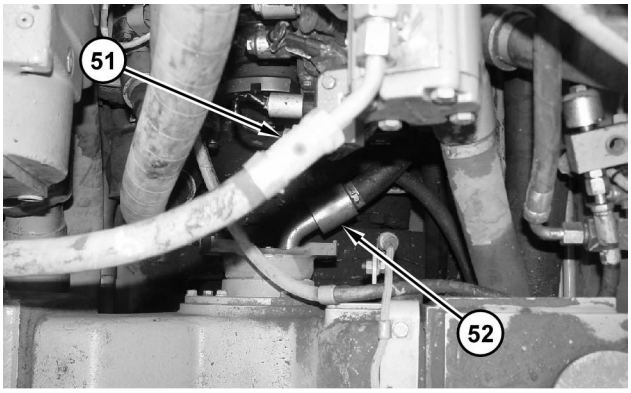


Illustration 586 g01249127

11. Connect hose assembly (52). Connect hose assembly (51).

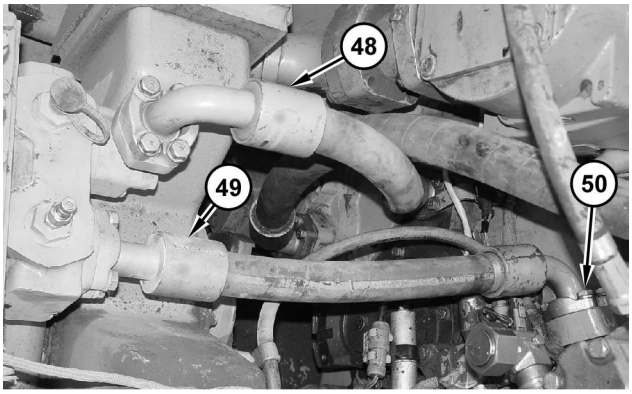


Illustration 587 g01249119

12. Connect hose assembly (48).

13. Position hose assembly (49) and tighten bolts (50).

14. Connect hose assembly (49).

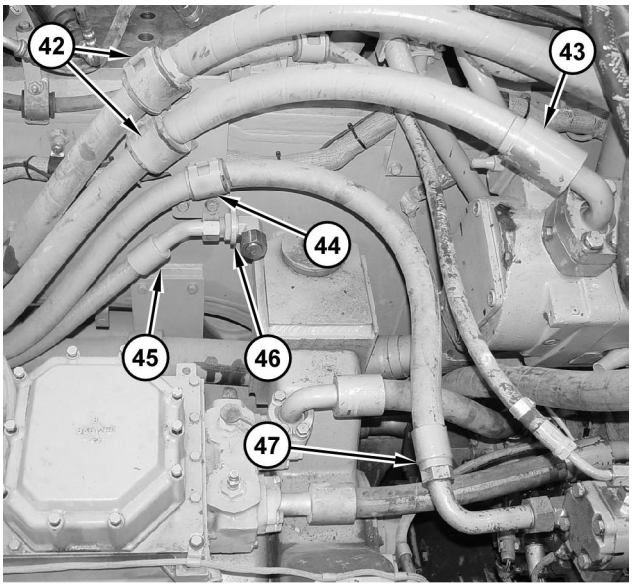


Illustration 588 g01249113

15. Connect hose assembly (47). Install bracket (46). Connect hose assembly (45). Install clip (44). Connect hose assembly (43). Install clips (42).

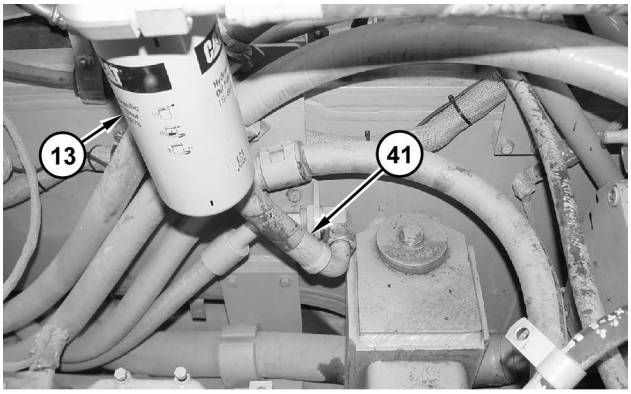


Illustration 589 g01249106

16. Position filter base assembly (13) and connect hose assembly (41).

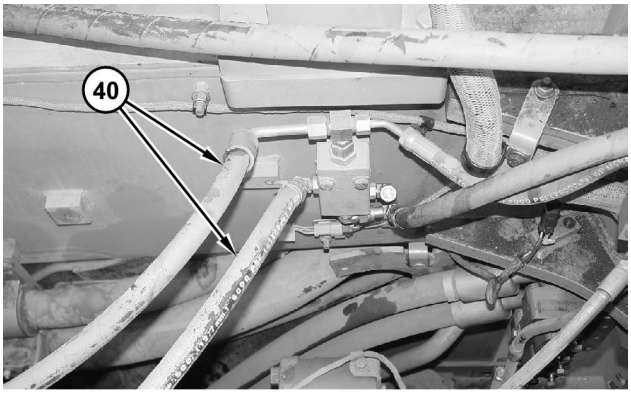


Illustration 590 g01249068

17. Connect hose assemblies (40).

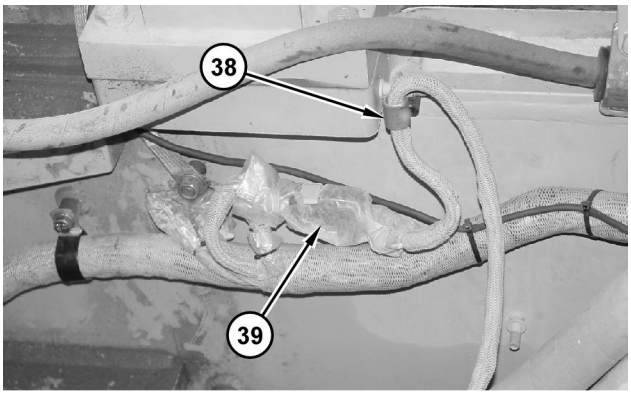


Illustration 591 g01249064

18. Connect harness assembly (39) and install clip (38).

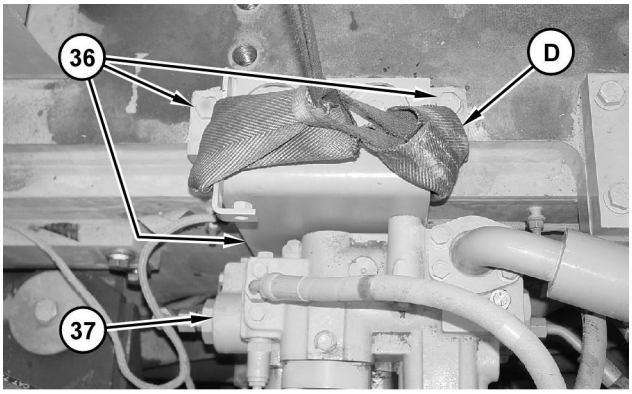


Illustration 592 g01248929

19. Use Tooling (D) and a suitable lifting device in order to install steering valve (37). The weight of steering valve (37) is approximately 79 kg (175 lb).

20. Install bolts (34).

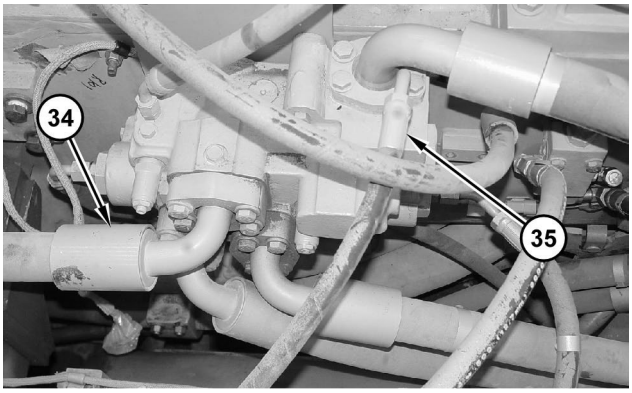


Illustration 593 g01248917

21. Connect hose assembly (35). Connect hose assembly (34).

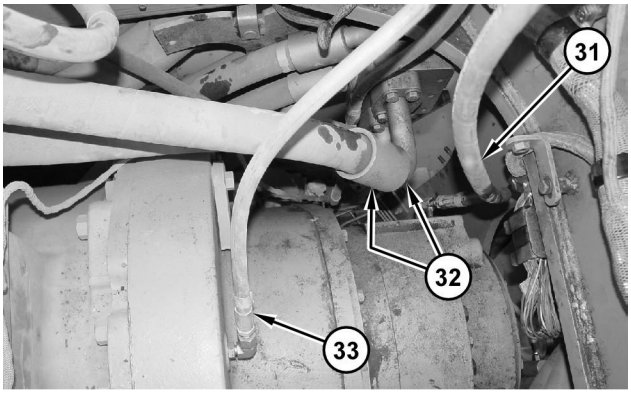


Illustration 594 g01248909

22. Connect hose assembly (33). Connect hose assemblies (32). Connect hose assembly (31).

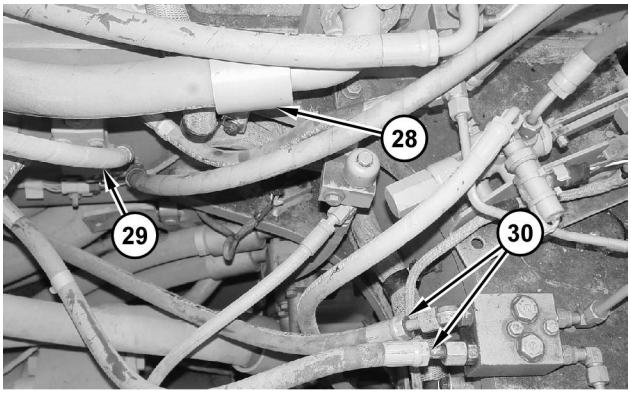


Illustration 595 g01248893

23. Connect hose assembly (30). Connect hose assembly (29). Connect hose assembly (28).

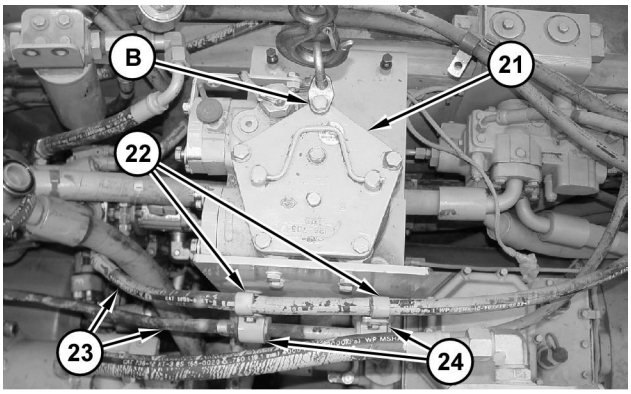


Illustration 596 g01248719

24. Use Tooling (B) and a suitable lifting device in order to install transmission filter (21). The weight of transmission filter (21) is approximately 70 kg (155 lb).

25. Position hose assemblies (23). Install clips (24) and clips (22).

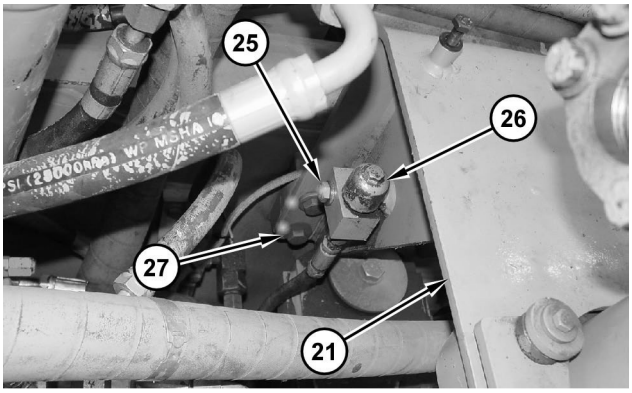


Illustration 597 g01248842

26. Install bolts (27).

27. Position oil breather (26) and install bolt (25).

28. Remove Tooling (B) from transmission filter (21).

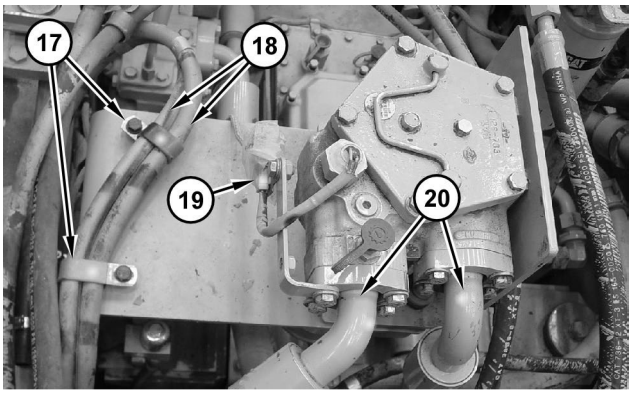


Illustration 598 g01248712

29. Connect hose assemblies (20).

30. Connect harness assembly (19).

31. Position hoses (18) and install clips (17).

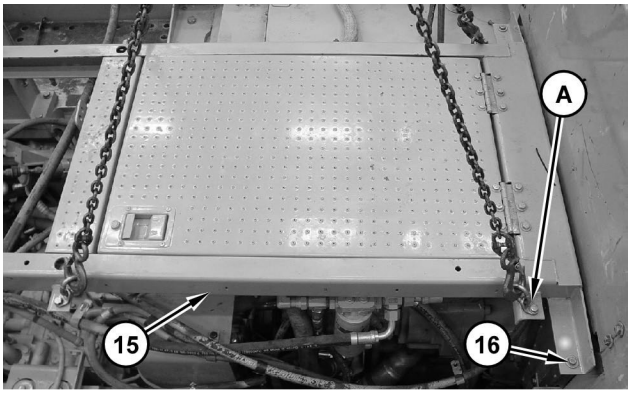


Illustration 599 g01248696

32. Use Tooling (A) and a suitable lifting device in order to install panel assembly (15). The weight of panel assembly is approximately 82 kg (180 lb). Install bolts (16).

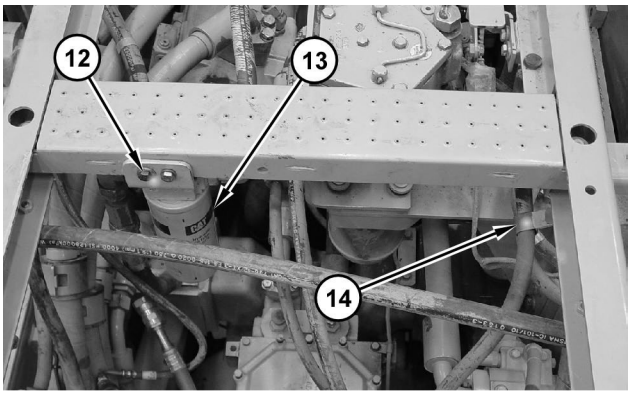


Illustration 600 g01248691

33. Install clip (14). Position filter base assembly (13) and install bolts (12).

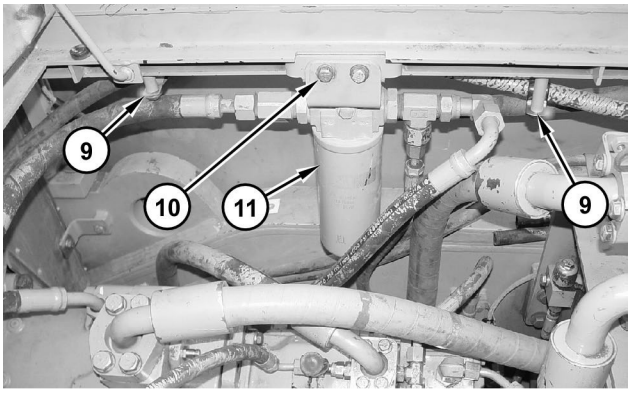


Illustration 601 g01248687

34. Position filter base assembly (11) and install bolts (10). Install clips (9).

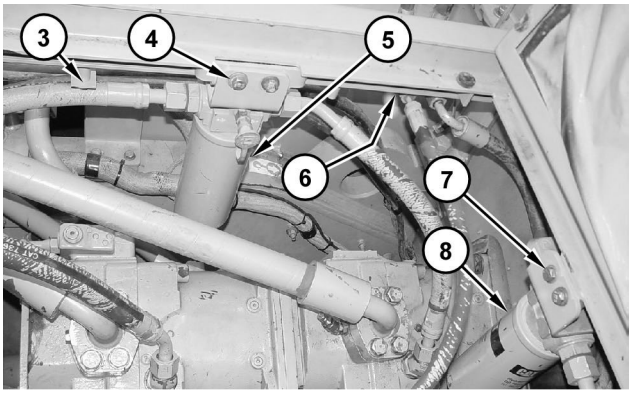


Illustration 602 g01248681

35. Position filter base assembly (8) and install bolts (7). Install bolts (6). Position filter base assembly (5) and install bolts (4). Connect bracket (3).

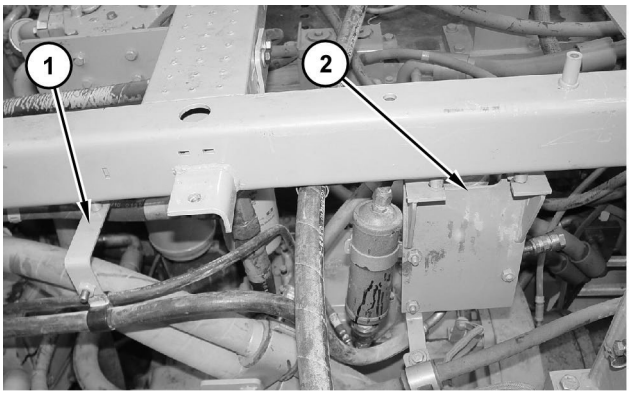


Illustration 603 g01248669

36. Connect bracket (2).

37. Connect bracket (1).

End By:

a. Install the transmission filter housing. Refer to Disassembly and Assembly, “Magnetic Filter Screen and Housing - Install”.

b. Install the rear drive shaft. Refer to Disassembly and Assembly, “Drive Shaft (Rear) - Remove and Install” .

c. Install the input drive shaft. Refer to Disassembly and Assembly, “Input Drive Shaft - Remove and Install” .

d. Install the cab. Refer to Disassembly and Assembly, “Cab - Install”.

i02517418

Parking Brake - Remove

SMCS Code: 4267-011

Removal Procedure

Table 21

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	FT-2468	Threaded Rod	2
C	138-7574	Link Bracket	6
D	1U-9200	Lever Puller Hoist	2

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the oil from the hydraulic oil tank into a suitable container for storage or proper disposal. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Brake) - Change”.

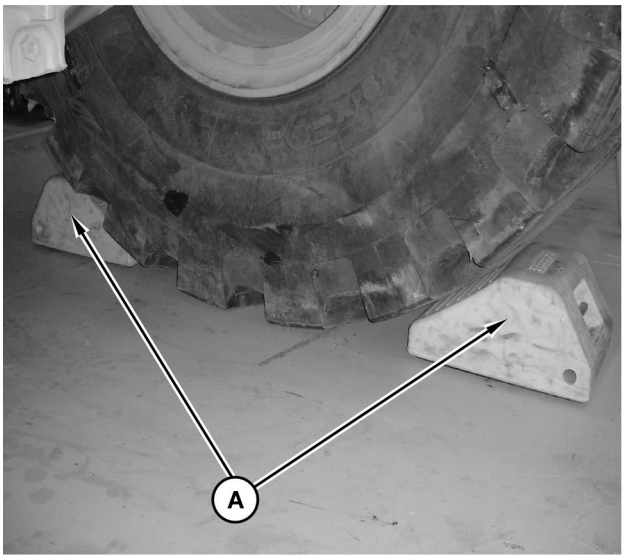


Illustration 604 g01243717

2. Install Tooling (A) in order to prevent any machine movement when the parking brake is released.

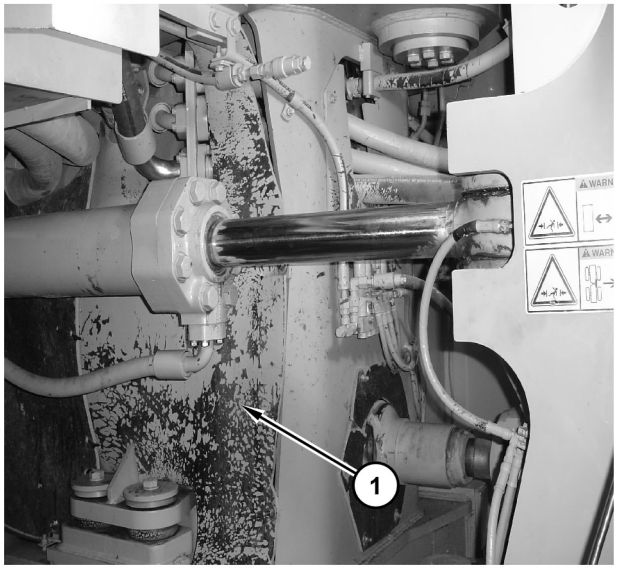


Illustration 605 g01259518

3. Remove sheet (1).

4. Repeat Step 3 for the opposite side.

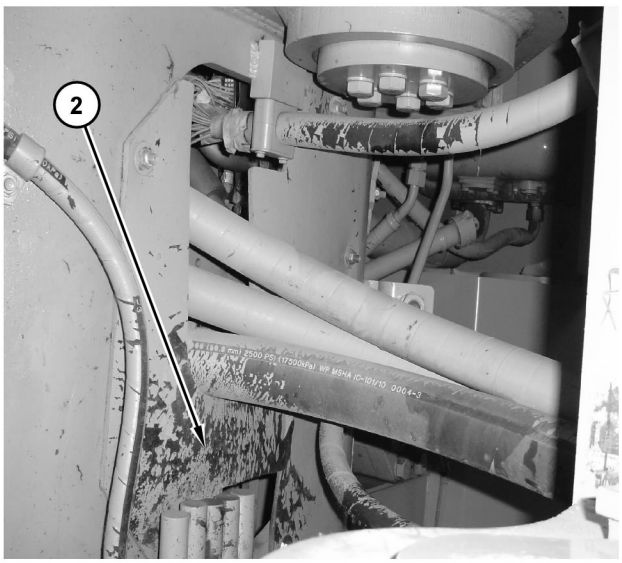


Illustration 606 g01259527

5. Remove sheet (2).

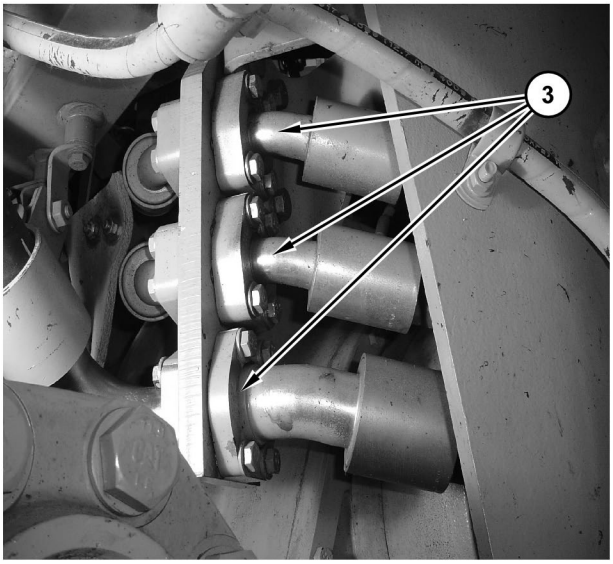


Illustration 607 g01243743

6. Remove hose assemblies (3).

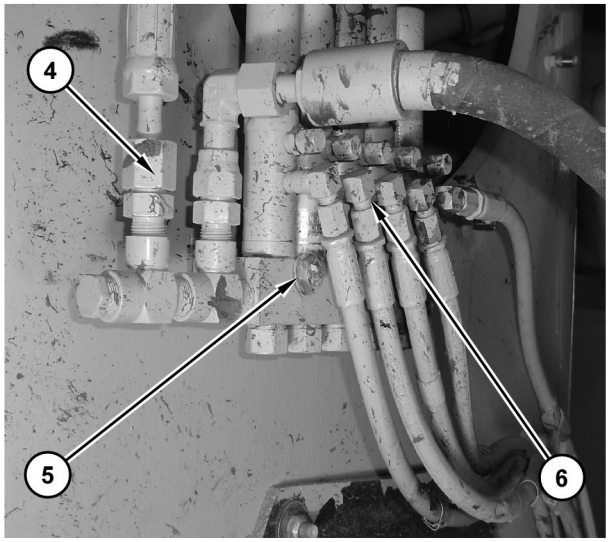


Illustration 608 g01243766

7. Disconnect hose assembly (4). Remove bolts (5) and the spacers. Position valve assembly (6) out of the way.

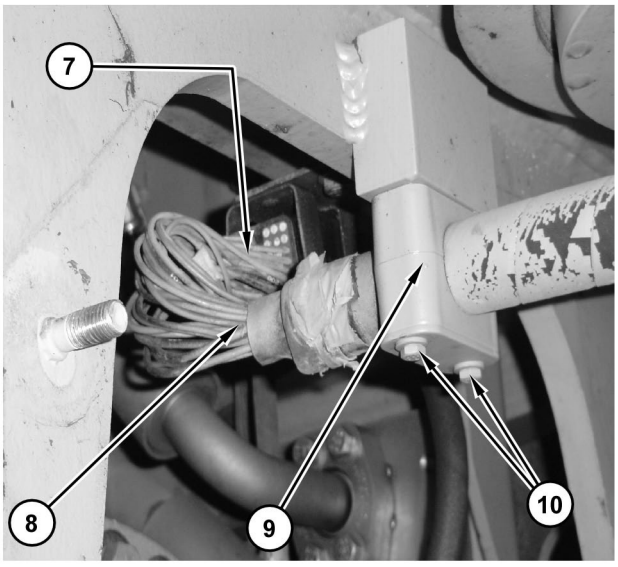


Illustration 609 g01243771

8. Loosen bolt (7). Disconnect harness assembly (8). Remove bolts (10) and clamp (9). Position harness assembly (8) out of the way.

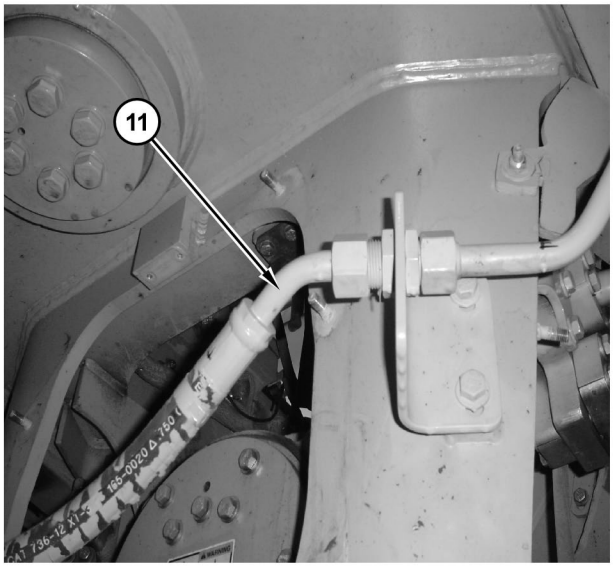


Illustration 610 g01243863

9. Disconnect hose assembly (11).

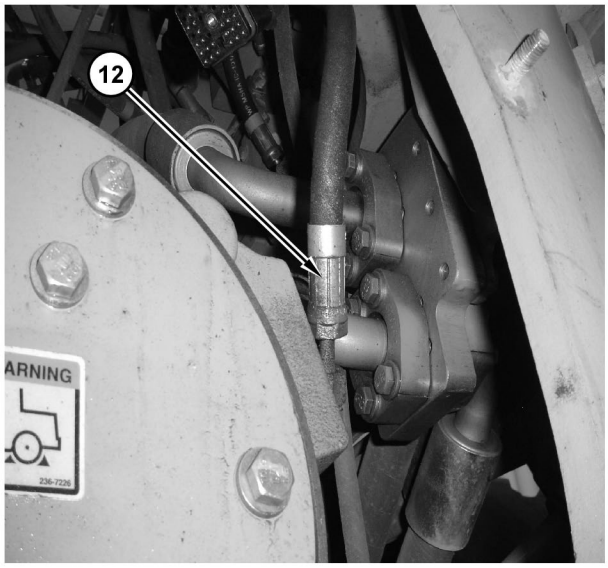


Illustration 611 g01243883

10. Disconnect hose assembly (12).

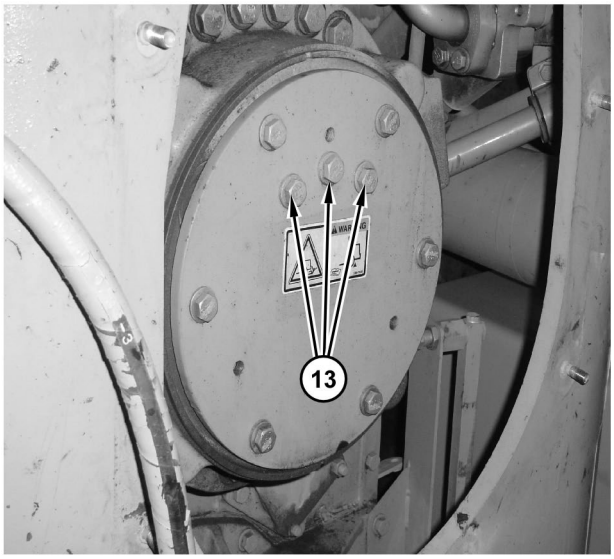


Illustration 612 g01243889

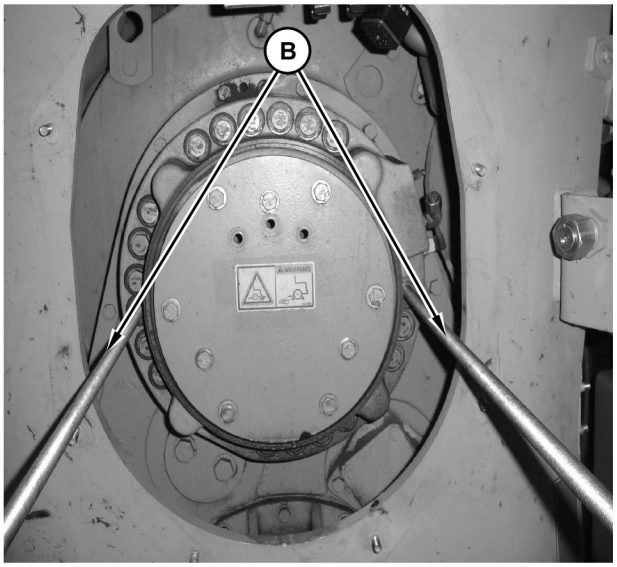


Illustration 614 g01243943

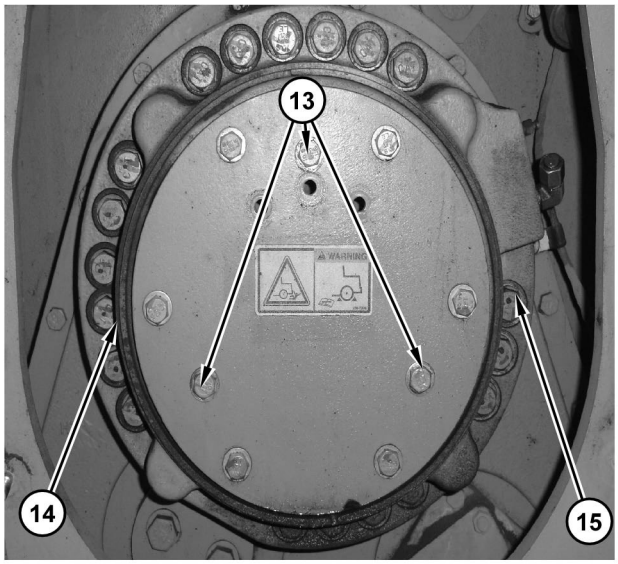


Illustration 613 g01243898

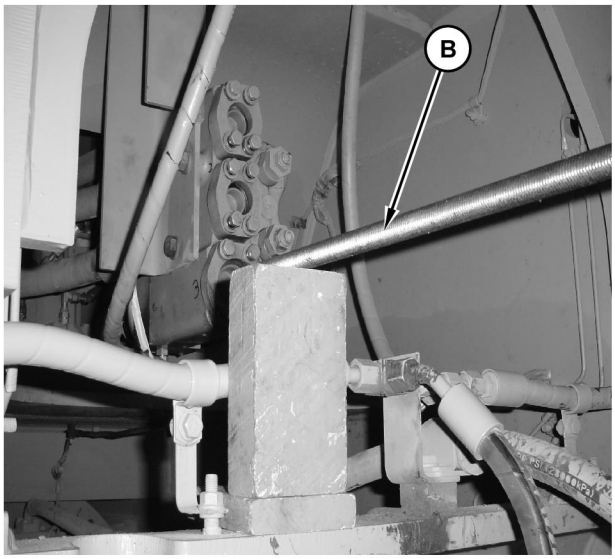


Illustration 615 g01243944

11. Remove bolts (13). Install bolts (13) into a different location in order to release the parking brake. Remove bolts (14) and (15).

12. Install Tooling (B) into the bolt holes from bolts (14) and (15). Use a suitable block in order to support the opposite end of Tooling (B).

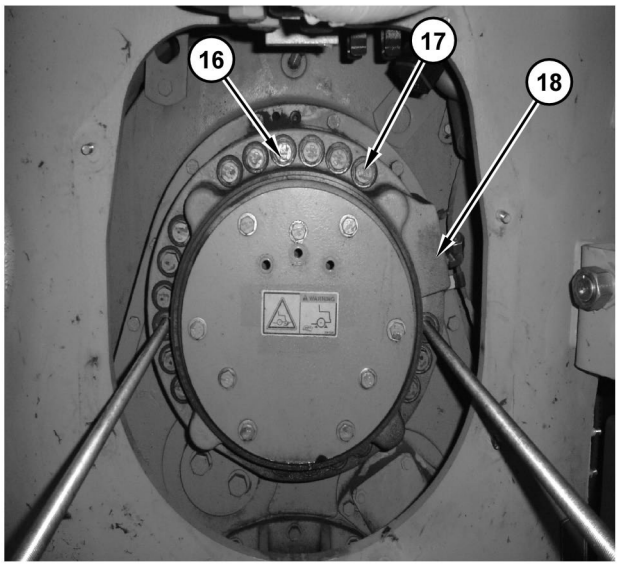


Illustration 616 g01243989

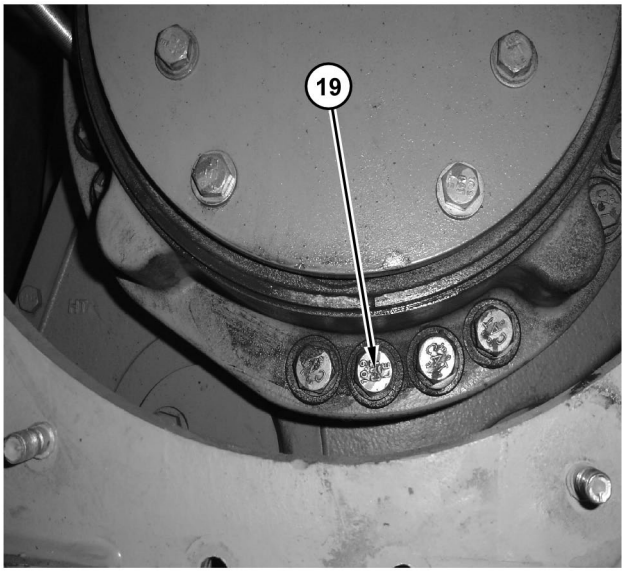


Illustration 617 g01243991

13. Do not remove bolts (16) and (19). Bolts (16) and (19) secure the parking brake assembly together. Bolts (16) and (19) are identified by the notches in the housing. Remove bolts (17) and fitting (18).

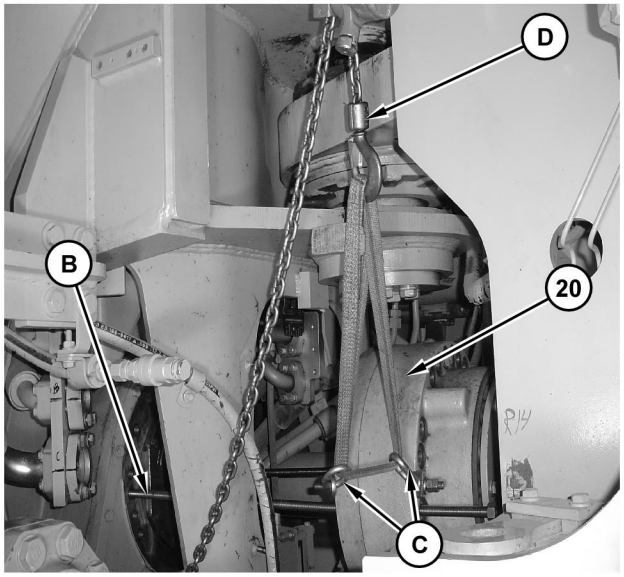


Illustration 618 g01244000

14. Retract parking brake assembly (20) on Tooling (B) for a distance of 508 mm (20.0 inch). Attach Tooling (C) to parking brake assembly (20). Attach Tooling (D) and a suitable lifting device to Tooling (C) and the machine structure. Repeat the use of Tooling (D) and Tooling (C) on the opposite side of the machine. The weight of parking brake assembly (20) is approximately 168 kg (370 lb).

15. Use Tooling (D) and Tooling (C) in order to support parking brake assembly (20). This will relieve weight from Tooling (B). Remove Tooling (B).

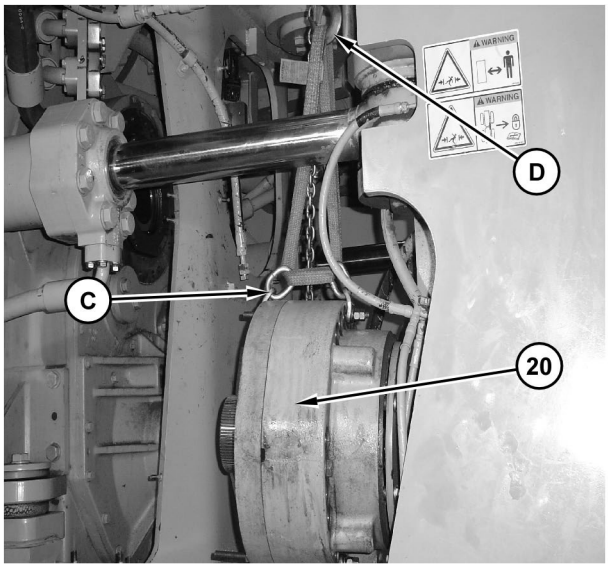


Illustration 619 g01244004

16. Carefully releaseone Tooling (D) in order to position parking brake assembly (20) under the steering cylinder.

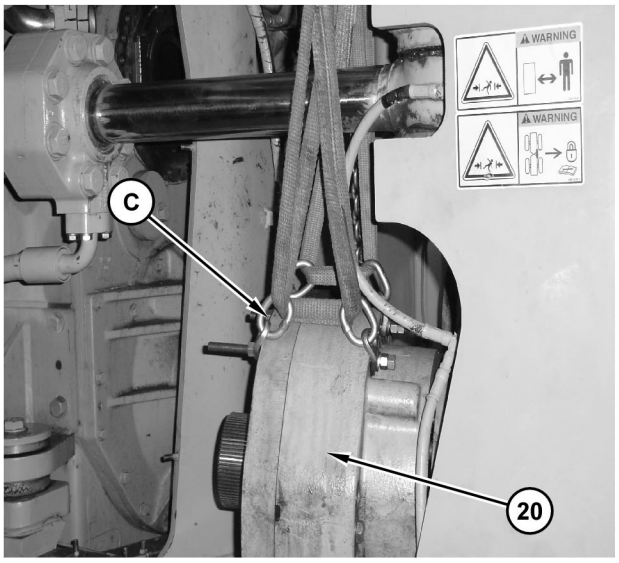


Illustration 620 g01244005

17. Attach Tooling (C) and a suitable lifting device to parking brake assembly (20). The weight of parking brake assembly (20) is approximately 168 kg (370 lb). Remove parking brake assembly (20).

i02517748

Parking Brake - Disassemble

SMCS Code: 4267-015

Disassembly Procedure

Table 22

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0074	Slide Hammer Puller	1
B	8B-7557	Adapter	1

Start By:

a. Remove the parking brake. Refer to Disassembly and Assembly, “Parking Brake - Remove”.

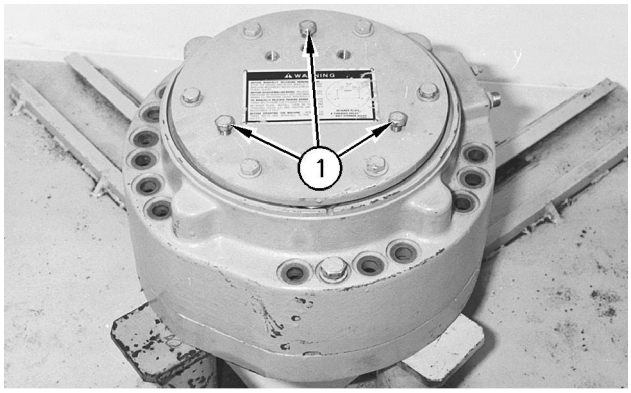


Illustration 621 g00350733

1. Remove bolts (1) that are used to disengage the parking brake.

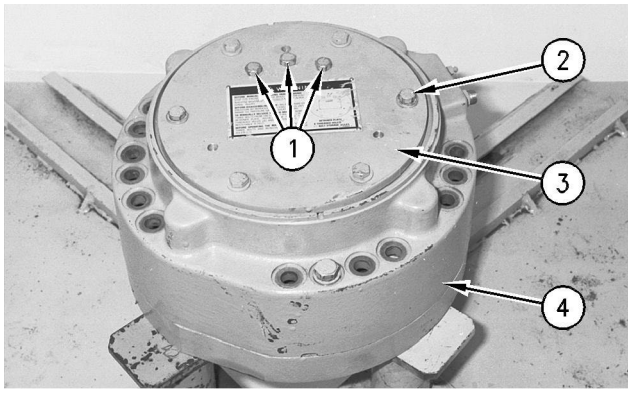


Illustration 622 g00351073

2. Install bolts (1) in the holes, as shown. Remove bolts (2) and the washers evenly.

3. Remove retaining plate (3) from brake housing (4).



Illustration 623 g00375378

4. Remove spacers (5) from the brake housing.

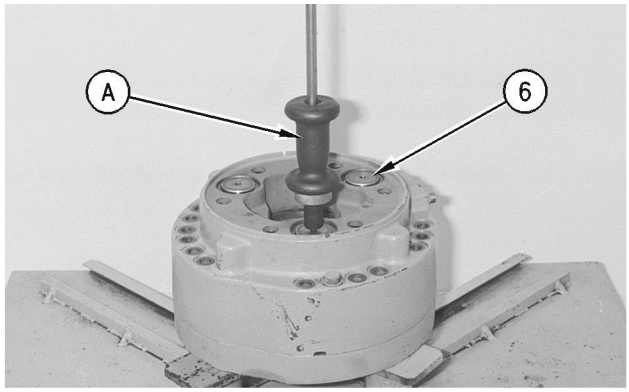


Illustration 624 g00375379

5. Use Tooling (A) and Tooling (B) in order to remove pistons (6) from the brake housing.

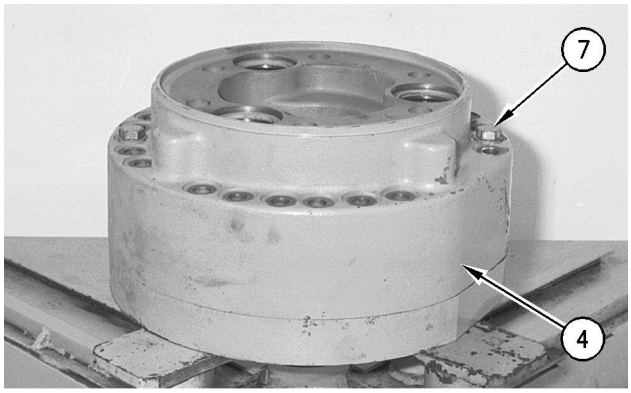


Illustration 625 g00375380

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

6. Loosen bolts (7) evenly until the spring tension against brake housing (4) is released. Then remove bolts (7) and the washers.

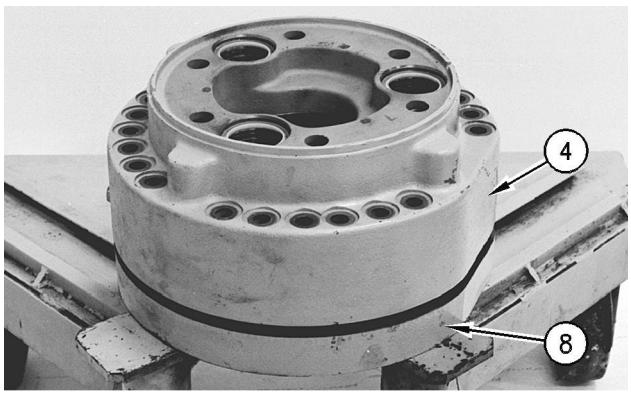


Illustration 626 g00375381

7. Use two persons to lift brake housing (4) off bearing cage assembly (8). The weight of brake housing (4) is approximately 41 kg (90 lb).

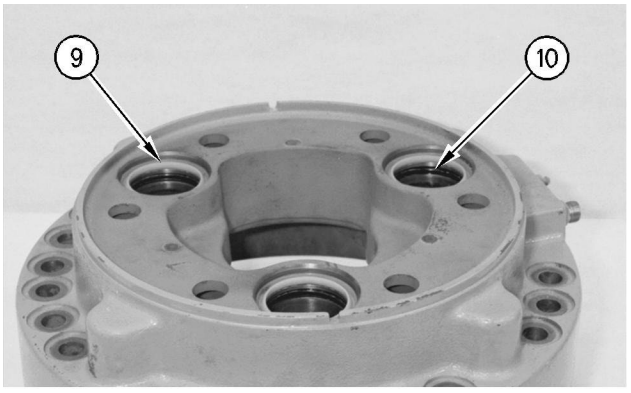


Illustration 627 g00375384

8. Remove lip seals (9) and O-ring seals (10).

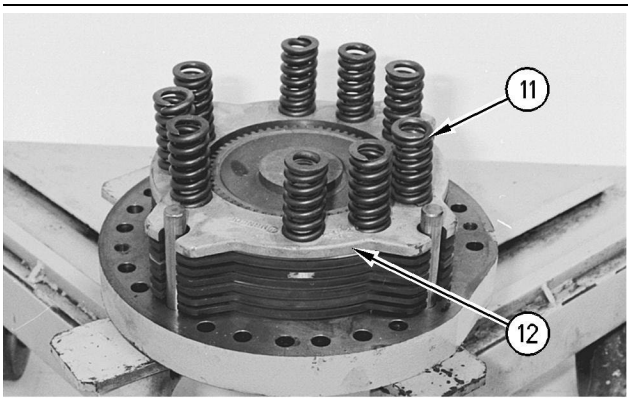


Illustration 628 g00375385

9. Remove springs (11) from pressure plate (12).

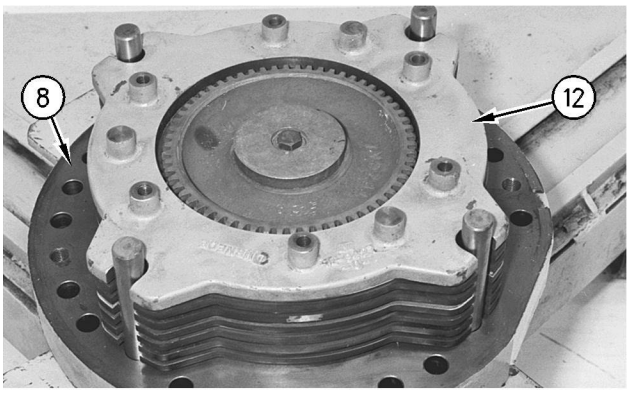


Illustration 629 g00375387

10. Remove pressure plate (12) from bearing cage assembly (8).

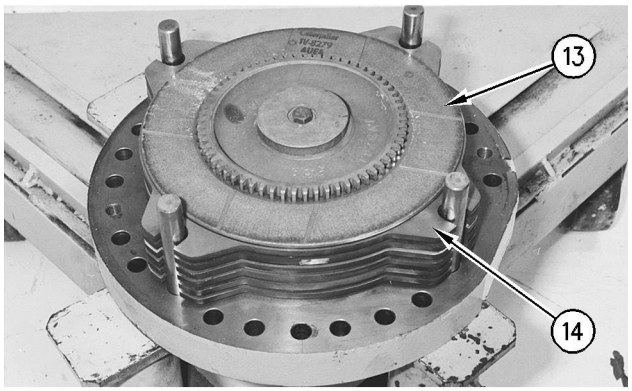


Illustration 630 g00375388

11. Remove brake discs (13) and clutch plates (14).

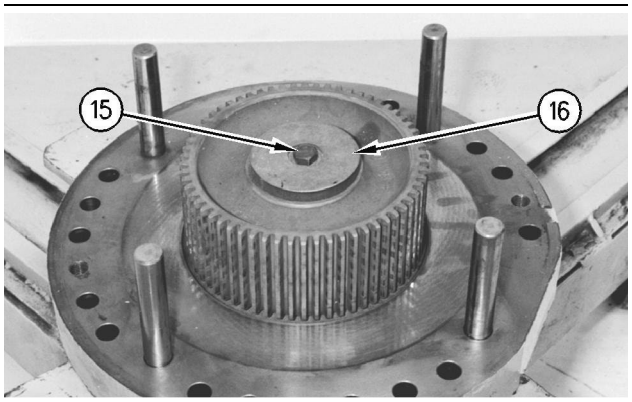


Illustration 631 g00375389

12. Remove bolt (15) and retainer (16) from the brake shaft.

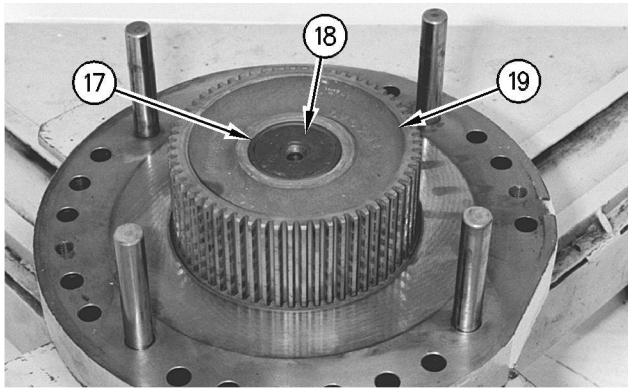


Illustration 632 g00375390

13. Remove seal (17) and hub (19) from brake shaft (18).

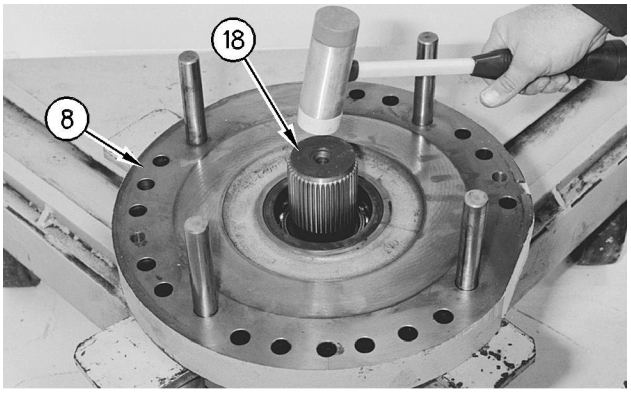


Illustration 633 g00375391

14. Use a rubber mallet to tap brake shaft (18) out of the bottom side of bearing cage assembly (8).

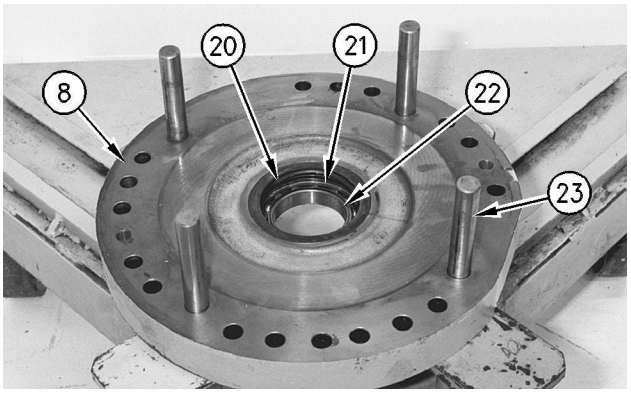


Illustration 634 g00375412

15. Remove lip seal (20), ring (21) and bearing (22) from bearing cage assembly (8).

16. If necessary, remove dowels (23).

i07352468

Parking Brake - Assemble

SMCS Code: 4267-016

Assembly Procedure

Table 23

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0074	Slide Hammer Puller Gp	1
B	8B-7557	Threaded Adapter	1
C	1P-0520	Driver Gp	1

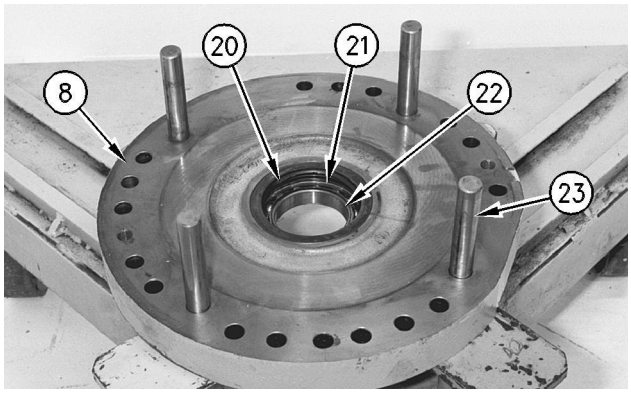


Illustration 635 g00375412

1. Use Tooling (C) to install bearing (22), ring (21), and lip seal (20) in bearing cage assembly (8).

2. If dowels (23) were removed, install the dowels.

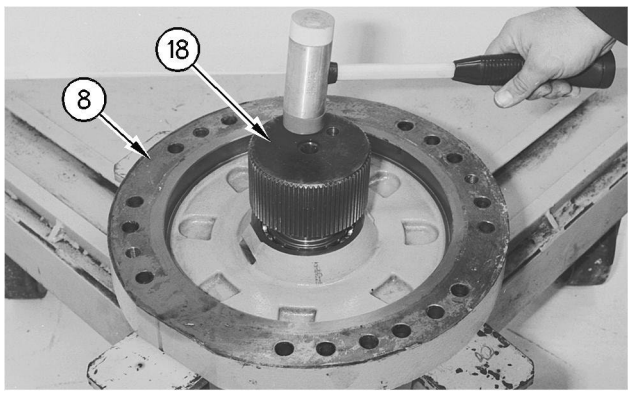


Illustration 636 g00379915

3. Turn bearing cage assembly (8) onto the opposite side. Use a rubber mallet to install brake shaft (18).

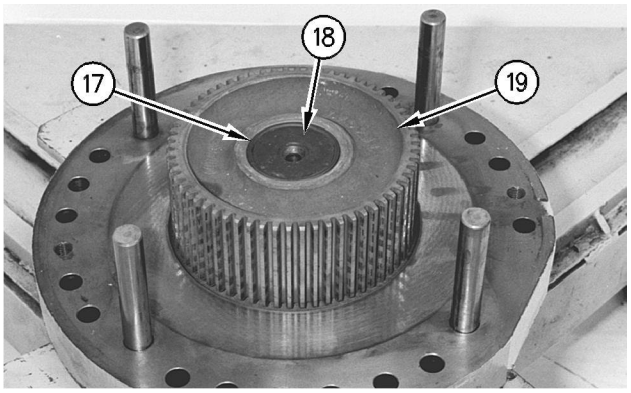


Illustration 637 g00375390

4. Turn the bearing cage assembly onto the opposite side. Install hub (19) and seal (17) on brake shaft (18).

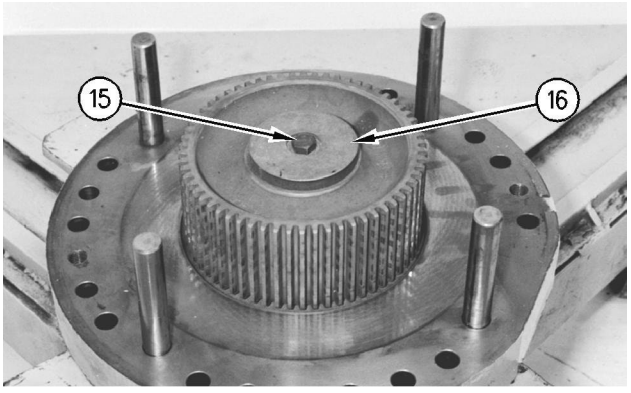


Illustration 638 g00375389

5. Install retainer (16) and bolt (15) on the brake shaft. Tighten bolt (15) to a torque of 105 ± 20 N·m (78 ± 15 lb ft).

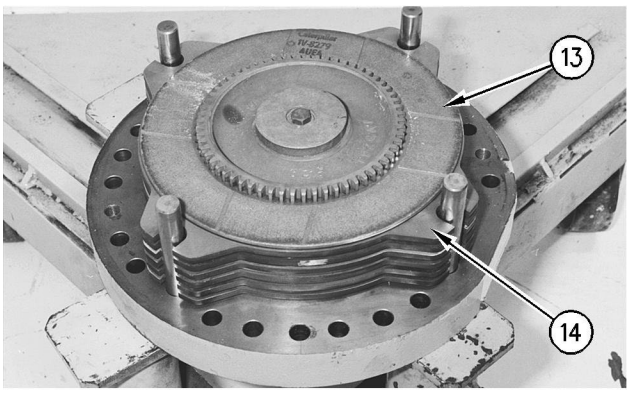


Illustration 639 g00375388

6. Install friction discs (13) and clutch plates (14) in alternating order. Start with a friction disc.

Note: BXY00435–UP and BTW00177–UP have more clutch plates than friction discs. For these machines start with a clutch plate.

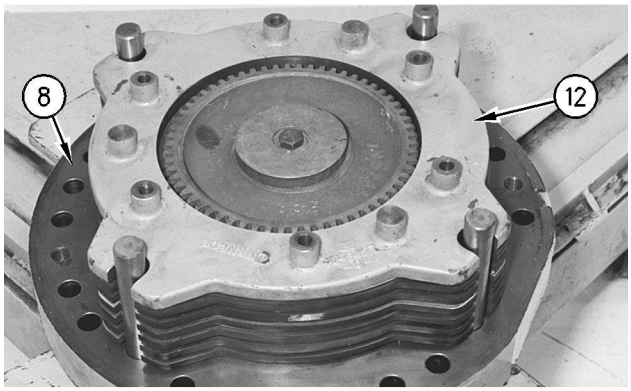


Illustration 640 g00375387

7. Install pressure plate (12) on bearing cage assembly (8).

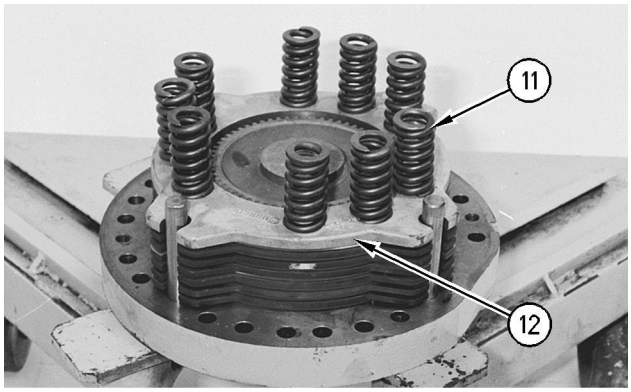


Illustration 641 g00375385

8. Install springs (11) on pressure plate (12).

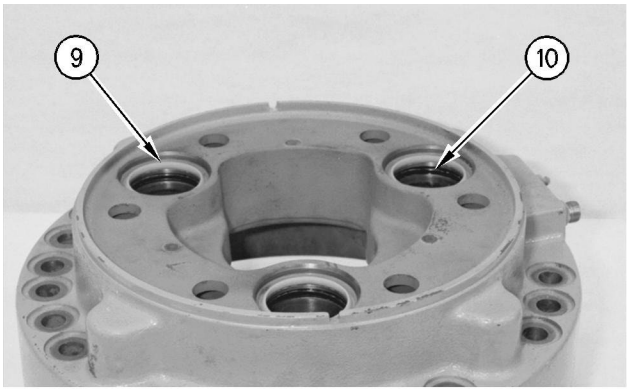


Illustration 642 g00375384

9. Install O-ring seals (10) and lip seals (9) in the bores of the brake housing.

Note: Lip seals (9) must contact the counterbore in the brake housing. Make sure that the sealing lips are facing outward. Lubricate the sealing lip with the lubricant that is being sealed.

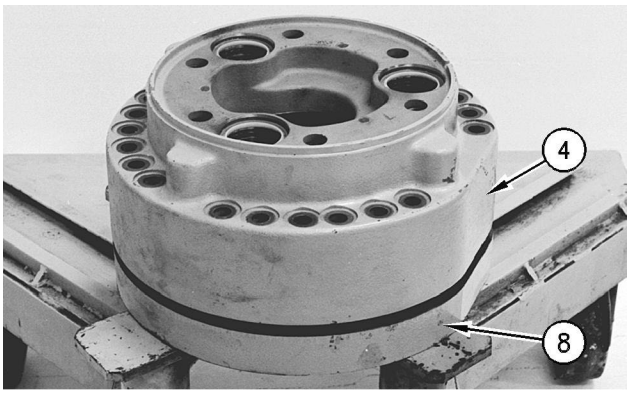


Illustration 643 g00375381

10. Use two persons to lift brake housing (4) onto bearing cage assembly (8). The weight of brake housing (4) is approximately 41 kg (90 lb).

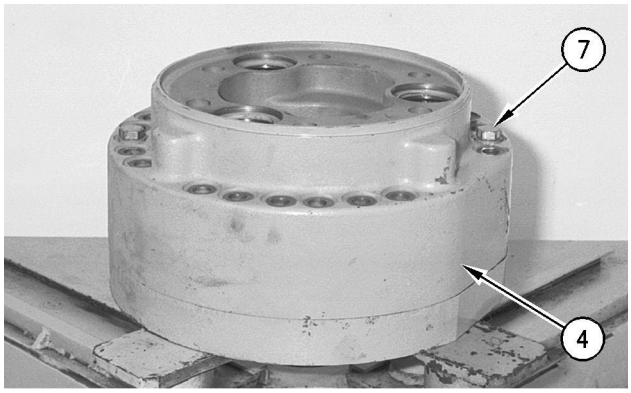


Illustration 644 g00375380

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

11. Install the washers and bolts (7) in brake housing (4). Tighten bolts (7) evenly to a torque of 270 ± 40 N·m (200 ± 30 lb ft).

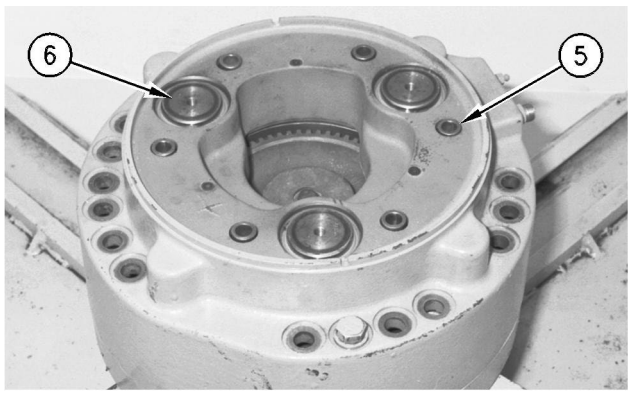


Illustration 645 g00380075

12. Lubricate pistons (6) lightly with the lubricant that is being sealed. Use Tooling (A) and Tooling (B) to install pistons (6) in the brake housing.

13. Install spacers (5) in the brake housing.

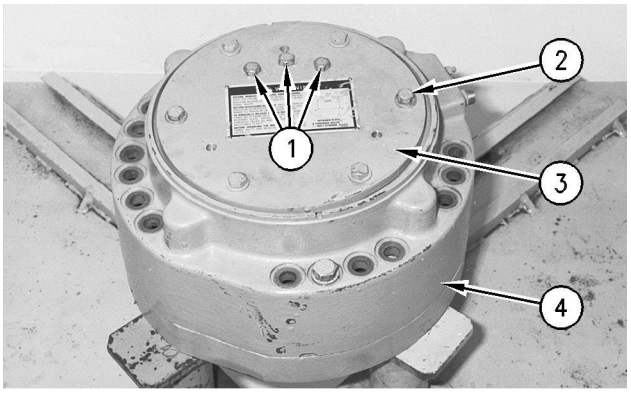


Illustration 646 g00351073

14. Install retaining plate (3) on brake housing (4).

15. Install the washers and bolts (2) that secure retaining plate (3) to brake housing (4). Tighten the bolts (2) evenly to a torque of 105 ± 20 N·m (78 ± 15 lb ft).

16. Remove bolts (1).

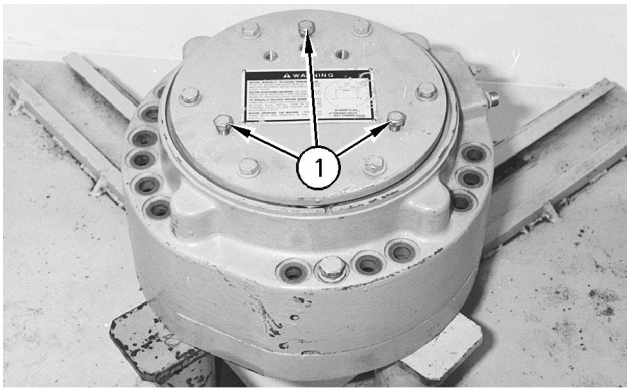


Illustration 647 g00350733

17. Install bolts (1) into a different location. Bolts (1) are used to disengage the parking brake.

End By:

a. Install the parking brake. Refer to Disassembly and Assembly, “Parking Brake - Install”.

i02517458

Parking Brake - Install

SMCS Code: 4267-012

Installation Procedure

Table 24

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	FT-2468	Threaded Rod	2
C	138-7574	Link Bracket	6
D	1U-9200	Lever Puller Hoist	2

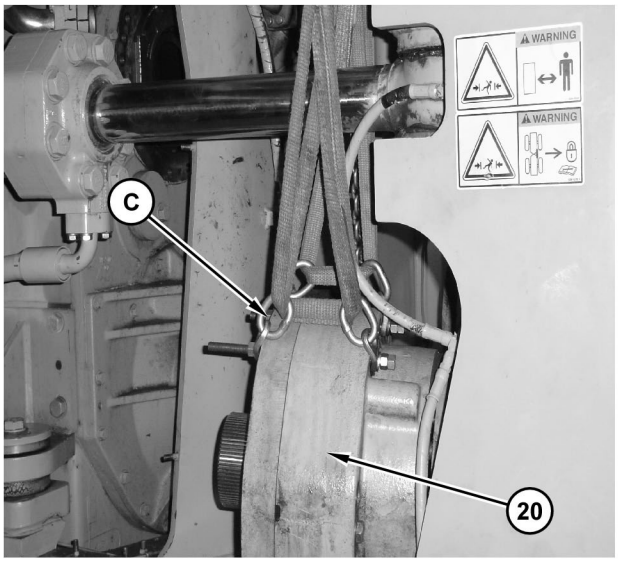


Illustration 648 g01244005

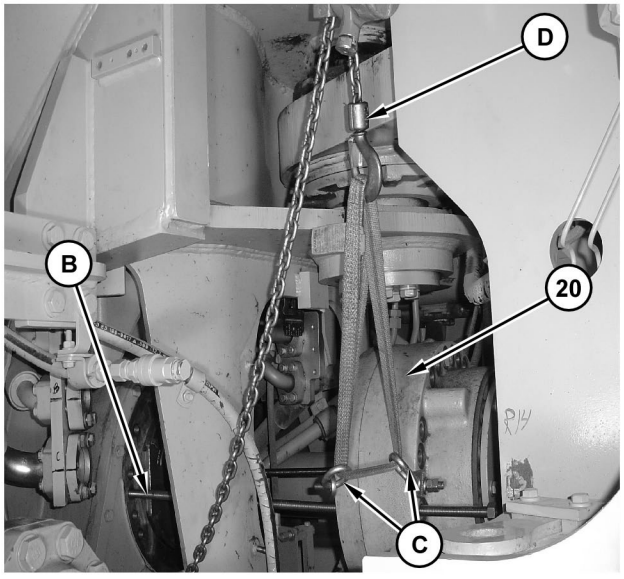


Illustration 649 g01244000

1. Attach Tooling (C) and a suitable lifting device to parking brake assembly (20). The weight of parking brake assembly (20) is approximately 168 kg (370 lb). Raise and position parking brake assembly (20) to the proper level. Attach Tooling (C) and Tooling (D) to parking brake assembly (20).

2. Carefully attach Tooling (C) and Tooling (D) in order to position parking brake assembly (20) under the steering cylinder.

3. Use Tooling (D) and Tooling (C) in order to support parking brake assembly (20). Install Tooling (B).

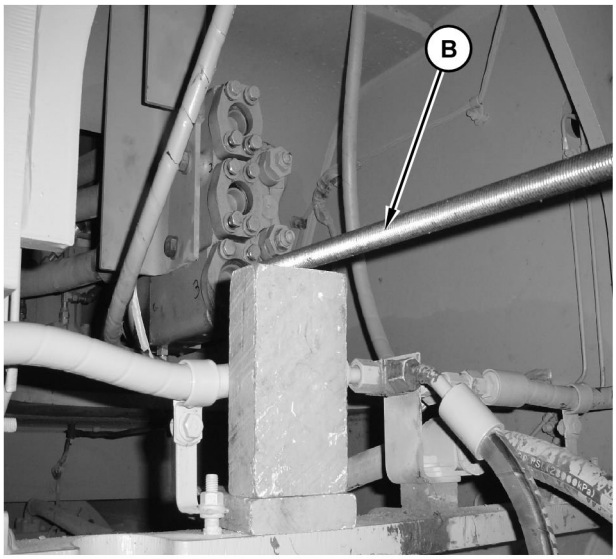


Illustration 650 g01243944

4. Support Tooling (B) with a suitable blocking.

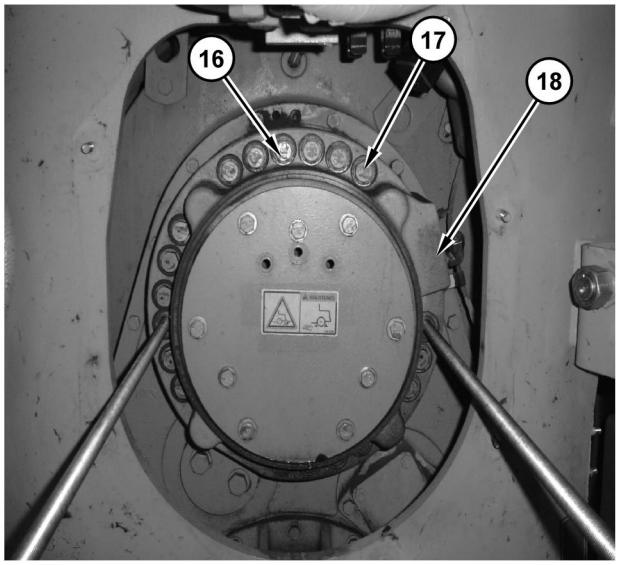


Illustration 651 g01243989

5. Position parking brake assembly (20) into the proper location. Install bolts (17) and fitting (18). Tighten bolts (17) to a torque of 270 ± 40 N·m (199 ± 30 lb ft).

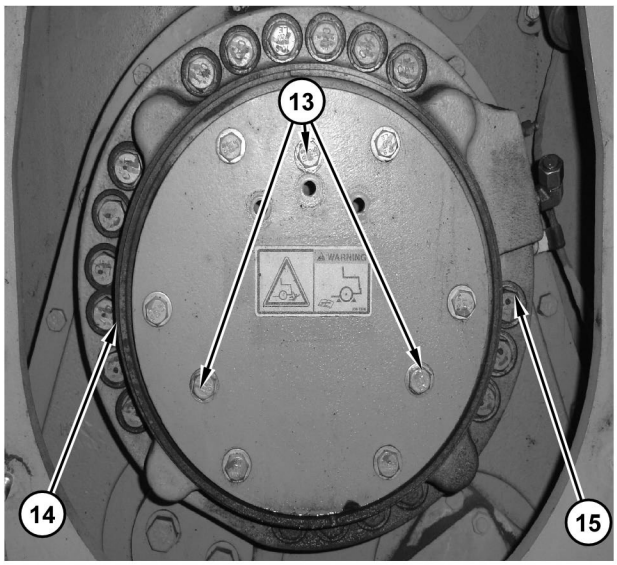


Illustration 652 g01243898

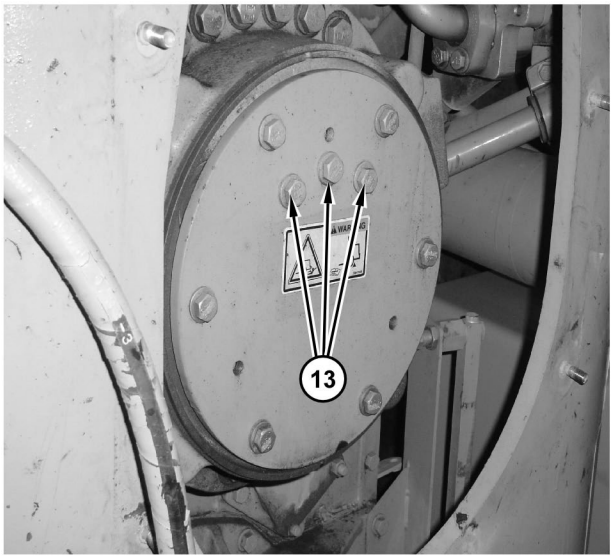


Illustration 653 g01243889

6. Remove Tooling (B). Install bolts (14) and (15). Remove bolts (13). Tighten bolts (14) and (15) to a torque of 270 ± 40 N·m (199 ± 30 lb ft). Install bolts (13) into a different location.

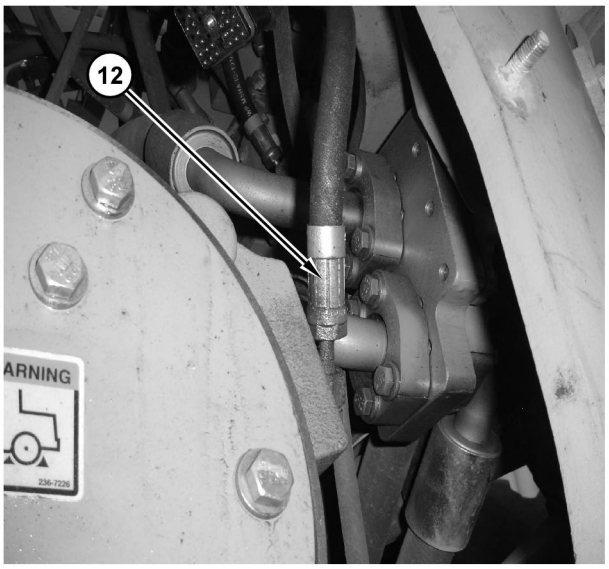


Illustration 654 g01243883

7. Connect hose assembly (12).

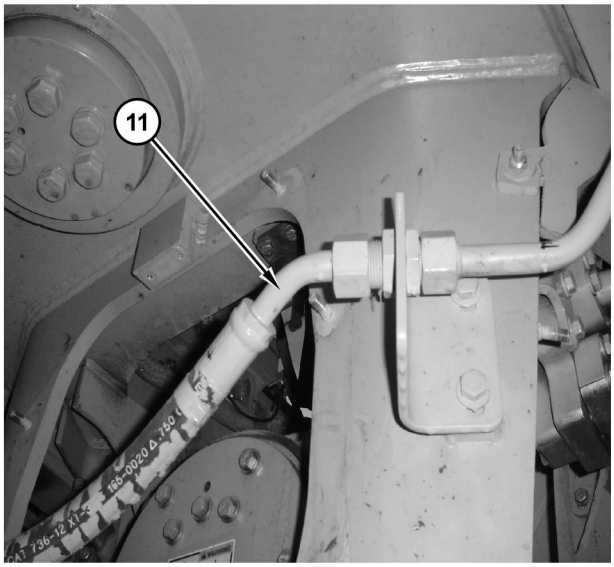


Illustration 655 g01243863

8. Connect hose assembly (11).

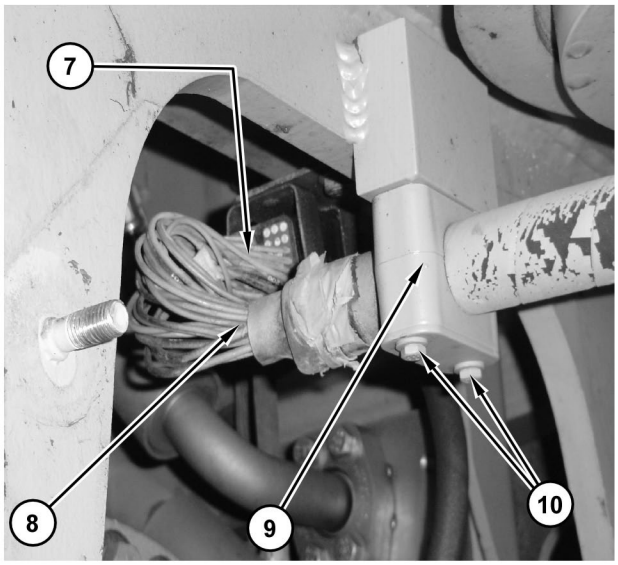


Illustration 656 g01243771

9. Connect harness assembly (8). Install clamp (9). Install bolts (10). Tighten bolt (7).

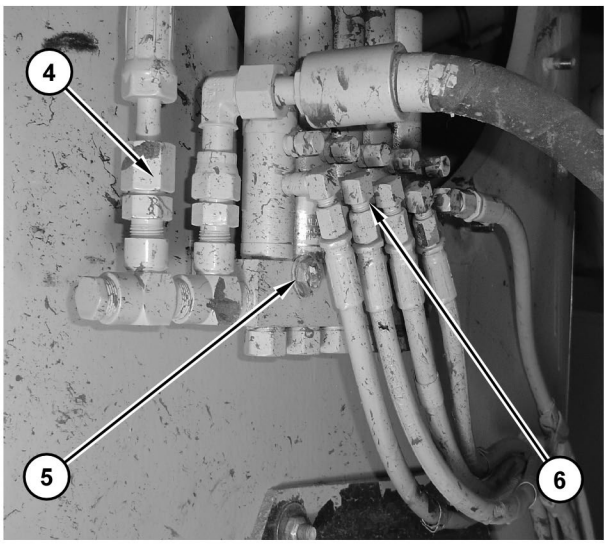


Illustration 657 g01243766

10. Install valve assembly (6) into position. Install bolts (5) and the spacers. Connect hose assembly (4).

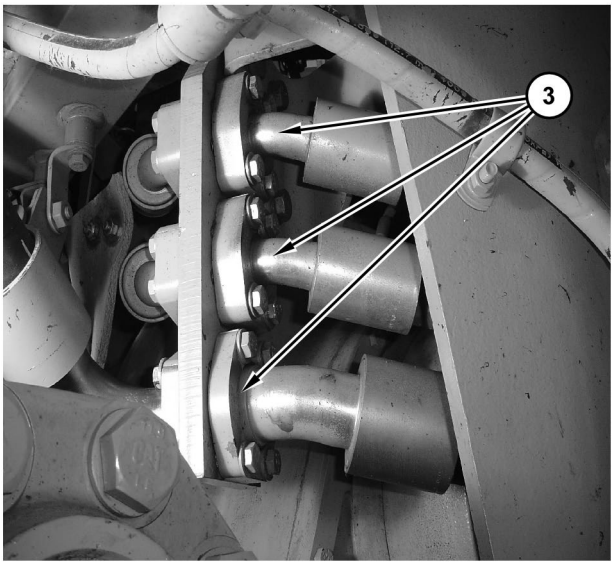


Illustration 658 g01243743

11. Install hose assemblies (3).



Illustration 659 g01259527

12. Install sheet (2).

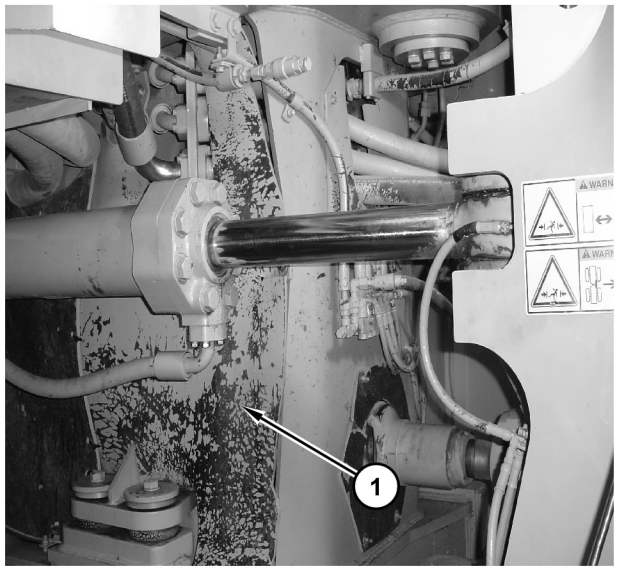


Illustration 660 g01243718

13. Install sheet (1).

14. Repeat Step 13 for the opposite side.

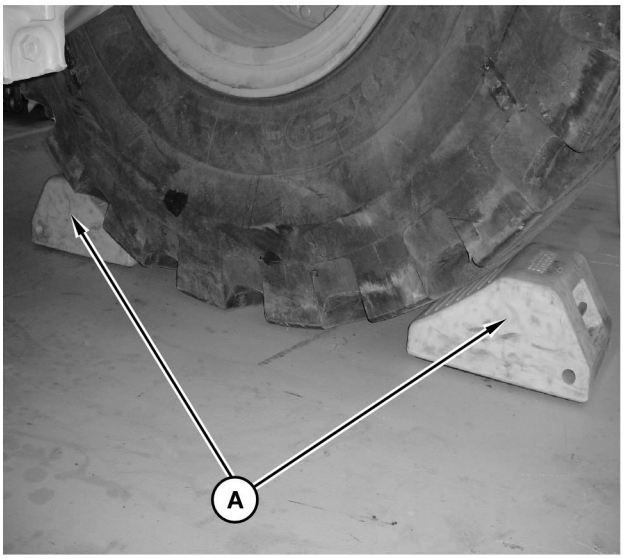


Illustration 661 g01243717

15. Remove Tooling (A) from the wheels of the machine.

16. Fill the hydraulic oil tank. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Brake) - Change”.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02492515

Drive Shaft (Front) and Drive Shaft Carrier Bearing - Remove

SMCS Code: 3253-011-FR; 3267-011-BD

Removal Procedure

Table 25

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	1U-9200	Lever Puller Hoist	1
C	154-6182	Forcing Bolt	1
D	138-7574	Link Bracket	2
E	1U-9200	Lever Puller Hoist	1

Start By:

a. Remove the center drive shaft. Refer to Disassembly and Assembly, “Drive Shaft (Center) - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

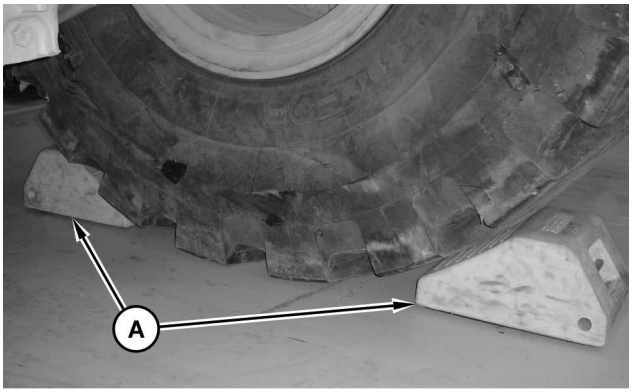


Illustration 662 g01246134

1. Install Tooling (A) on both sides of the tire.

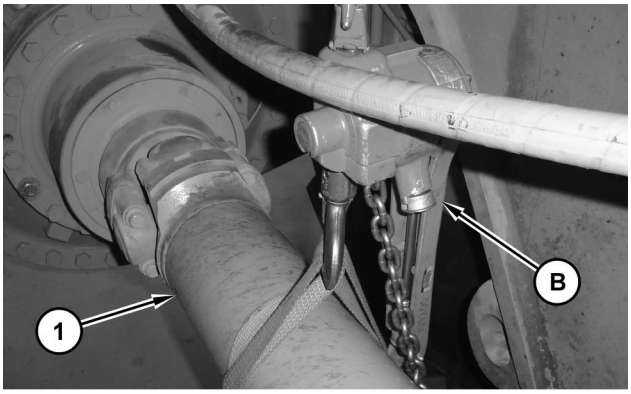


Illustration 663 g01246218

2. Install Tooling (B) and a suitable lifting device onto drive shaft and drive shaft carrier bearing assembly (1) and the machine frame.

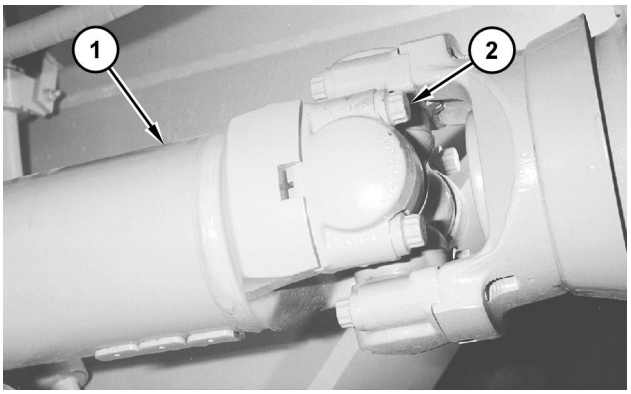


Illustration 664 g01246223

3. Remove bolts (2) in order to separate drive shaft and drive shaft carrier bearing assembly (1) from the spider.

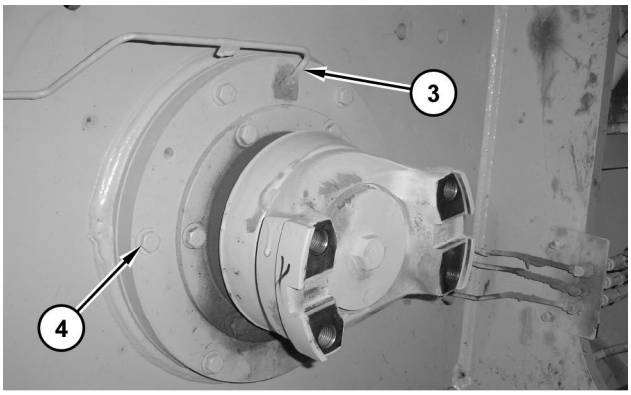


Illustration 665 g01246386

4. Disconnect tube assembly (3). Remove bolts (4).

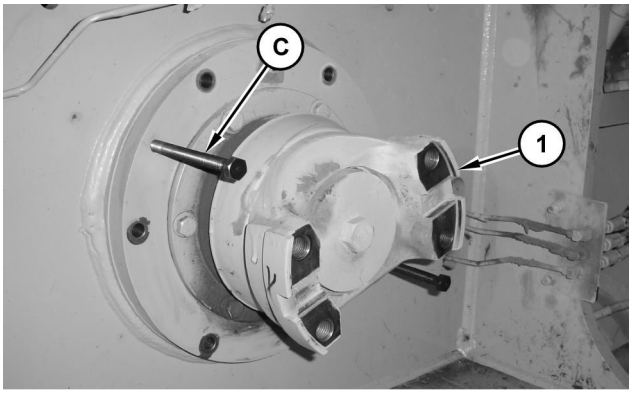


Illustration 666 g01246263

5. Use Tooling (C) in order to separatedrive shaft and drive shaft carrier bearing assembly (1) from the machine frame. Remove Tooling (C).

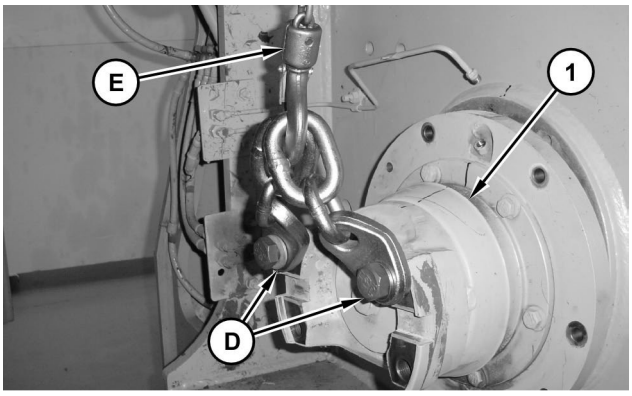


Illustration 667 g01246281

6. Attach Tooling (D) onto drive shaft and drive shaft carrier bearing assembly (1). Attach Tooling (E) onto the machine frame and onto Tooling (D). The weight of drive shaft and drive shaft carrier bearing assembly (1) is approximately 127 kg (280 lb).

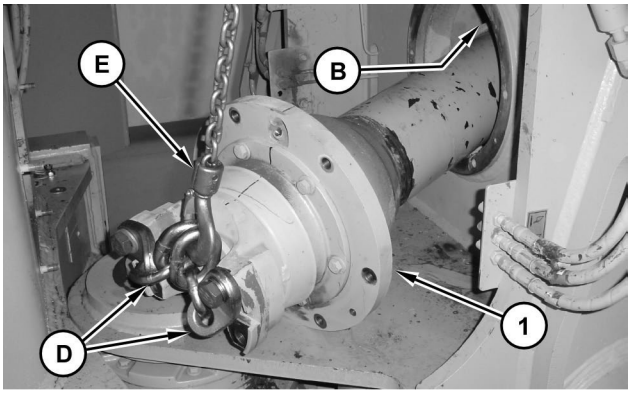


Illustration 668 g01246300

7. Use Tooling (B), Tooling (D), and Tooling (E) in order to position drive shaft and drive shaft carrier bearing assembly (1), as shown. Remove Tooling (B), Tooling (D), and Tooling (E) from drive shaft and drive shaft carrier bearing assembly (1).

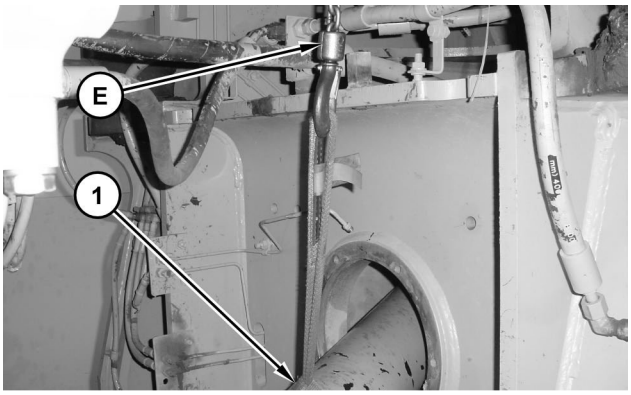


Illustration 669 g01246309

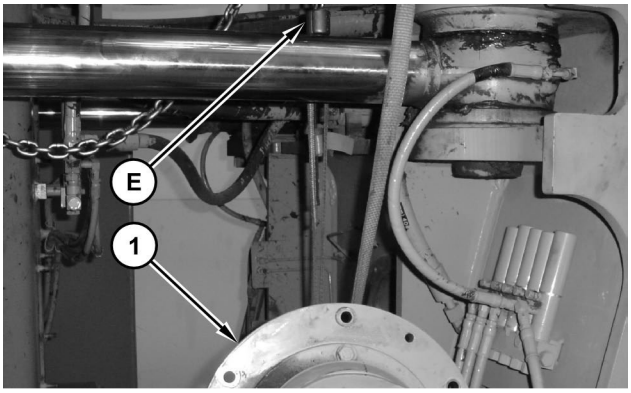


Illustration 670 g01246310

8. Use Tooling (E) and a suitable lifting device in order to position drive shaft and drive shaft carrier bearing (1) under steering cylinder (5), as shown.

9. Attach two suitable lifting devices onto drive shaft and drive shaft carrier bearing (1). Remove Tooling (E).

10. Remove drive shaft and drive shaft carrier bearing assembly (1).

i02492517

Drive Shaft (Front) and Drive Shaft Carrier Bearing - Install

SMCS Code: 3253-012-FR; 3267-012-BD

Installation Procedure

Table 26

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	1U-9200	Lever Puller Hoist	1
D	138-7574	Link Bracket	2
E	1U-9200	Lever Puller Hoist	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the front drive shaft and the carrier bearing. Inspect the front drive shaft and the carrier bearing. Replace all seals and all damaged parts with new parts.

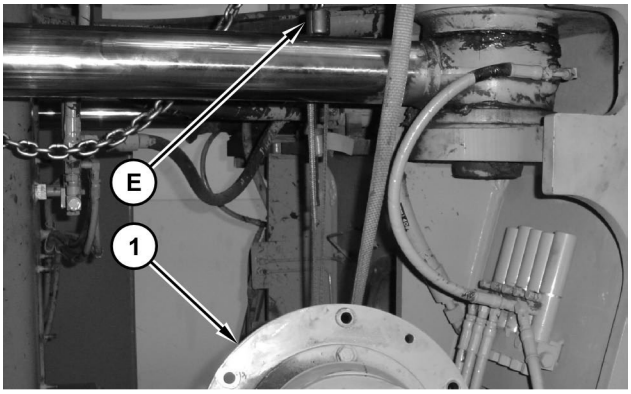


Illustration 671 g01246310

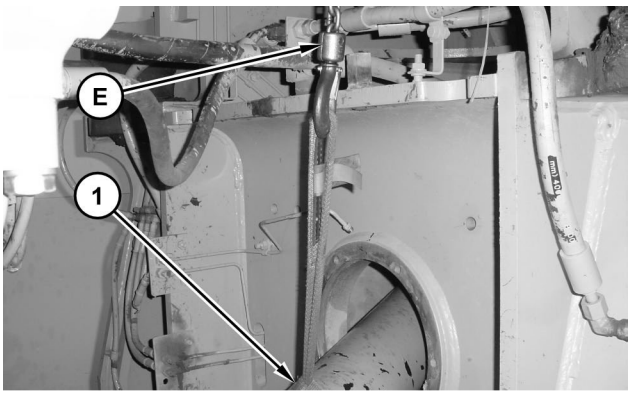


Illustration 672 g01246309

2. Use two suitable lifting devices in order to position drive shaft and drive shaft carrier bearing assembly (1) under the steering cylinder, as shown. The weight of drive shaft and drive shaft carrier bearing assembly (1) is approximately 127 kg (280 lb).

3. Attach Tooling (E) and a suitable lifting device onto drive shaft and drive shaft carrier bearing assembly (1) and position drive shaft and drive shaft carrier bearing assembly (1) into the machine frame.

4. Remove Tooling (E).

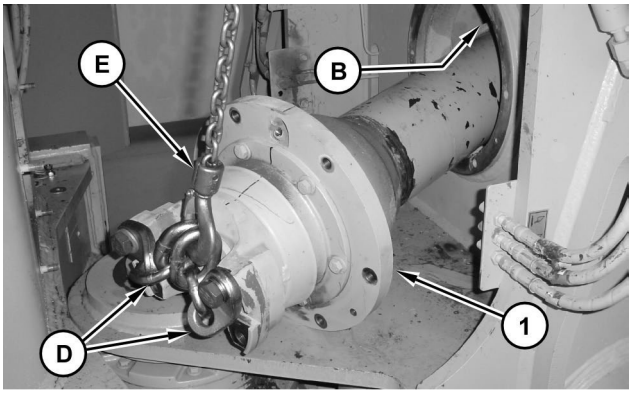


Illustration 673 g01246300

5. Attach Tooling (D), Tooling (E), and Tooling (B) onto drive shaft and drive shaft carrier bearing assembly (1).

6. Use Tooling (D), Tooling (E), and Tooling (B) in order to position drive shaft and drive shaft carrier bearing assembly (1) onto the machine frame.

7. Remove Tooling (B), Tooling (D), and Tooling (E).

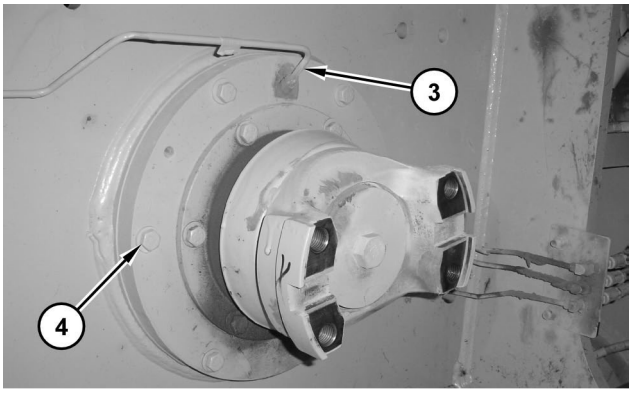


Illustration 674 g01246386

8. Install bolts (4). Connect tube assembly (3).

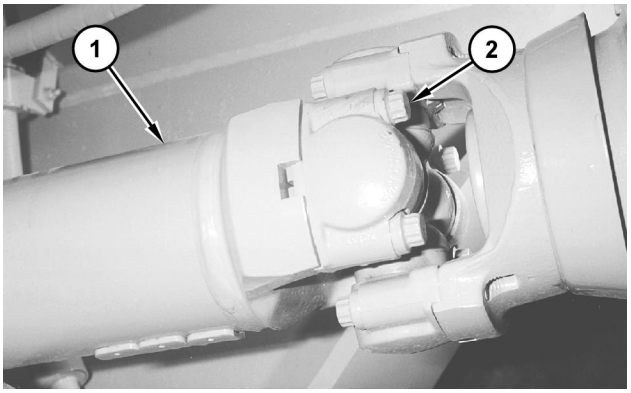


Illustration 675 g01246223

9. Use Tooling (B) and a suitable lifting device in order to position drive shaft and drive shaft carrier bearing assembly (1). Install bolts (2) in order to connect drive shaft and drive shaft carrier bearing assembly (1) onto the spider.

10. Tighten bolts (2) to a torque of 530 ± 70 N·m (391 ± 52 lb ft).

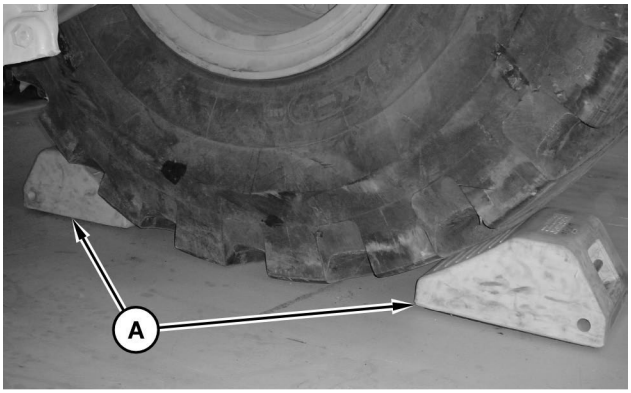


Illustration 676 g01246134

11. Remove Tooling (A).

End By:

a. Install the center drive shaft. Refer to Disassembly and Assembly, “Drive Shaft (Center) - Remove and Install”.

i02494238

Drive Shaft (Center) - Remove and Install

SMCS Code: 3253-010-CE

Removal Procedure

Table 27

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	1U-9200	Lever Puller Hoist	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

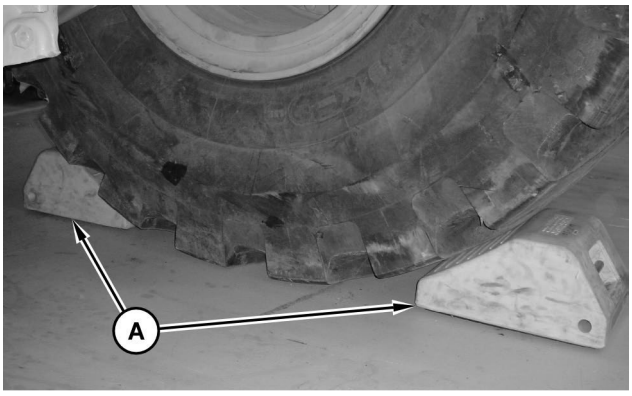


Illustration 677 g01246134

1. Install Tooling (A) on both sides of the tire.



Illustration 678 g01247157

2. Remove guard (1).

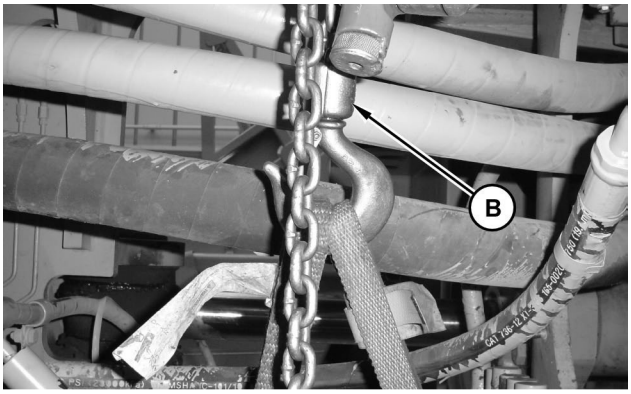


Illustration 679 g01247156

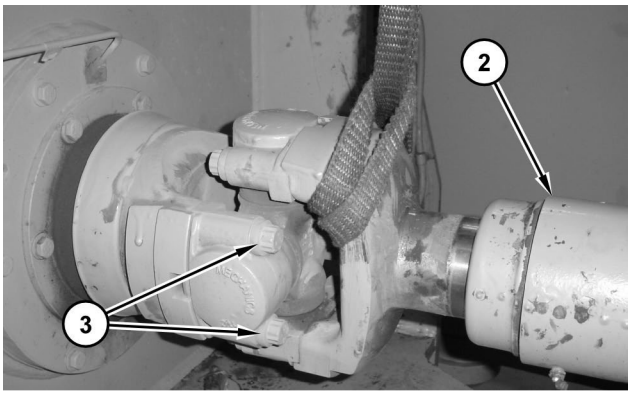


Illustration 680 g01247161

3. Attach Tooling (B) and two suitable lifting devices onto center drive shaft (2). Secure Tooling (B) onto the machine frame. The weight of center drive shaft (2) is approximately 82 kg (180 lb).

4. Remove bolts (3) from both ends of center drive shaft (2).

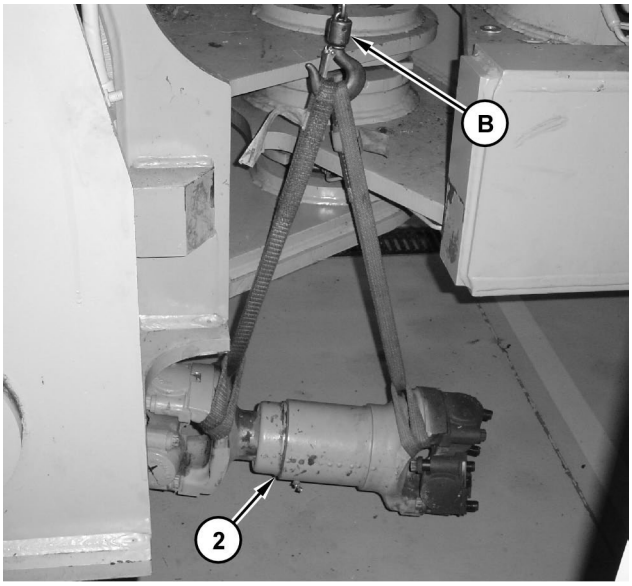


Illustration 681 g01247148

5. Use Tooling (B) in order to remove center drive shaft (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
When the center drive shaft is installed, it must be installed in phase with the front and rear drive shafts. Serious component damage could occur. Be certain that all the joint group, all the yokes, and all the lubricating fittings are aligned.

Note: Clean the mating faces of the yokes and the drive shaft.

Note: Align all the yokes before the installation procedure.

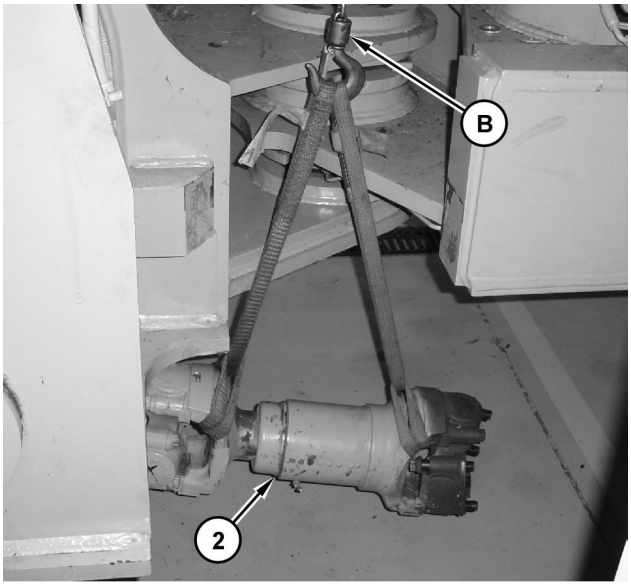


Illustration 682 g01247148

1. Attach Tooling (B) and two suitable lifting devices onto center drive shaft (2). Secure Tooling (B) onto the machine frame. The weight of center drive shaft (2) is approximately 82 kg (180 lb).

2. Use Tooling (B) and two suitable lifting devices in order to position center drive shaft (2).

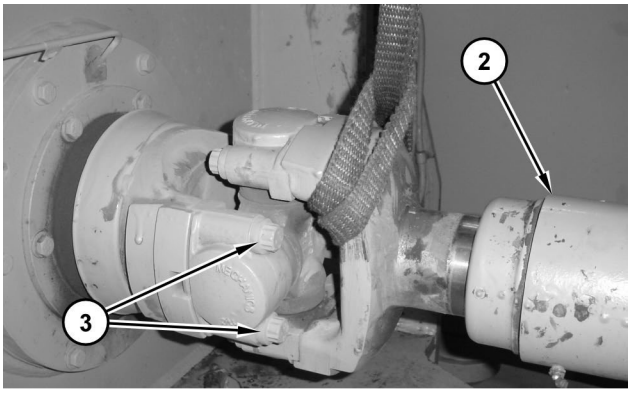


Illustration 683 g01247161

3. Install bolts (3) onto both ends of center drive shaft (2). Tighten bolts (3) to a torque of 530 ± 70 N·m (4691 ± 620 lb in).



Illustration 684 g01247157

4. Install guard (1).

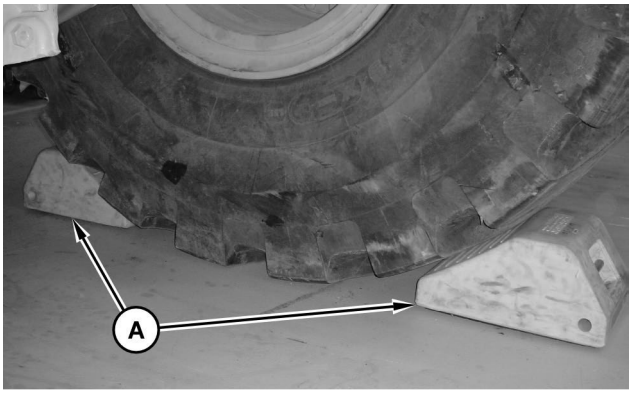


Illustration 685 g01246134

5. Remove Tooling (A) from both sides of the tire.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02504721

Drive Shaft (Rear) - Remove and Install

SMCS Code: 3253-010-RE

Removal Procedure

Start By:

a. Remove the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install”.

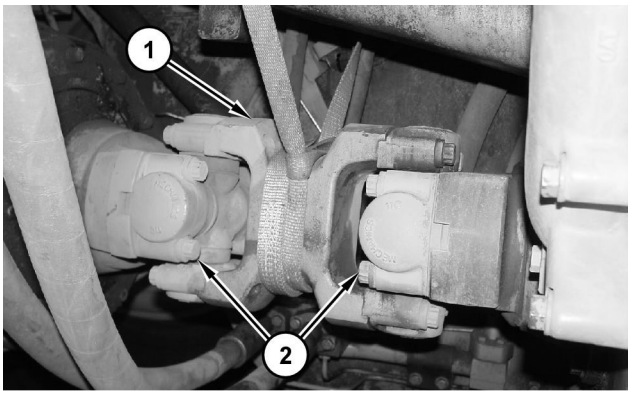


Illustration 686 g01253878

1. Attach a suitable lifting device onto rear drive shaft (1). The weight of rear drive shaft (1) is approximately 61 kg (135 lb).

2. Remove bolts (2).

3. Use the suitable lifting device in order to lower rear drive shaft (1) to the ground.

Installation Procedure

NOTICE
When the rear drive shaft is installed, it must be installed in phase with the rear axle assembly yoke. The rear drive shaft must be installed in phase with the center and front drive shafts. Serious component damage could occur. Be certain that all the joint groups, all the yokes, and all the lubricating fittings are aligned.

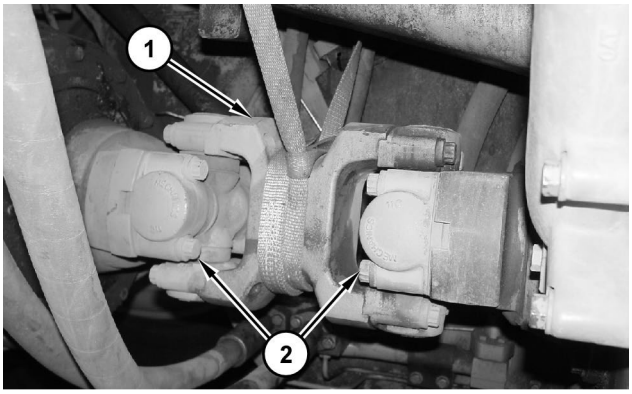


Illustration 687 g01253878

1. Use a suitable lifting device in order to install rear drive shaft (1). The weight of rear drive shaft (1) is approximately 61 kg (135 lb).

2. Install bolts (2). Tighten bolts (2) to a torque of 530 ± 70 N·m (400 ± 50 lb ft).

3. Lubricate the rear drive shaft. Refer to Operation and Maintenance Manual, “Drive Shaft Universal Joints - Lubricate”.

End By:

a. Install the power train guard. Refer to Disassembly and Assembly, “Power Train Guard (Transmission) - Remove and Install”.

i02500884

Tire and Rim (Front) - Remove and Install

SMCS Code: 4202-010-FR

Removal Procedure

Table 28

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7536	Lift Stand	2
	4C-5809	Hydraulic Pump	1
B	155-3597	Wheel Chock	4

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

⚠ WARNING

Follow the recommended procedure for removal and installation of tires and or wheel assemblies.

Ensure that the machine and tire and or wheel assembly are properly supported at all times.

Improper procedures that are used to remove and install tires and or wheel assemblies can result in personal injury or death.

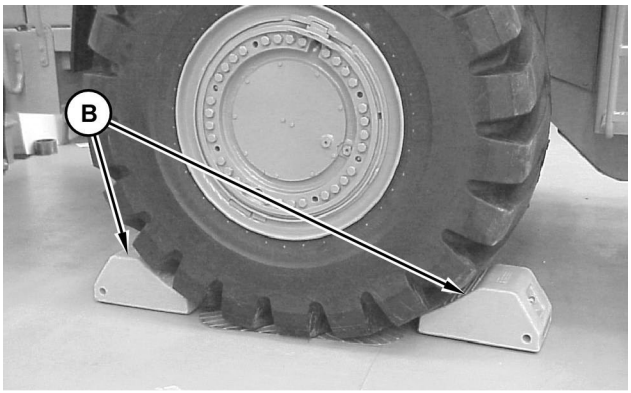


Illustration 688 g01250875
Typical Example

1. Use Tooling (B) in order to chock the rear tires, as shown.

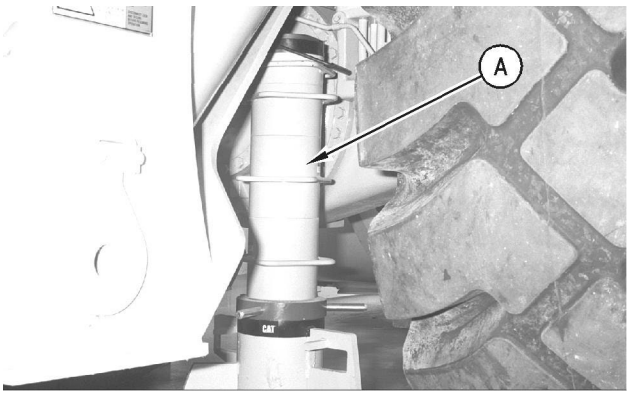


Illustration 689 g00855343
990 Wheel Loader

2. Position Tooling (A) under the machine, as shown.

3. Use Tooling (A) in order to raise tire and rim assembly (2) off the ground.

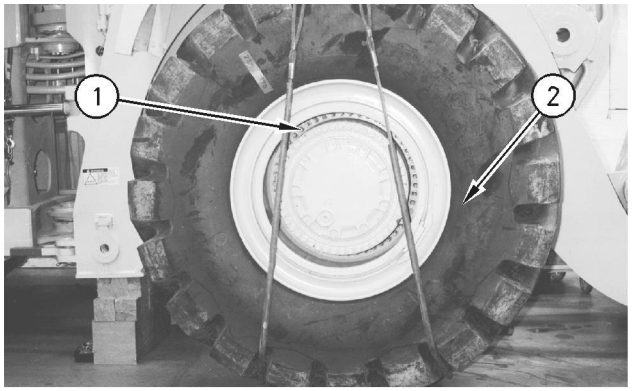


Illustration 690 g00855394
990 Wheel Loader

4. Attach a suitable lifting device onto tire and rim assembly (2).

5. Remove nuts (1).

6. Use the suitable lifting device in order to remove tire and rim assembly (2). The weight of tire and rim assembly (2) is approximately 3175 kg (7000 lb).

Installation Procedure

Table 29

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7536	Lift Stand	2
	4C-5809	Hydraulic Pump	1
A	155-3597	Wheel Chock	4

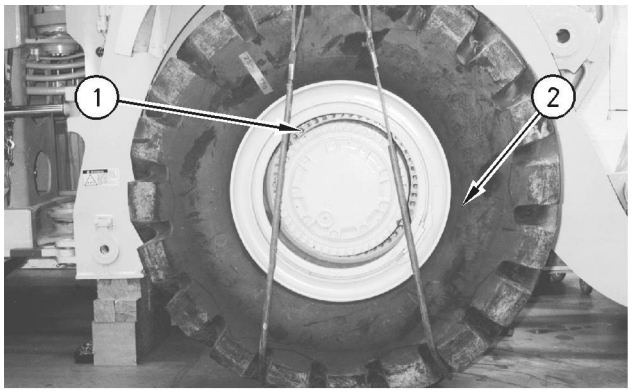


Illustration 691 g00855394
990 Wheel Loader

1. Attach a suitable lifting device onto tire and rim assembly (2), as shown.

2. Use the suitable lifting device in order to install tire and rim assembly (2). The weight of tire and rim assembly (2) is approximately 3175 kg (7000 lb).

3. Install nuts (1). Tighten nuts (1) to a torque of 900 ± 100 N·m (660 ± 75 lb ft).

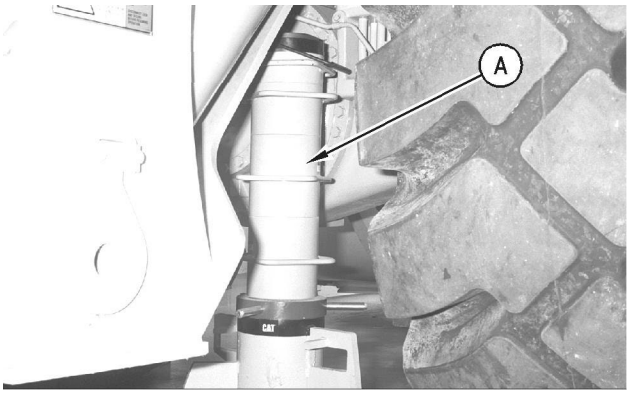


Illustration 692 g00855343
990 Wheel Loader

4. Use Tooling (A) in order to lower the machine to the ground.

5. Remove Tooling (A).

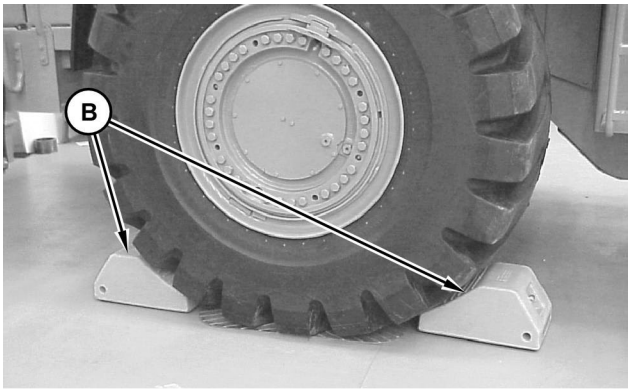


Illustration 693 g01250875
Typical Example

6. Remove Tooling (B).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02500891

Tire and Rim (Rear) - Remove and Install

SMCS Code: 4202-010-RE

Removal Procedure

Table 30

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7536	Lift Stand	2
	4C-5809	Hydraulic Pump	1
B	155-3597	Wheel Chock	4

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

WARNING

Follow the recommended procedure for removal and installation of tires and or wheel assemblies.

Ensure that the machine and tire and or wheel assembly are properly supported at all times.

Improper procedures that are used to remove and install tires and or wheel assemblies can result in personal injury or death.

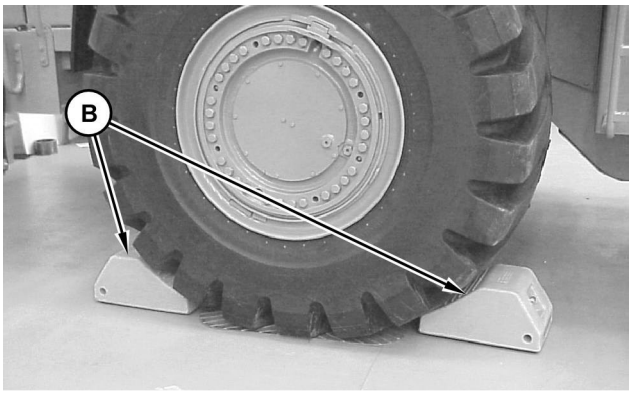


Illustration 694 g01250875

Typical Example

1. Use Tooling (B) in order to chock the front tires.

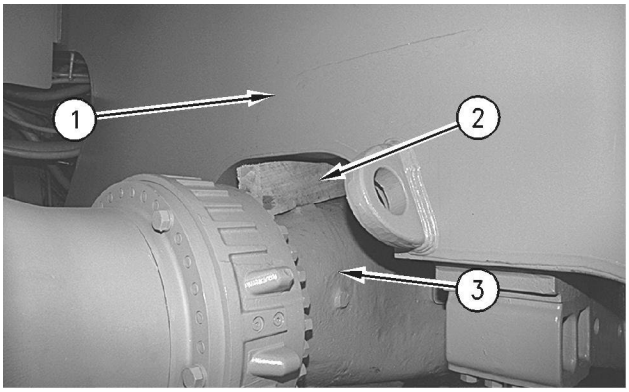


Illustration 695 g00367854

Typical Example

WARNING

Improper blocking of the rear axle housing can cause personal injury.

The rear axle housing is made to oscillate. During removal and installation of the rear tires and rims, the rear axle housing must be prevented from oscillating.

Place wood blocks between the rear axle housing and the rear main frame to prevent oscillation of the rear axle housing.

2. Place a suitable block (2) between axle housing (3) and rear main frame (1) on both sides of the machine.

Note: This will prevent the rear axle housing from oscillating.

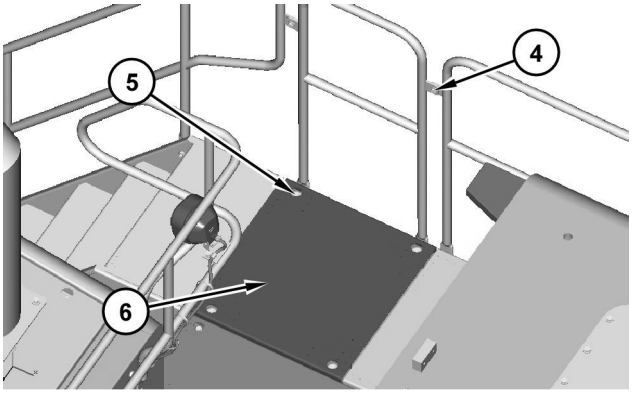


Illustration 696 g01250881

3. Remove bolts (4). Remove bolts (5). Use two people in order to remove panel assembly and handrail (6). The weight of panel assembly and handrail (6) is approximately 27 kg (60 lb).

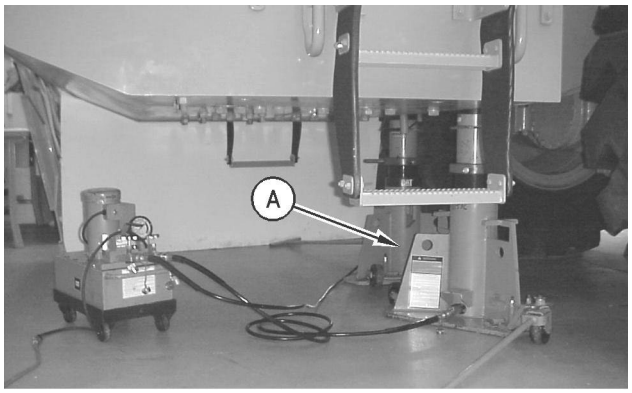


Illustration 697 g00683052

4. Position Tooling (A) under the rear frame.

5. Use Tooling (A) in order to raise the rear of the machine until the tires are off the ground.

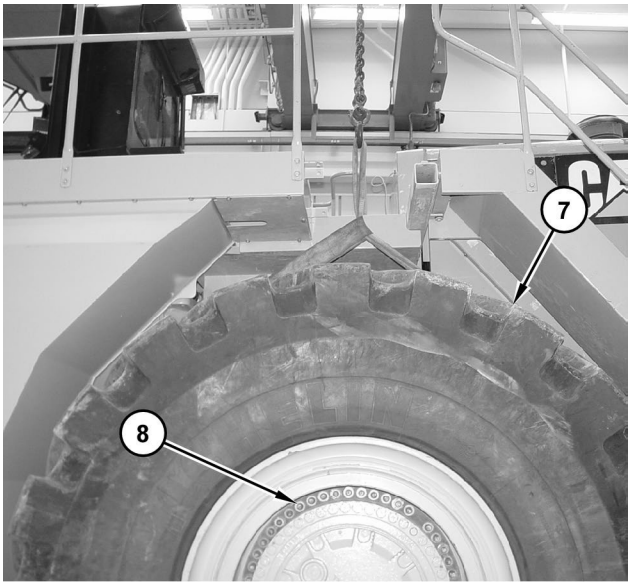


Illustration 698 g01253319

6. Attach a suitable lifting device onto tire and rim assembly (7).

7. Remove nuts (8) from the rim.

8. Use the suitable lifting device in order to remove tire and rim assembly (7). The weight of tire and rim assembly (7) is approximately 3175 kg (7000 lb).

Installation Procedure

Table 31

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7536	Lift Stand	2
	4C-5809	Hydraulic Pump	1
B	155-3597	Wheel Chock	4

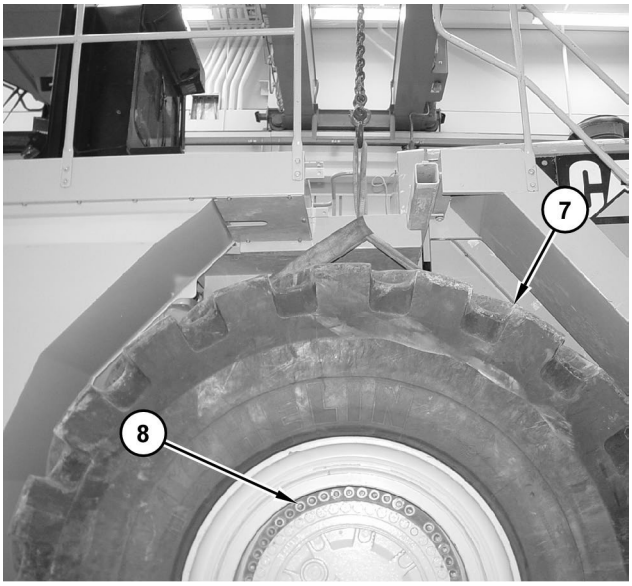


Illustration 699 g01253319

1. Attach a suitable lifting device onto tire and rim assembly (7).

2. Use the suitable lifting device in order to install tire and rim assembly (7). The weight of tire and rim assembly (7) is approximately 3175 kg (7000 lb).

3. Install nuts (8). Tighten nuts (8) to a torque of 900 ± 100 N·m (660 ± 75 lb ft).

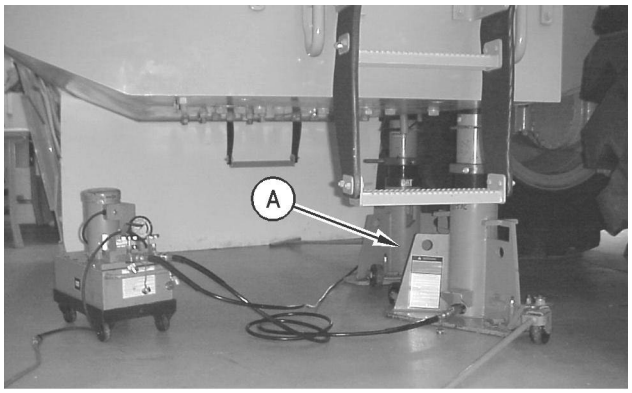


Illustration 700 g00683052

4. Use Tooling (A) in order to lower the machine to the ground.

5. Remove Tooling (A).

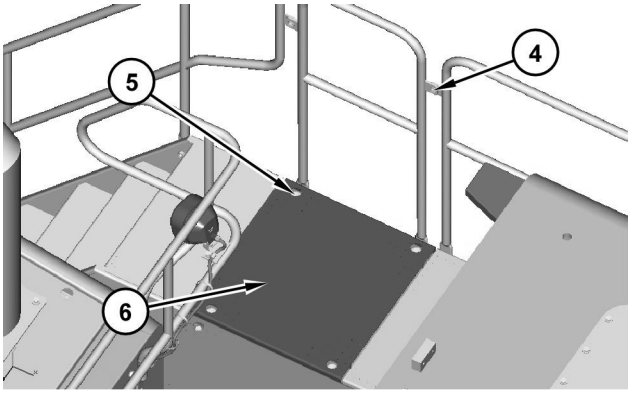


Illustration 701 g01250881

6. Use two people in order to install panel assembly and handrail (6). The weight of panel assembly and handrail (6) is approximately 27 kg (60 lb). Install bolts (5). Install bolts (4).

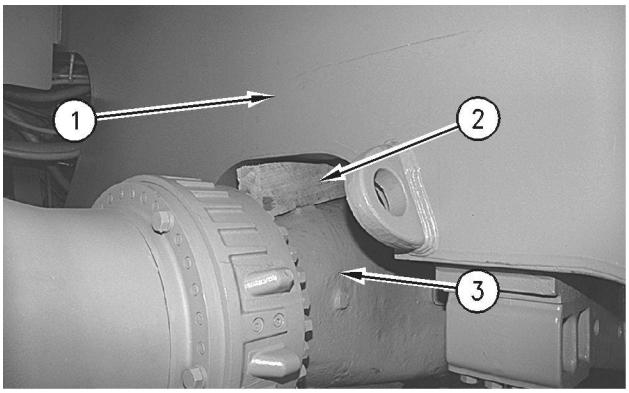


Illustration 702 g00367854

Typical Example

⚠ WARNING

Improper blocking of the rear axle housing can cause personal injury.

The rear axle housing is made to oscillate. During removal and installation of the rear tires and rims, the rear axle housing must be prevented from oscillating.

Place wood blocks between the rear axle housing and the rear main frame to prevent oscillation of the rear axle housing.

7. Remove suitable block (2) that is between axle housing (3) and rear main frame (1) from both sides of the machine.

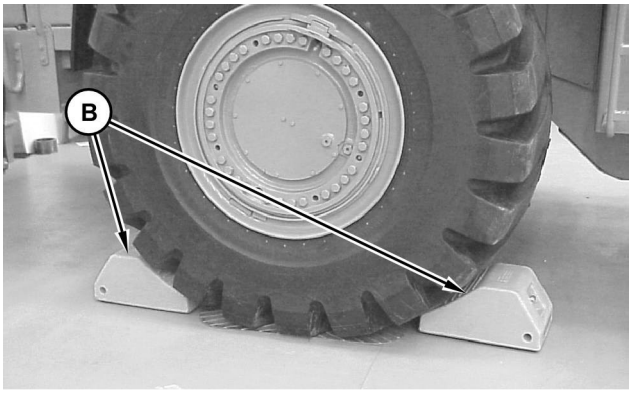


Illustration 703 g01250875
Typical Example

8. Remove Tooling (B).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02500994

Fixed Axle (Front) - Remove

SMCS Code: 3278-011-FR

Removal Procedure

Table 32

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7576	Link Bracket	4
B	137-4370	Load Leveler (15 Ton)	1

Start By:

a. Remove the front wheel assemblies. Refer to Disassembly and Assembly, “Tire and Rim (Front) - Remove and Install” .

b. Remove the front axle guards. Refer to Disassembly and Assembly, “Axle Guards (Front) - Remove and Install”.

c. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “Hydraulic System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hot oil or hot components.

At operating temperature, oil is hot and under pressure. Hot oil can cause burns.

Remove the fill cap only when the engine is stopped, and the fill cap is cool enough to touch with your bare hand.

Do not allow hot oil or components to contact skin.

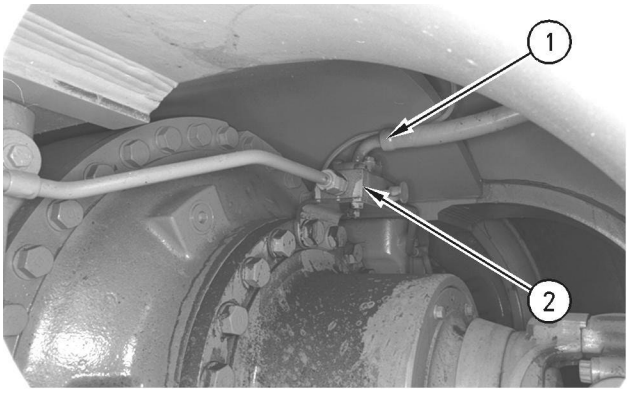


Illustration 704 g00856777

1. Remove hose assembly (1) from block (2).

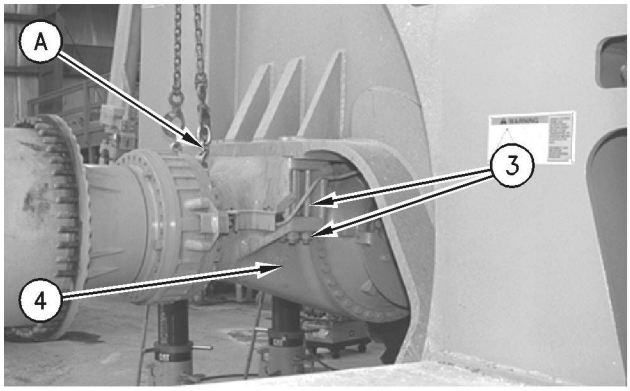


Illustration 705 g00856775

2. Attach Tooling (A) to the left side and the right side of the front axle assembly, as shown.

3. Attach Tooling (B) and a suitable lifting device to Tooling (A).

4. Remove bolts (3) from each side of front axle assembly (4).

5. Use Tooling (A), Tooling (B), and a suitable lifting device in order to lower front axle assembly (4) to the ground. The weight of front axle assembly is approximately 5230 kg (11500 lb).

i02500996

Fixed Axle (Front) - Install

SMCS Code: 3278-012-FR

Installation Procedure

Table 33

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7576	Link Bracket	4
B	137-4370	Load Leveler (15 Ton)	1

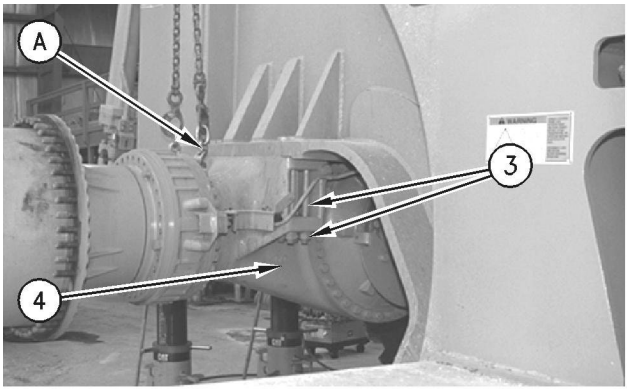


Illustration 706 g00856775

1. Attach Tooling (A) to the left and right sides of the front axle assembly, as shown.

2. Attach Tooling (B) and a suitable lifting device onto Tooling (A).

3. Install front axle assembly (4) onto the machine. The weight of front axle assembly (4) is approximately 5230 kg (11500 lb).

4. Install bolts (3) onto each side of axle housing (4). Tighten bolts (3) to a torque of 2000 ± 250 N·m (1480 ± 185 lb ft).

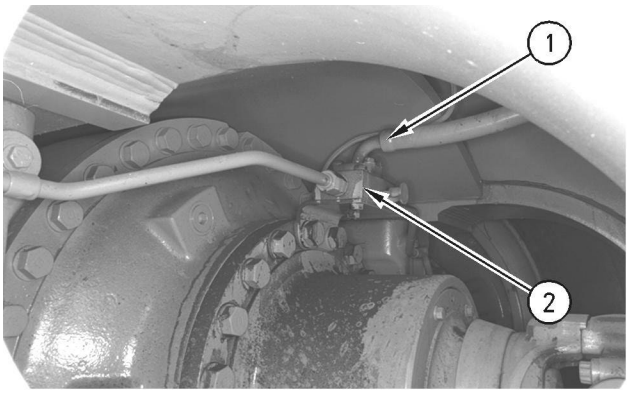


Illustration 707 g00856777

5. Install hose assembly (1) onto block (2).

6. Purge the air from the front service brakes. Refer to the Systems Operation, Testing, & Adjusting Manual for the machine that is being serviced for the proper procedure.

7. Check the oil level of the hydraulic tank. Refer to the Operations and Maintenance Manual for the machine that is being serviced for the proper procedure.

End By:

a. Install the front axle guards. Refer to Disassembly and Assembly, “Axle Guards (Front) - Remove and Install”.

b. Install the front wheel assemblies. Refer to Disassembly and Assembly, “Tire and Rim (Front) - Remove and Install”.

i02504789

Oscillating Axle (Rear) - Remove

SMCS Code: 3278-011-RE

Removal Procedure

Table 34

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7576	Link Bracket	4
B	164-4035	Shackle	2
C	137-4370	Load Leveler (15 ton)	1

Start By:

a. Remove the rear wheels. Refer to Disassembly and Assembly, “Tire and Rim (Rear) - Remove and Install”.

b. Remove the front crankcase guard. Refer to Disassembly and Assembly, “Crankcase Guard - Remove and Install”.

c. Remove the power train guard. Refer to Disassembly and Assembly, “Powertrain Guard (Transmission) - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

At operating temperature, the steering and brake hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible personal injury, release the pressure in the steering and brake hydraulic system before hydraulic lines or components are disconnected or removed.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

Note: Use suitable blocks in order to prevent the axle housing from oscillating during the removal procedure.

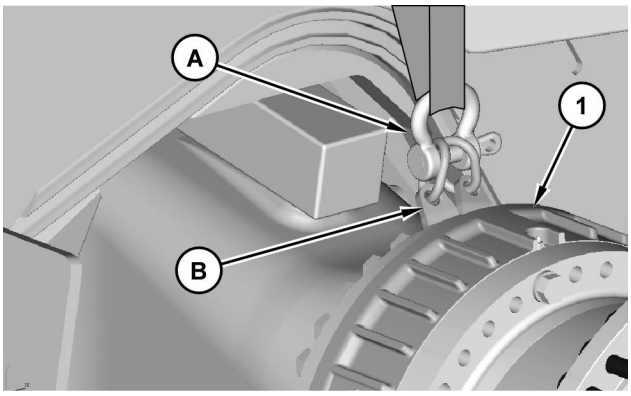


Illustration 708 g01253986

1. Attach Tooling (A), Tooling (B), and Tooling (C) onto rear oscillating axle (1). The weight of rear oscillating axle (1) is approximately 6500 kg (14330 lb). Repeat this procedure for the opposite side.

2. Use Tooling (A), Tooling (B), and Tooling (C) in order to support the weight of rear oscillating axle (1).

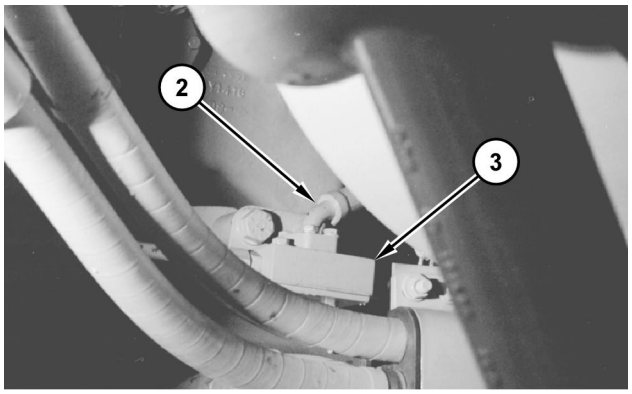


Illustration 709 g01253989

3. Disconnect hose assembly (2) from manifold (3) on the top of the rear oscillating axle.

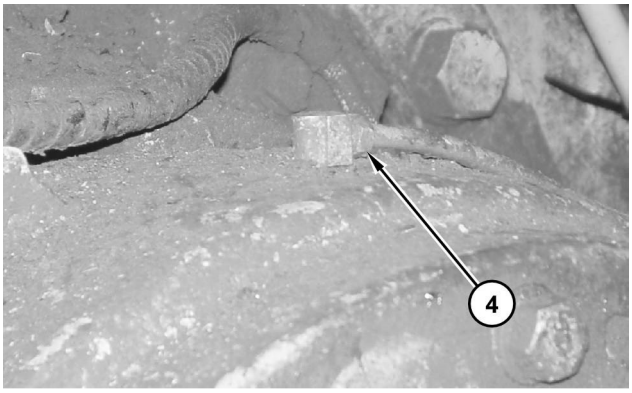


Illustration 710 g01254001

4. Disconnect tube assembly (4) from the front trunnion support.

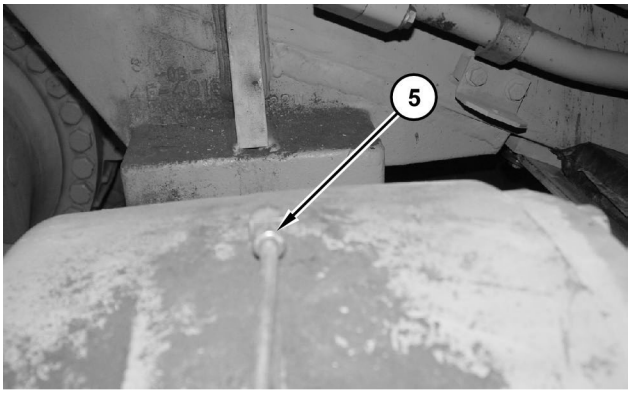


Illustration 711 g01254003

5. Disconnect tube assembly (5) from the rear trunnion support.

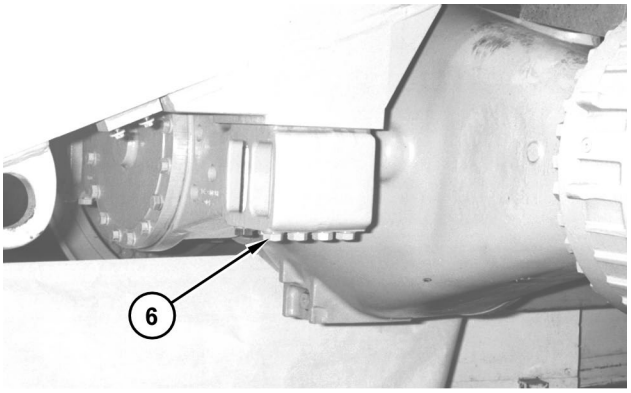


Illustration 712 g01256395

6. Remove bolts (6) from each side of the rear trunnion support.

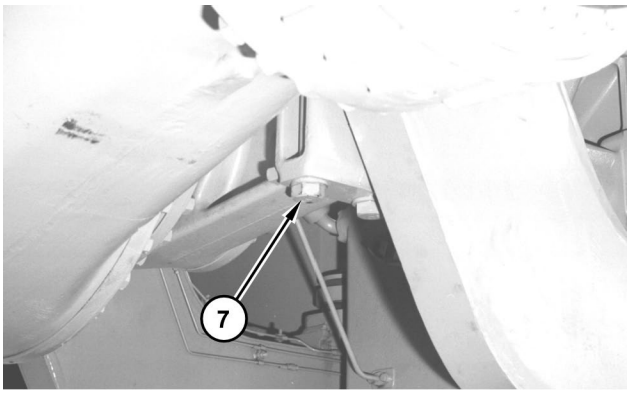


Illustration 713 g01256397

7. Remove bolts (7) from each side of the front trunnion support.

Note: Before removing the rear oscillating axle from the machine, ensure that all lines, tubes, and hoses have been disconnected.

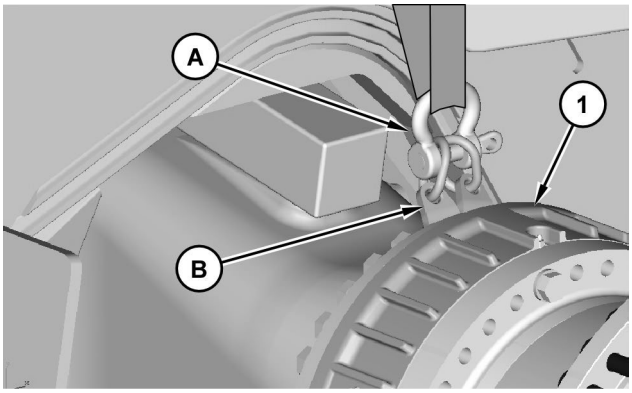


Illustration 714 g01253986

8. Use Tooling (A), Tooling (B), and Tooling (C) in order to remove rear oscillating axle (1).

i07425991

Trunnion Support (Oscillating Axle, Front) - Remove

SMCS Code: 3268-011-FR

Removal Procedure

Table 35

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2

Start By:

a. Remove the rear axle. Refer to Disassembly and Assembly, “Oscillating Axle (Rear) - Remove”.

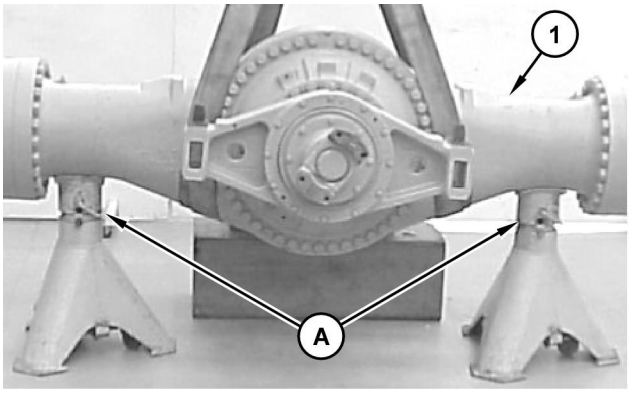


Illustration 715 g01254060

1. Place rear oscillating axle (1) on Tooling (A) and use suitable cribbing on the opposite side to keep axle (1) from rolling.

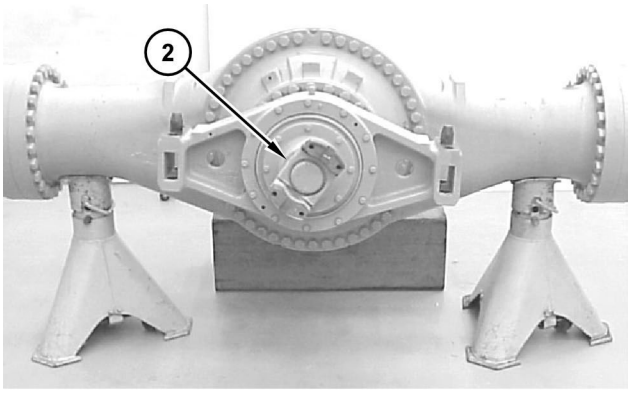


Illustration 716 g01254067

2. Remove yoke (2).

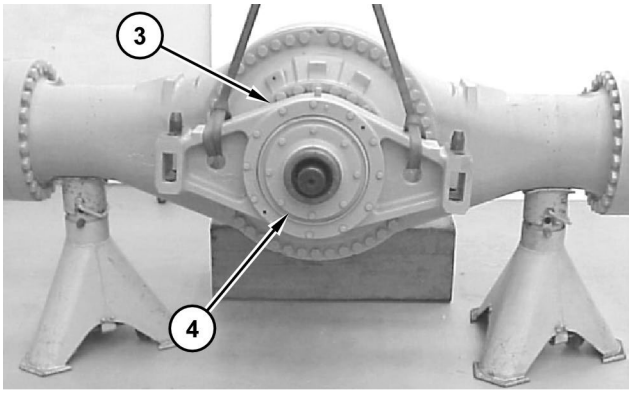


Illustration 717 g01254068

3. Attach a suitable lifting device to front trunnion support (3). The weight of front trunnion support (3) is approximately 205 kg (450 lb).

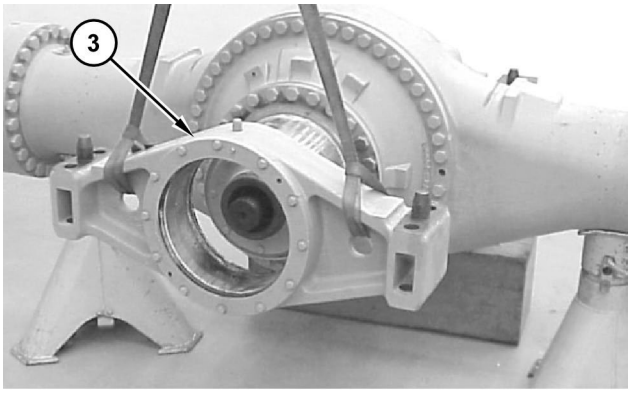


Illustration 718 g01254069

4. Remove front trunnion support (3) from the differential pinion.

i02509724

Trunnion Support (Oscillating Axle, Front) - Disassemble

SMCS Code: 3268-015-FR

Disassembly Procedure

Start By:

a. Remove the front trunnion support from the rear axle. Refer to Disassembly and Assembly, "Trunnion Support (Oscillating Axle, Front) - Remove".

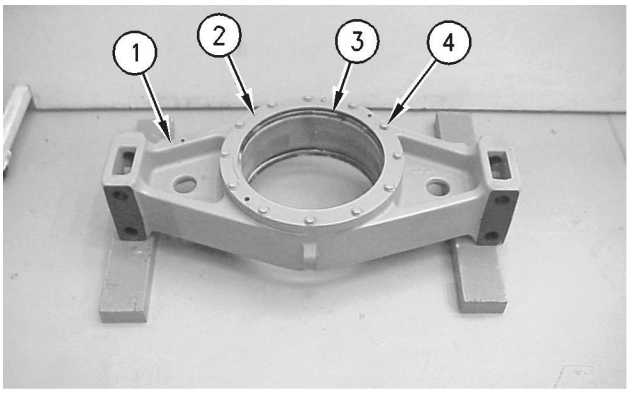


Illustration 719 g00623033

1. Place trunnion support (1) on suitable cribbing.

2. Remove O-ring seal (3).

3. Remove bolts (4) that fasten retainer (2) to front trunnion support (1).

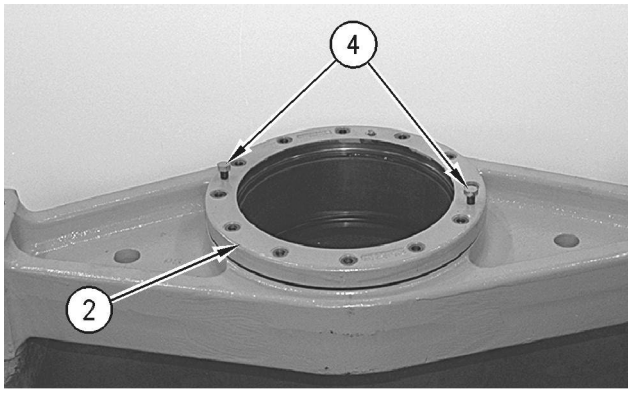


Illustration 720 g00623036

4. Install two of bolts (4) in the threaded holes of retainer (2).

Note: Tighten the bolts evenly in order to remove retainer (2).

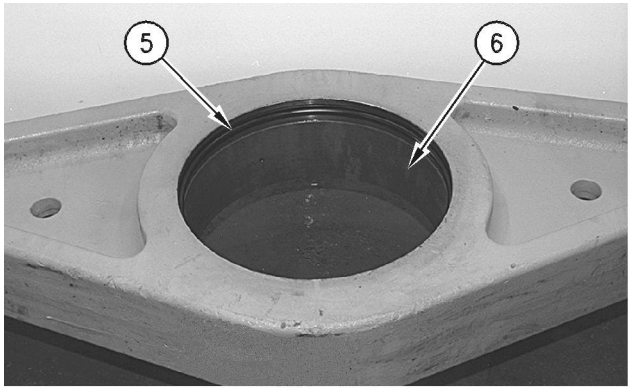


Illustration 721 g00623038

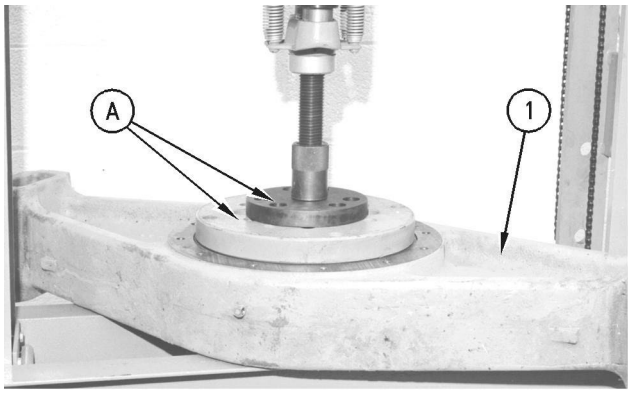


Illustration 722 g00862200

5. Turn the front trunnion support onto the opposite side and remove O-ring seal (5).

6. Use Tooling (A) and a suitable press in order to remove sleeve bearing (6) from the front trunnion support (1).

i02509588

Trunnion Support (Oscillating Axle, Front) - Assemble

SMCS Code: 3268-016-FR

Assembly Procedure

Table 36

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3546	Plate	1
A	8M-9012	Plate	1
B	5P-0960	Grease Cartridge	1

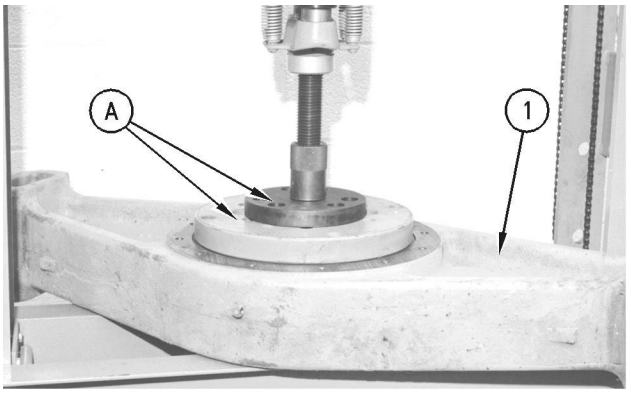


Illustration 723 g00862200

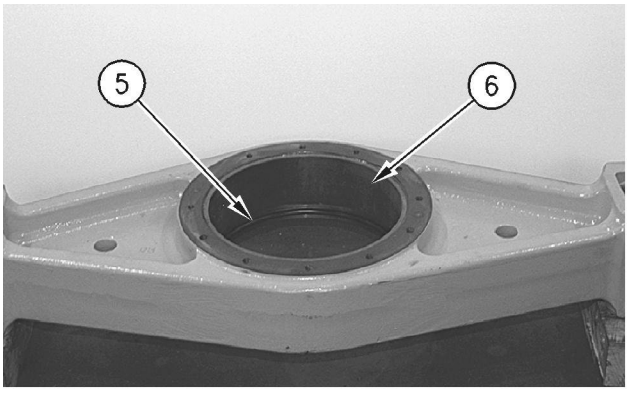


Illustration 724 g00623318

1. Place front trunnion support (1) in a suitable press. Make sure that the retainer side of the front trunnion support is facing upward.

2. Use Tooling (A) in order to install sleeve bearing (6) until the sleeve bearing is seated against the shoulder of front trunnion support (1).

3. Install O-ring seal (5).

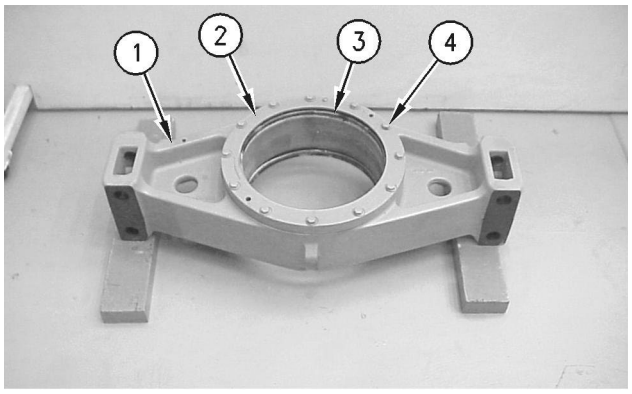


Illustration 725 g00630003

4. Install retainer (2) and bolts (4).

5. Install O-ring seal (3).

6. Apply Tooling (B) to the O-ring seals and the sleeve bearing.

End By:

a. Install the front trunnion support on the rear axle. Refer to Disassembly and Assembly, "Trunnion Support (Oscillating Axle, Front) - Install".

i02504958

Trunnion Support (Oscillating Axle, Front) - Install

SMCS Code: 3268-012-FR

Installation Procedure

Table 37

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2
B	5P-0960	Grease Cartridge	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the front trunnion and the bearing in the front trunnion support. Apply Tooling (B) onto the bearing and the seals on the front trunnion support.

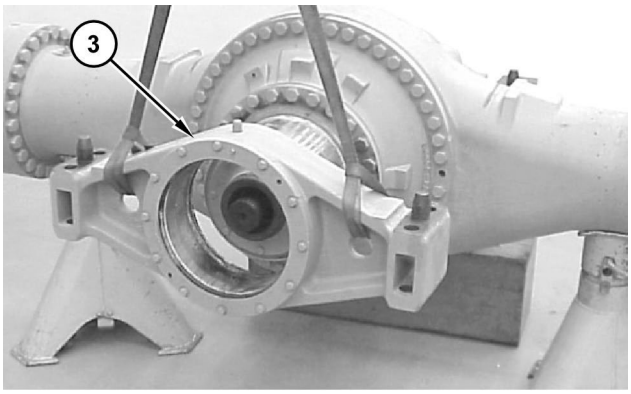


Illustration 726 g01254069

2. Use a suitable lifting device in order to install front trunnion support (3). The weight of front trunnion support (3) is approximately 205 kg (450 lb).

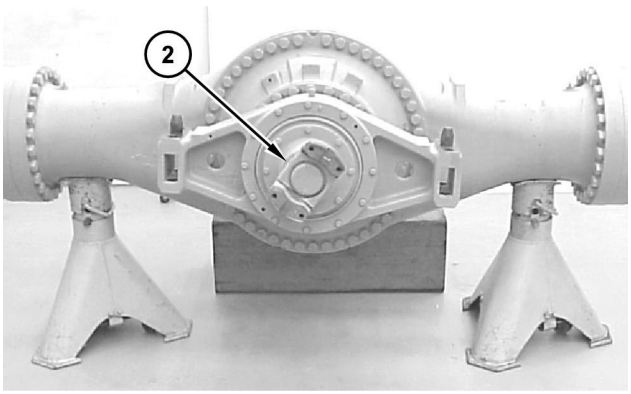


Illustration 727 g01254067

3. Install yoke (2) onto the differential pinion.

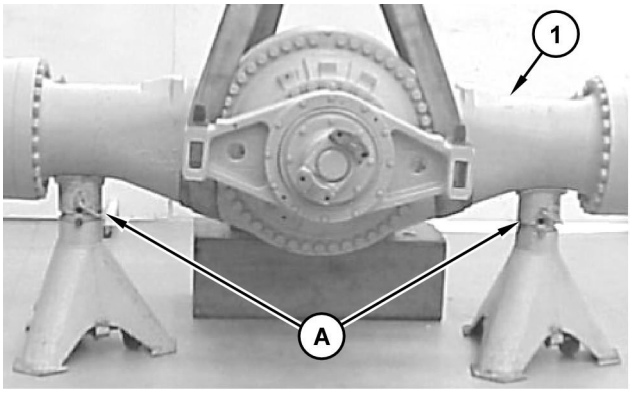


Illustration 728 g01254060

4. Remove rear oscillating axle (1) from Tooling (A).

End By:

a. Install the rear axle. Refer to Disassembly and Assembly, “Oscillating Axle (Rear) - Install”.

i07425995

Trunnion Support (Oscillating Axle, Rear) - Remove

SMCS Code: 3268-011-RE

Removal Procedure

Table 38

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2
B	128-5049	Guide Stud	2

Start By:

a. Remove the rear axle. Refer to Disassembly and Assembly, “Oscillating Axle (Rear) - Remove”.

1. Drain the oil from the rear axle into a suitable container for storage or disposal.

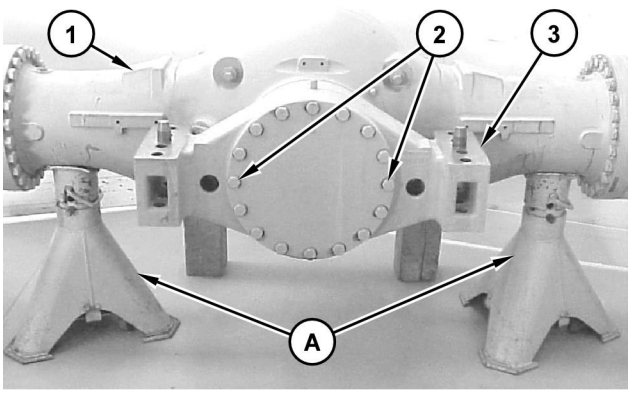


Illustration 729 g01254119
Typical Example

2. Place the rear oscillating axle (1) on Tooling (A) and use suitable cribbing on the opposite side to keep axle (1) from rolling.

3. Remove two of bolts (2) from rear trunnion support (3).

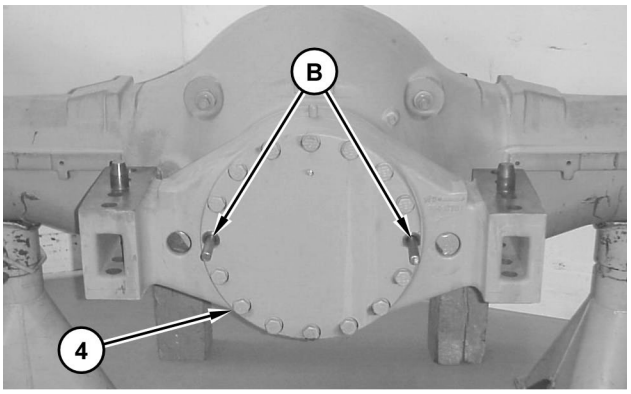


Illustration 730 g01254123
Typical Example

4. Install Tooling (B).

5. Remove bolts (4).

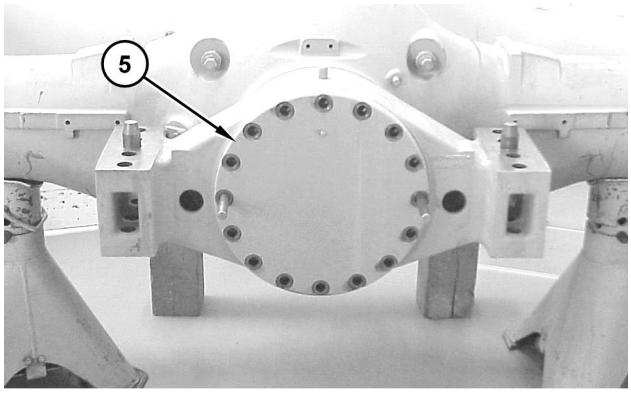


Illustration 731 g01254124
Typical Example

6. Use two people to remove cover (5). The weight of cover (5) is approximately 34 kg (75 lb).

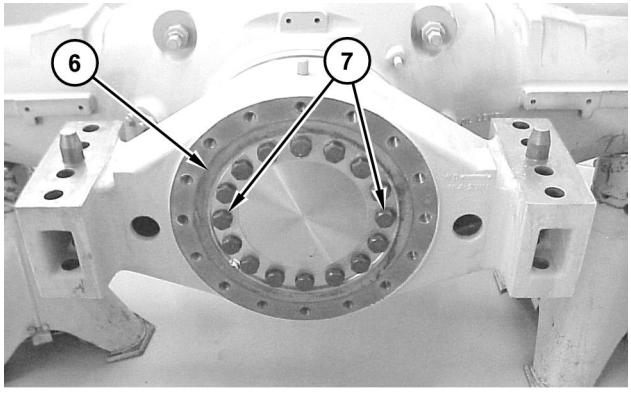


Illustration 732 g01254125
Typical Example

7. Remove thrust bearing (6) and bolts (7).

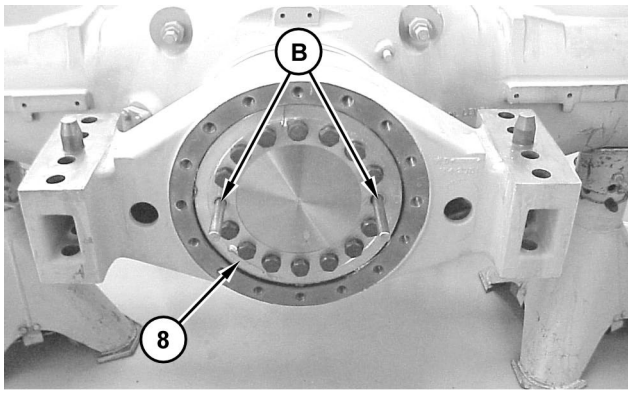


Illustration 733 g01254126
Typical Example

8. Install Tooling (B).

9. Remove bolts (8).

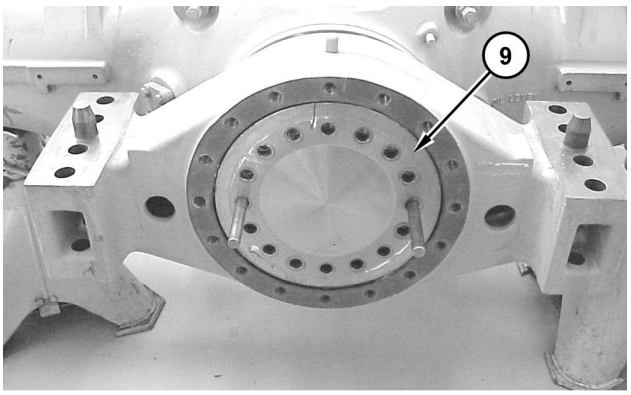


Illustration 734 g01254149

10. Remove thrust plate (9).

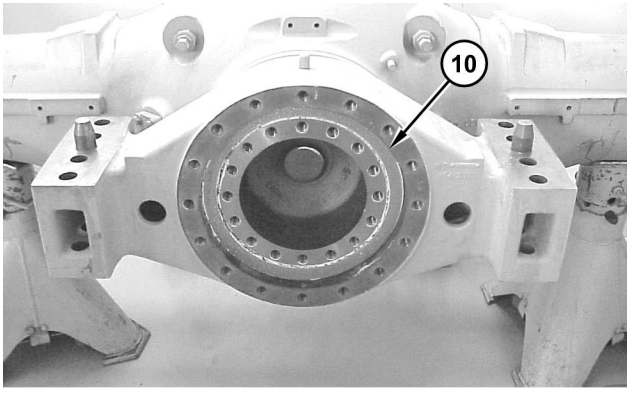


Illustration 735 g01254150

11. Remove thrust bearing (10).

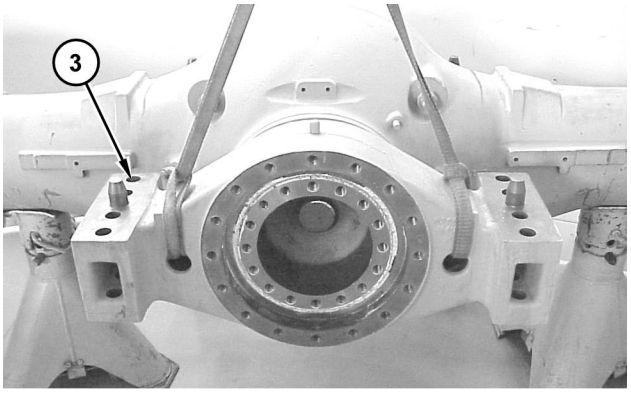


Illustration 736 g01254151

12. Use a suitable lifting device to remove rear trunnion support (3) from the rear trunnion. The weight of rear trunnion support (3) is approximately 242 kg (532 lb).

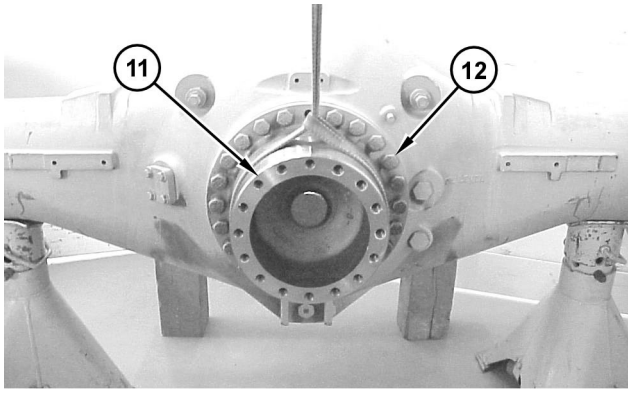


Illustration 737 g01254153

13. Attach a suitable lifting device to trunnion (11). The weight of trunnion (11) is approximately 64 kg (140 lb).

14. Remove bolts (12).

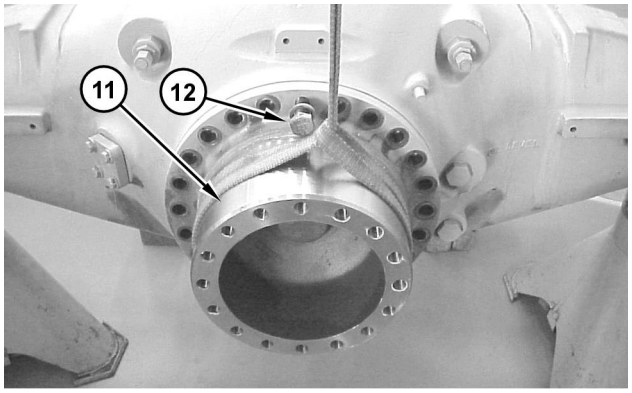


Illustration 738 g01254157

15. Install two of bolts (12) in the two threaded holes that are in trunnion (11).

16. Tighten bolts (12) evenly to separate the trunnion from the rear axle housing.

17. Use the suitable lifting device to remove trunnion (11).

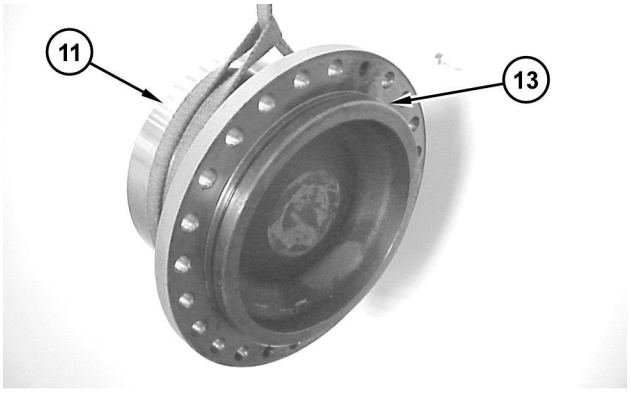


Illustration 739 g01254159

18. Remove O-ring seal (13) from trunnion (11).

i02509713

Trunnion Support (Oscillating Axle, Rear) - Disassemble

SMCS Code: 3268-015-RE

Disassembly Procedure

Start By:

a. Remove the rear trunnion support from the rear axle. Refer to Disassembly and Assembly, “Trunnion Support (Oscillating Axle, Rear) - Remove”.

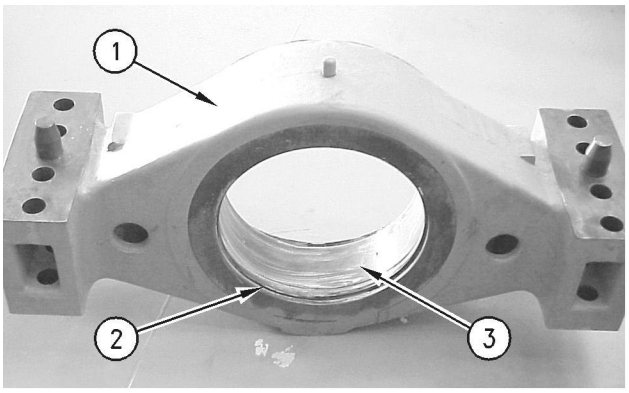


Illustration 740 g00684908
Typical Example

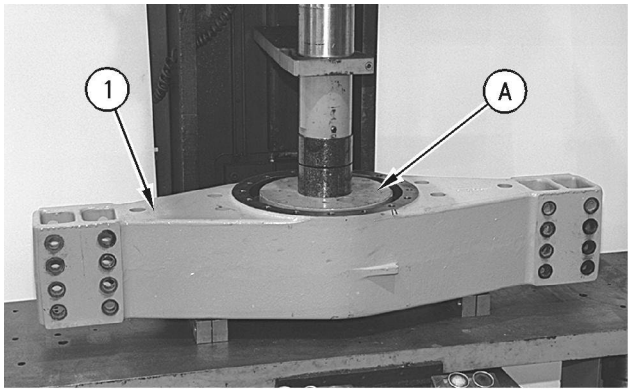


Illustration 741 g00623392

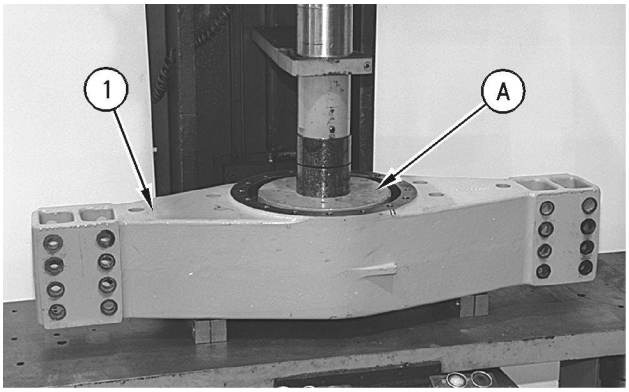


Illustration 742 g00623392

1. Remove O-ring seal (2) from rear trunnion support (1).

2. Use Tooling (A) and a suitable press in order to remove sleeve bearing (3) from rear trunnion support (1).

i02509715

Trunnion Support (Oscillating Axle, Rear) - Assemble

SMCS Code: 3268-016-RE

Assembly Procedure

Table 39

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3546	Plate	1
	8M-9012	Plate	1
B	5P-0960	Grease Cartridge	1

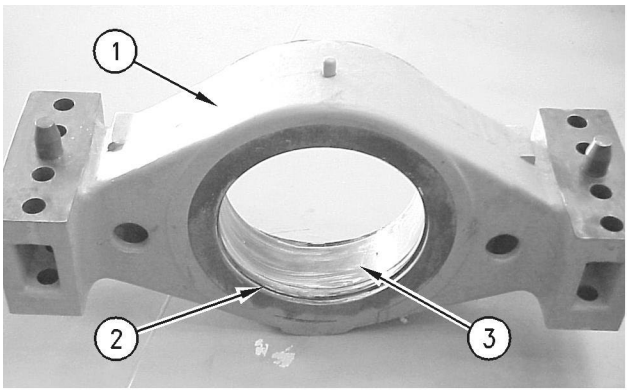


Illustration 743 g00684908

Typical Example

1. Place rear trunnion support (1) in a suitable press. Make sure that the side for the cover is facing upward.

2. Use Tooling (A) in order to install sleeve bearing (3) until the sleeve bearing is seated against the shoulder of rear trunnion support (1).

3. Install O-ring seal (2).

4. Apply Tooling (B) onto the O-ring seal and the sleeve bearing.

End By:

a. Install the rear trunnion support on the rear axle. Refer to Disassembly and Assembly, “Trunnion Support (Oscillating Axle, Rear) - Install”.

i06558060

Trunnion Support (Oscillating Axle, Rear) - Install

SMCS Code: 3268-012-RE

Installation Procedure

Table 40

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2
B	128-5049	Guide Stud	2
C	5P-0960	Grease Cartridge	-
D	6V-5765	Sealant	-

1. Thoroughly clean all components and inspect the condition of the components. Replace all seals and any parts that are worn or damaged.

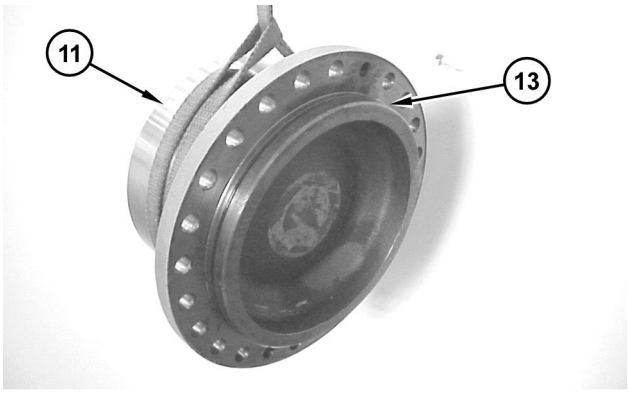


Illustration 744 g01254159

2. Install O-ring seal (13) on trunnion (11). Apply a thin coat of oil on the O-ring seal.

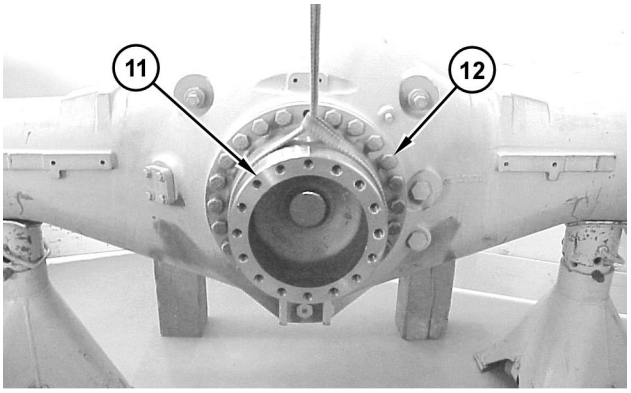


Illustration 745 g01254153

3. Use a suitable lifting device to carefully install trunnion (11). The weight of trunnion (11) is approximately 64 kg (140 lb).

4. Install bolts (12) to secure trunnion (11) to the rear axle housing. Tighten bolts (12) to a torque of 750 ± 90 N·m (553 ± 66 lb ft).

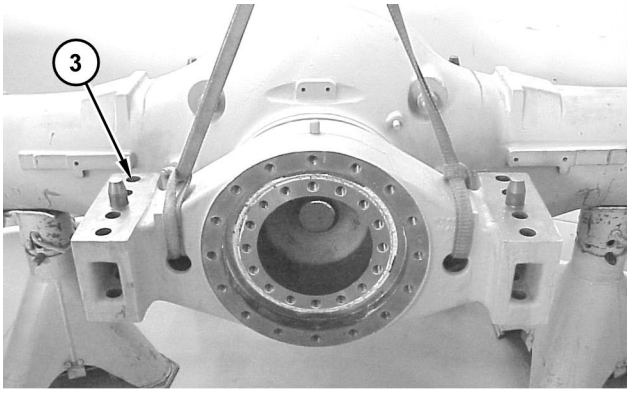


Illustration 746 g01254151

5. Apply Tooling (C) to the seal and the sleeve bearing in rear trunnion support (3).

6. Use a suitable lifting device to install rear trunnion support (3) on the rear trunnion. The weight of rear trunnion support (3) is approximately 242 kg (532 lb).

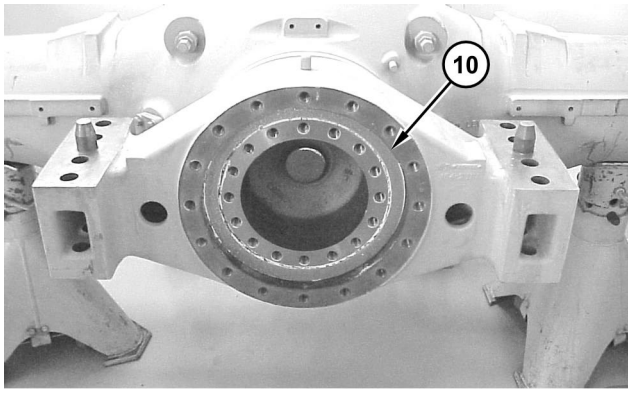


Illustration 747 g01254150

7. Apply Tooling (C) onto the faces of thrust bearing (10).

8. Install thrust bearing (10).

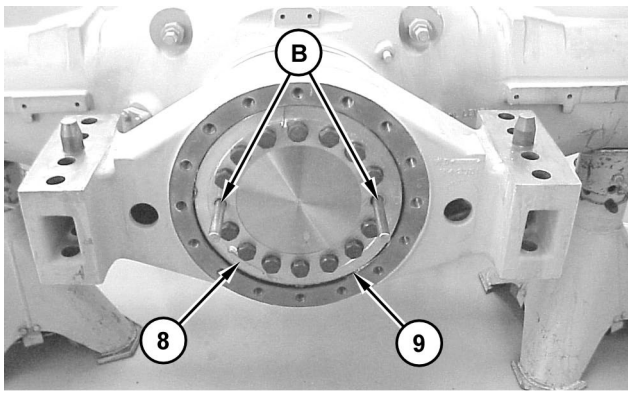


Illustration 748 g01254193

9. Install Tooling (B) in the threaded holes.

10. Install thrust plate (9) and bolts (8).

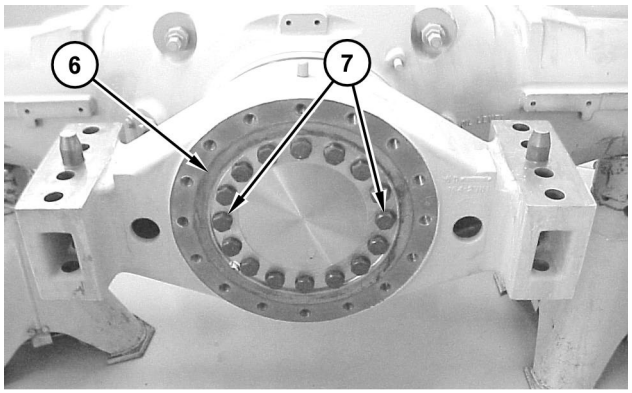


Illustration 749 g01254125
Typical Example

11. Remove Tooling (B).

12. Install bolts (7). Tighten bolts (7) and (8) to a torque of 475 ± 60 N·m (350 ± 45 lb ft).

13. Apply Tooling (C) onto the faces of thrust bearing (6).

14. Install thrust bearing (6).

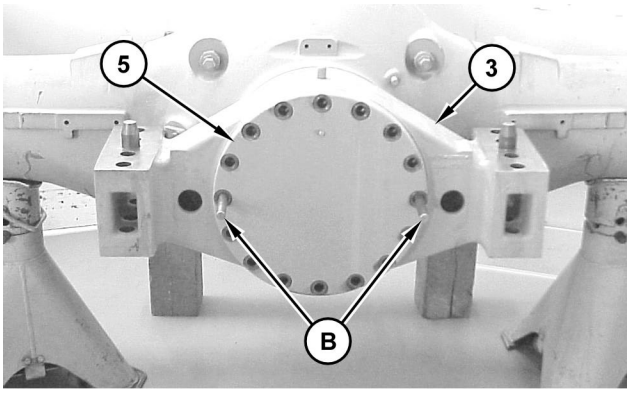


Illustration 750 g01254196
Typical Example

15. Install Tooling (B) into the threaded holes.

16. Apply Tooling (D) to the mating surfaces of rear trunnion support (3) and cover (5).

Note: Surfaces must be free of burrs before assembly.

17. Use two people to install cover (5). The weight of cover (5) is approximately 34 kg (75 lb).

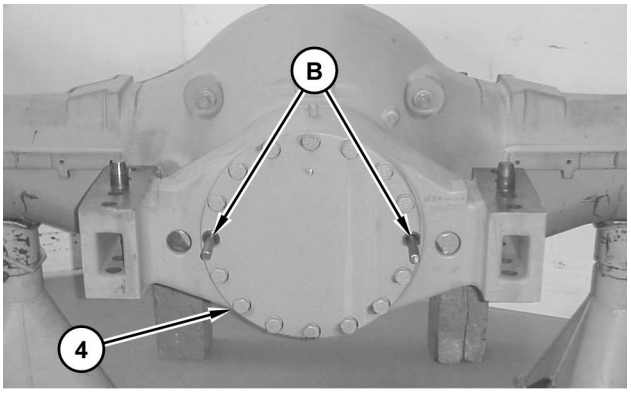


Illustration 751 g01254123
Typical Example

18. Install bolts (4).

19. Remove Tooling (B).

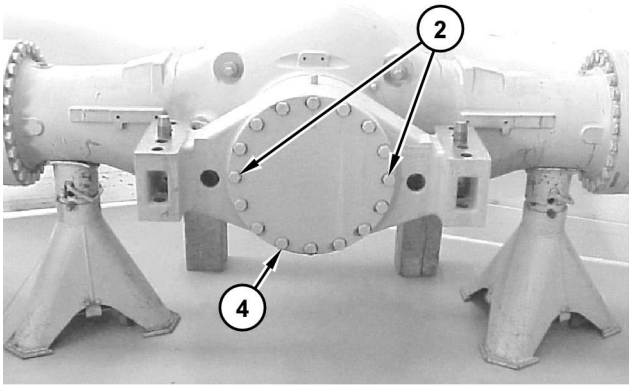


Illustration 752 g01254205
Typical Example

20. Install bolts (2). Tighten bolts (4) and bolts (2) to a torque of 475 ± 60 N·m (350 ± 45 lb ft).

21. Fill the rear oscillating axle with oil. Refer to Operation and Maintenance, “Capacities (Refill)”.

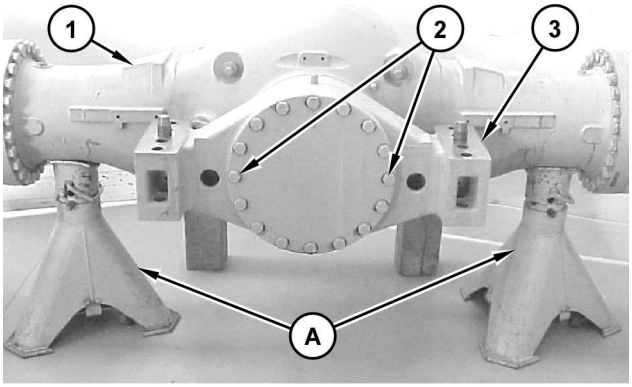


Illustration 753 g01254119
Typical Example

22. Remove rear oscillating axle (1) from Tooling (A).

End By:

a. Install the rear oscillating axle. Refer to Disassembly and Assembly, “Oscillating Axle (Rear) - Install”.

i02504940

Oscillating Axle (Rear) - Install

SMCS Code: 3278-012-RE

Installation Procedure

Table 41

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7576	Link Bracket	4
B	164-4035	Shackle	2
C	137-4370	Load Leveler (15 ton)	1
D	5P-3931	Anti-Seize Compound	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Clean the mating surfaces of the rear oscillating axle and of the rear loader frame prior to the installation of the rear axle assembly.

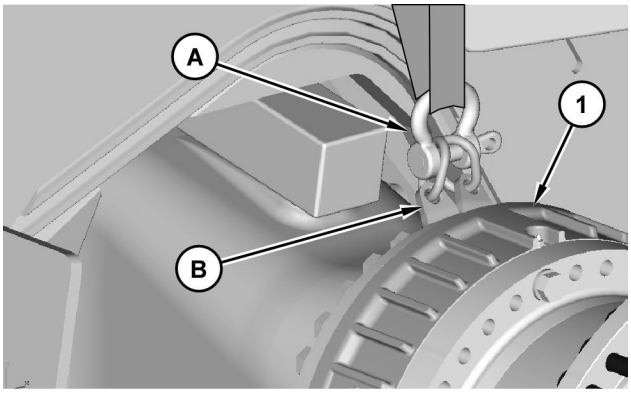


Illustration 754 g01253986

1. Use Tooling (A), Tooling (B), and Tooling (C) in order to install rear oscillating axle (1). The weight of rear oscillating axle (1) is approximately 6500 kg (14330 lb).

Note: Make sure that the dowels are aligned with the holes in the rear main frame.

2. Apply Tooling (D) onto the dowels.

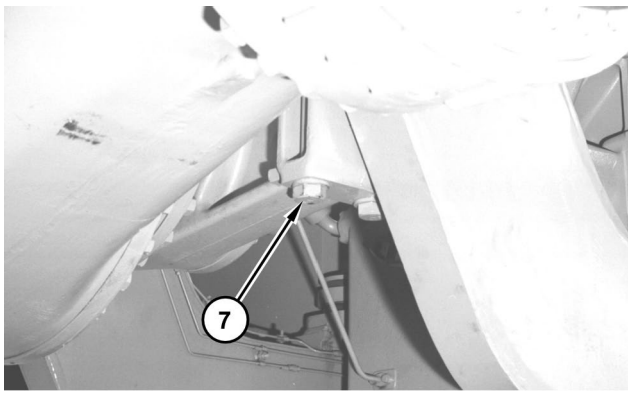


Illustration 755 g01256397

3. Install bolts (7) onto each side of the front trunnion support. Tighten bolts (7) to a torque of 1800 ± 200 N·m (1330 ± 150 lb ft).

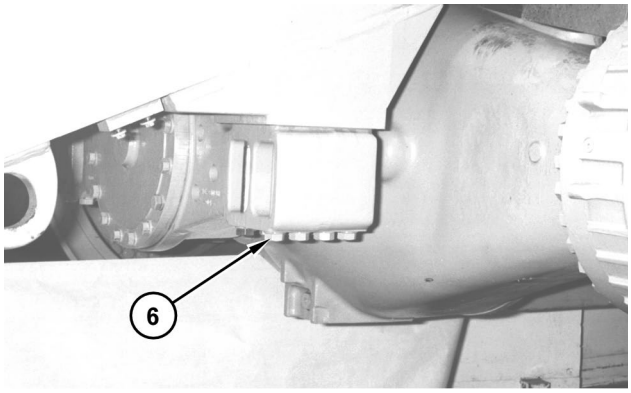


Illustration 756 g01256395

4. Install bolts (6) onto each side of the rear trunnion support. Tighten bolts (6) to a torque of 900 ± 100 N·m (665 ± 75 lb ft).

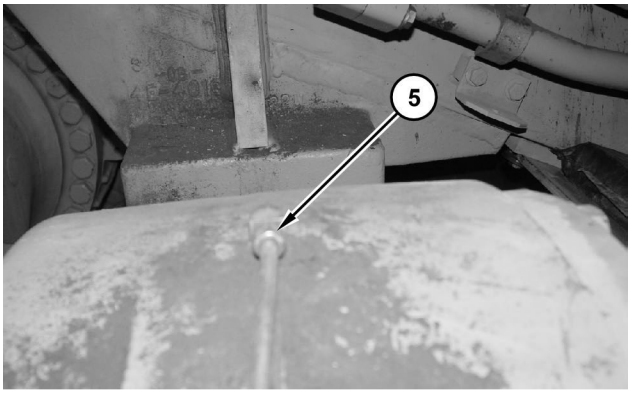


Illustration 757 g01254003

5. Connect tube assembly (5) to the rear trunnion support.

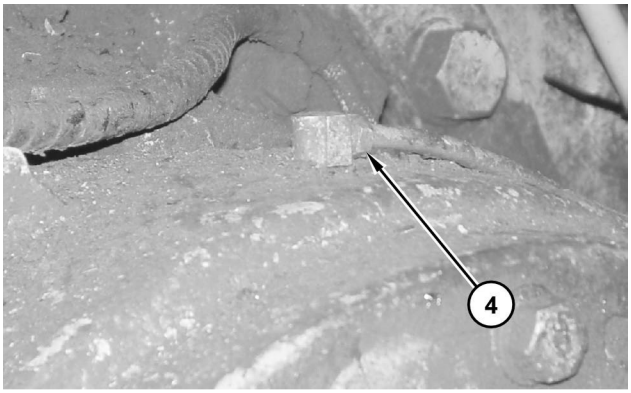


Illustration 758 g01254001

6. Connect tube assembly (4) to the front trunnion support.

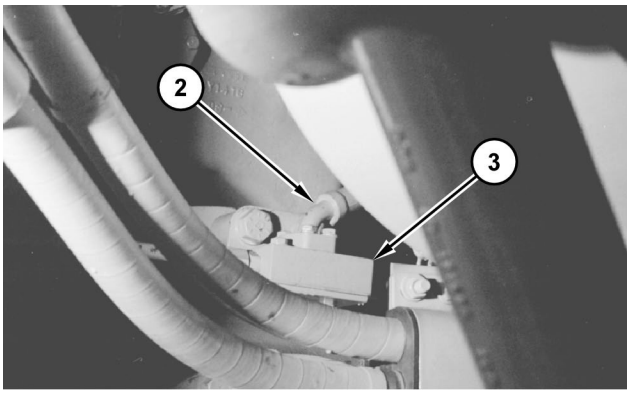


Illustration 759 g01253989

7. Connect hose assembly (2) to manifold (3) on the top of the rear oscillating axle.

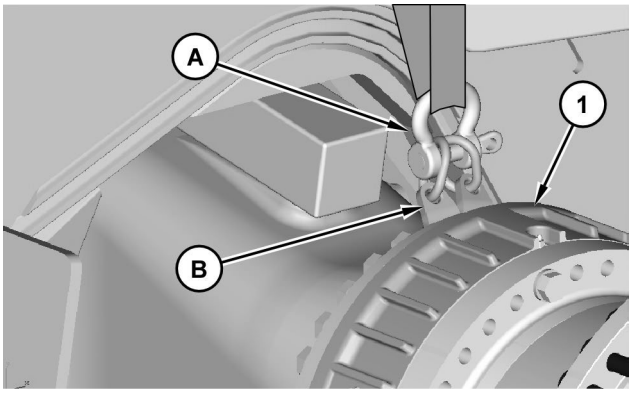


Illustration 760 g01253986

8. Remove Tooling (A), Tooling (B), and Tooling (C) from rear oscillating axle (1).

End By:

a. Install the power train guard. Refer to Disassembly and Assembly, “Powertrain Guard (Transmission) - Remove and Install”.

b. Install the front crankcase guard. Refer to Disassembly and Assembly, “Crankcase Guard - Remove and Install”.

c. Install the rear wheels. Refer to Disassembly and Assembly, “Tire and Rim (Rear) - Remove and Install”.

i02504745

Axle Shaft - Remove

SMCS Code: 3259-011

Removal Procedure

Table 42

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	1
B	7L-0654	Stud	1
C	8L-4612	Bolt	3
D	1P-7407	Eyebolt	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: The removal procedures for the front axle shafts and for the rear axle shafts are identical.

Note: The axle shafts can be removed while the axle assemblies are still on the machine. If the axle assemblies are still installed, chock the wheels and connect the steering frame lock before you perform the removal procedure. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

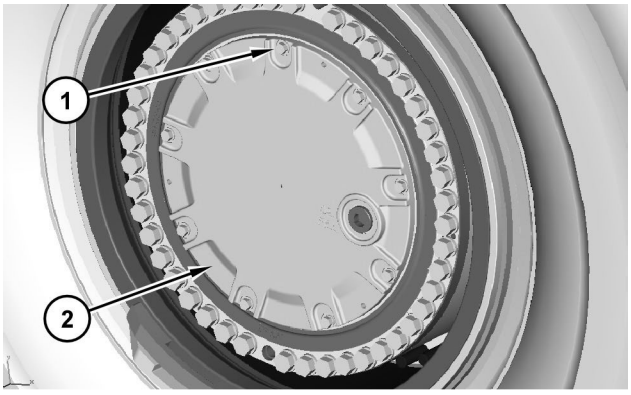


Illustration 761 g01255026

1. Position the wheel with the drain plug at the bottom. Drain the oil from the axle housing and from the final drives into a suitable container for storage or disposal.

2. Remove one of bolt (1) from cover (2).

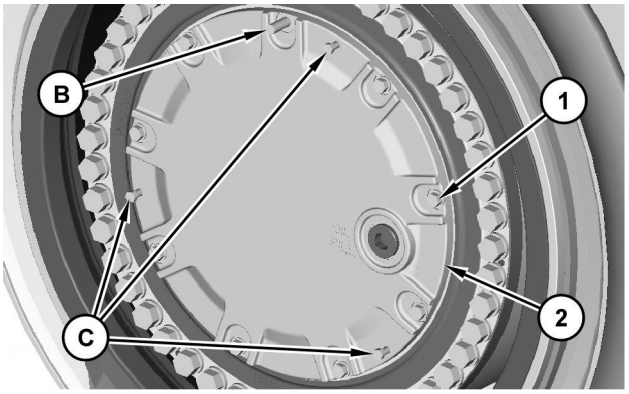


Illustration 762 g01255027

3. Install Tooling (B) in place of bolt (1).

4. Remove the remaining bolts (1) from cover (2).

5. Install Tooling (C) in cover (2). Tighten Tooling (C) evenly in order to loosen cover (2).

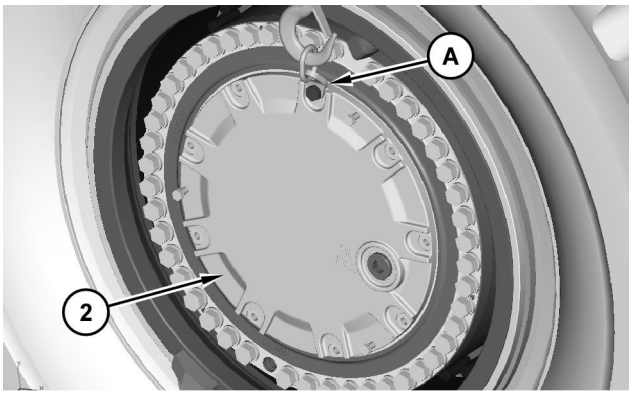


Illustration 763 g01254982

6. Attach Tooling (A) and a suitable lifting device to cover (2).

7. Use Tooling (A) and a suitable lifting device in order to remove cover (2) from the final drive. The weight of cover (2) is approximately 32 kg (70 lb).

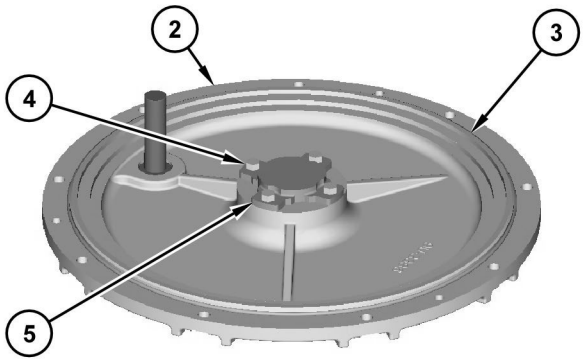


Illustration 764 g01254963

8. Remove O-ring seal (3) from cover (2).

9. Remove bolts (4) and axle shaft spacer (5) from the back of cover (2).

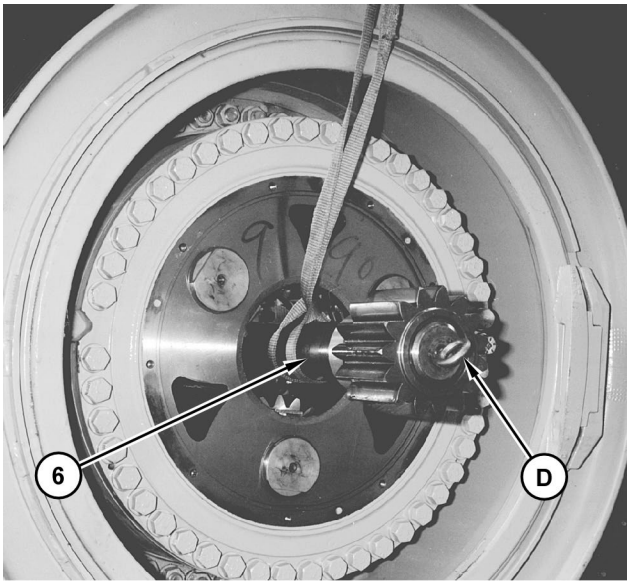


Illustration 765 g01254972

10. Install Tooling (D) into the end of axle shaft (6), as shown.

11. Use Tooling (D) in order to retract axle shaft (6) from the final drive assembly by 762 mm (30.0 inch).

12. Use a suitable lifting device in order to remove axle shaft (6). The weight of axle shaft (6) is approximately 107 kg (235 lb).

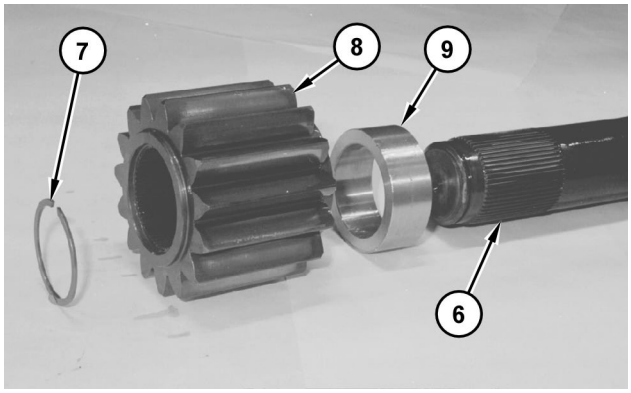


Illustration 766 g01254968

13. Remove retaining ring (7), sun gear (8), and spacer (9) from the end of axle shaft (6).

14. Repeat Step 1 through Step 13 for the remaining axle shaft.

i02504749

Axle Shaft - Install

SMCS Code: 3259-012

Installation Procedure

Table 43

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	1
E	4C-8154	Axle Installer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The installation procedures for the front axle shafts and for the rear axle shafts are identical.

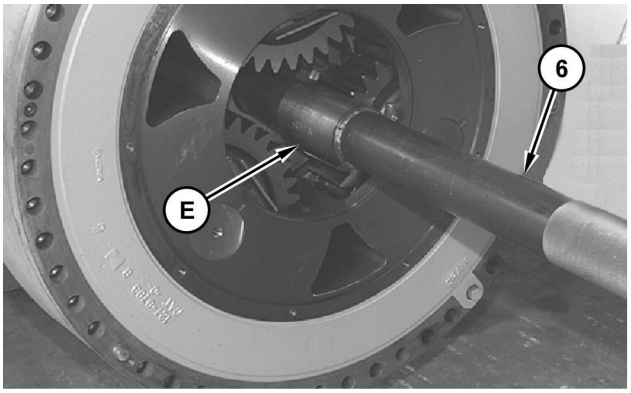


Illustration 767 g01255055

1. Use a suitable lifting device in order to position axle shaft (6) into the final drive. The weight of axle shaft (6) is approximately 107 kg (235 lb).

2. Remove the suitable lifting device.

3. Slide Tooling (E) over the end of axle shaft (6), as shown.

4. Use Tooling (E) in order to guide axle shaft (6) into the splines of the service brake and the splines of the differential.

5. Remove Tooling (E).

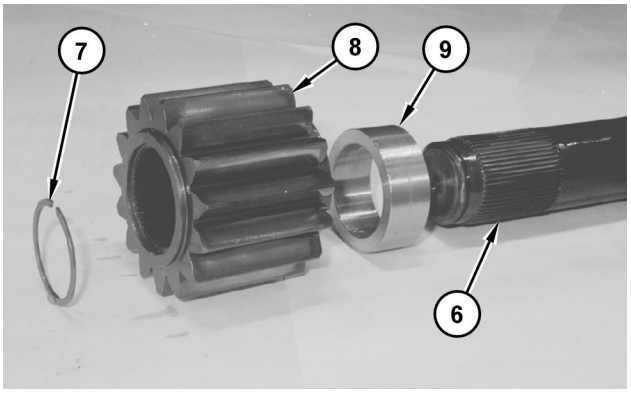


Illustration 768 g01254968

6. Place spacer (9) and sun gear (8) on the end of axle shaft (6).

7. Align the sun gear with the planetary gears and slide the sun gear completely onto the axle shaft. Install retaining ring (7).

Note: It may be necessary to rotate the wheel assembly in order to align the sun gear with the planetary gears. If the axle assembly and the tires are still installed on the machine, the tire must be raised off the ground in order to rotate the wheel assembly.

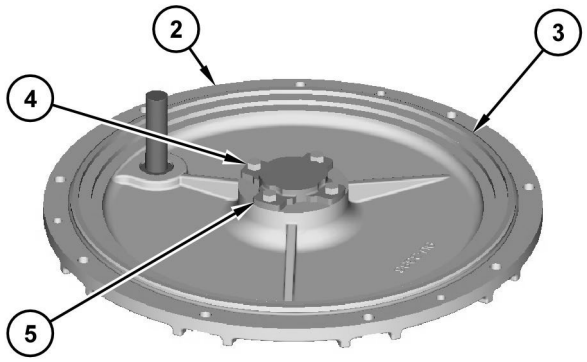


Illustration 769 g01254963

8. Install axle shaft spacer (5) and bolts (4) to the back of cover (2).

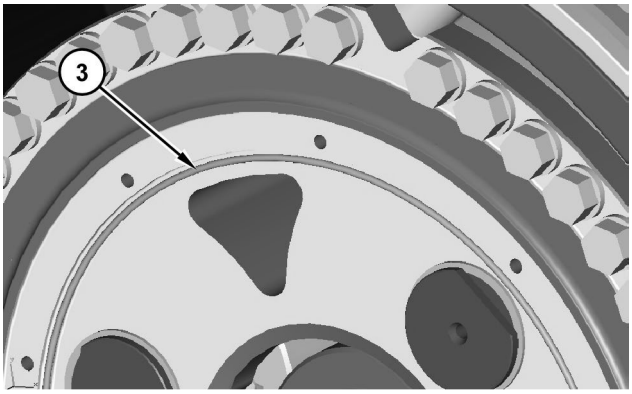


Illustration 770 g01255072

9. Install a new O-ring seal (3) in the groove of the final drive assembly.

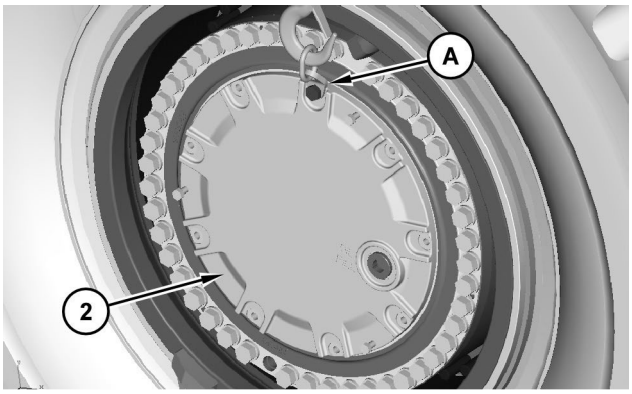


Illustration 771 g01254982

10. Use Tooling (A) in order to install cover (2). The weight of cover (2) is approximately 32 kg (70 lb).

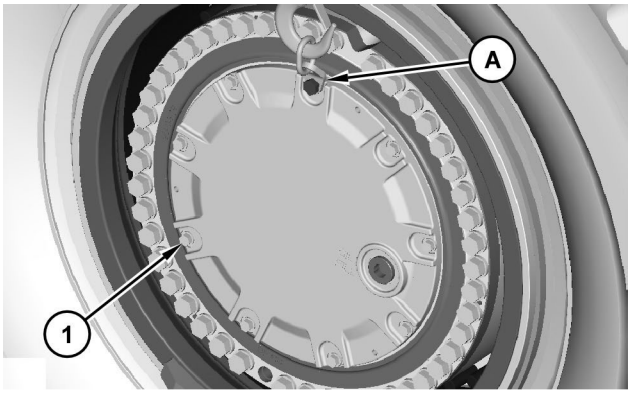


Illustration 772 g01255078

11. Install cover (2) and bolts (1).

12. Remove Tooling (A).

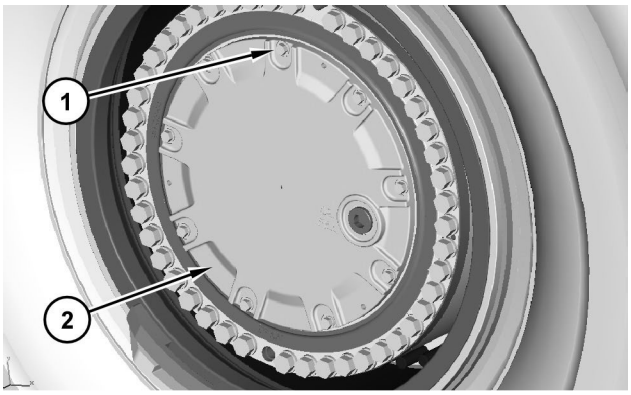


Illustration 773 g01255026

13. Install final bolt (1). The torque for bolts (1) is 135 ± 20 N·m (100 ± 15 lb ft).

14. Install the drain plug into the final drive.

15. Fill the axle housing and the final drives with oil. Refer to the Operation and Maintenance Manual, “Differential and Final Drive Oil - Change”.

End By:

a. Disconnect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02501054

Final Drive Planetary Carrier - Remove

SMCS Code: 4084-011

Removal Procedure

Table 44

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT-0901	Bracket	1
B	FT-0121	Lifting Bracket	1
C	5J-0490	Bolt	3

Start By:

a. Remove the axle shaft. Refer to Disassembly and Assembly, “Axle Shaft - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

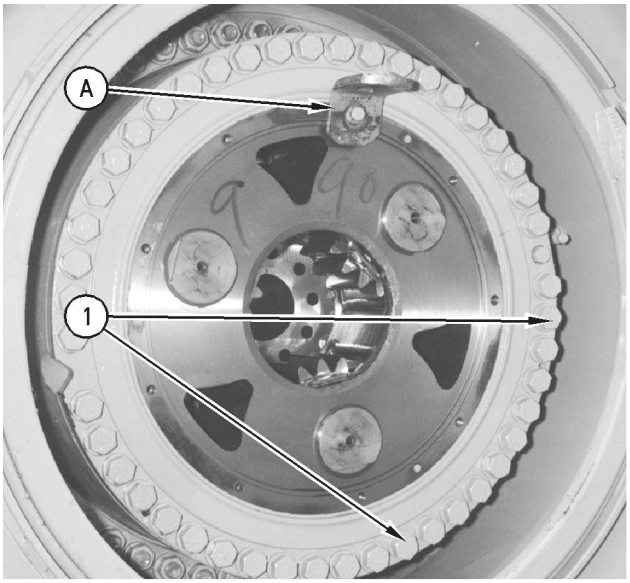


Illustration 774 g00854971

1. Attach Tooling (A) to the final drive planetary carrier, as shown.

2. Attach a suitable lifting device to Tooling (A).

3. Remove bolts (1).

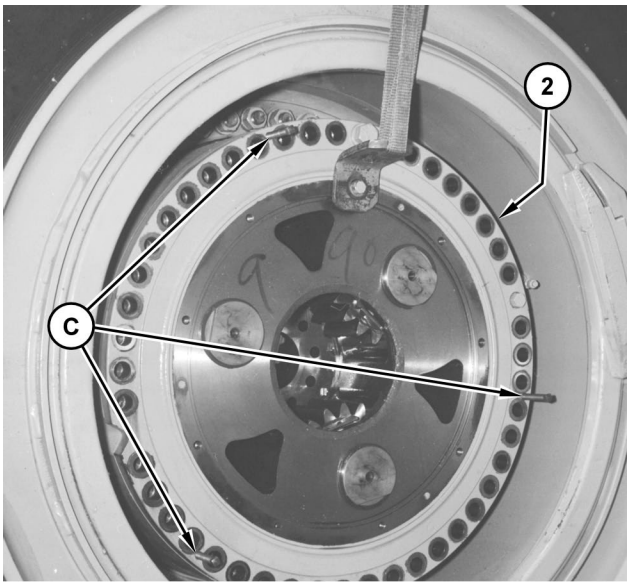


Illustration 775 g01250979

4. Install Tooling (C) in wheel assembly (2), as shown.

5. Tighten Tooling (C) evenly in order to loosen the final drive planetary carrier.

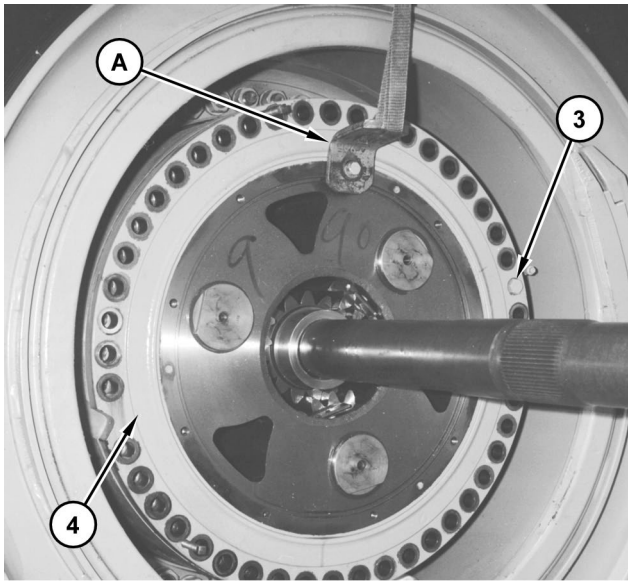


Illustration 776 g01250990

6. Attach a suitable lifting device to the axle shaft.

7. Use the suitable lifting device in order to install the axle shaft with the sun gear in the final drive planetary carrier, as shown.

Note: The axle shaft is used to hold the final drive planetary carrier level during the removal from the ring gear.

8. Remove drain plug (3) in order to prevent damage.

9. Use Tooling (A) and the suitable lifting device in order to remove final drive planetary carrier (4) from the ring gear. The weight of final drive planetary carrier (4) is approximately 284 kg (625 lb).

10. Remove the O-ring seal from the outside diameter of the final drive planetary carrier.

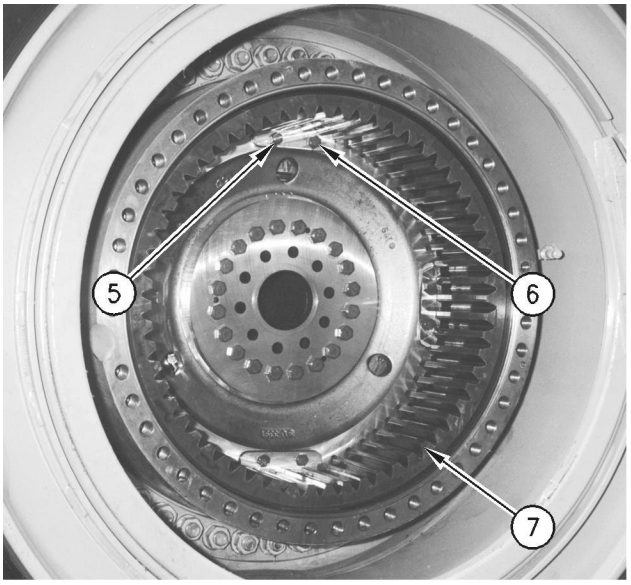


Illustration 777 g00854991

11. Remove bolts (5) and retainers (6) from ring gear (7).

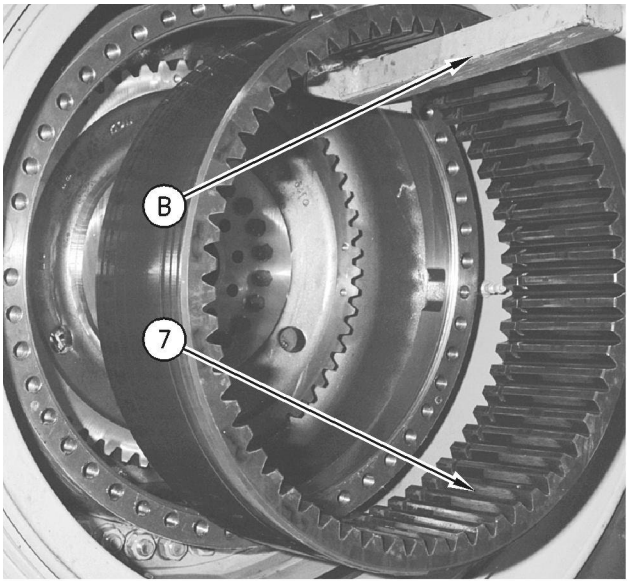


Illustration 778 g00854997

12. Attach Tooling (B) to ring gear (7), as shown.

13. Use Tooling (B) and a suitable lifting device in order to remove ring gear (7) from the reaction hub. The weight of ring gear (7) is approximately 107 kg (235 lb).

i02501056

Final Drive Planetary Carrier - Disassemble

SMCS Code: 4092-015

Disassembly Procedure

Table 45

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-7407	Eyebolt	1

Start By:

a. Remove the final drive planetary carrier. Refer to Disassembly and Assembly, "Final Drive Planetary Carrier - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

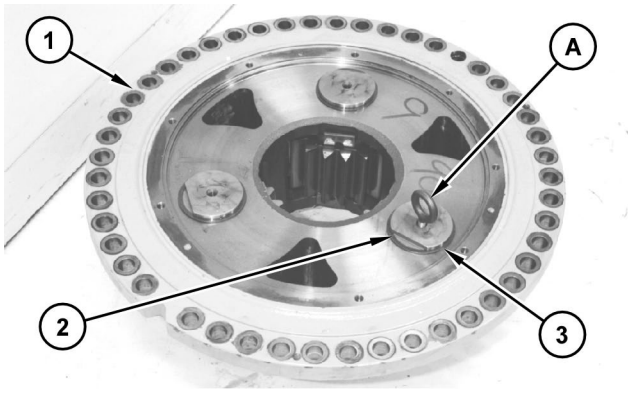


Illustration 779 g01251089

1. Install Tooling (A) in planetary carrier shaft (2).

2. Remove retaining ring (3).

3. Remove planetary carrier shaft (2) from carrier housing (1).

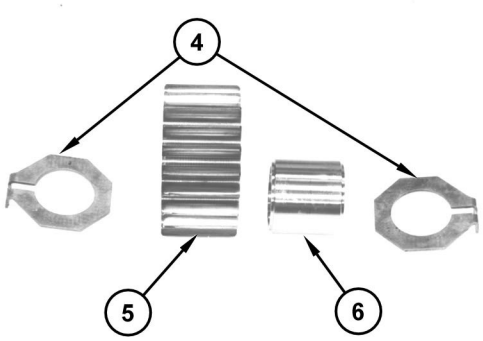


Illustration 780 g01251090

4. Remove thrust washers (4) and planetary gear (5).

5. Remove sleeve bearing (6) from planetary gear (5).

6. Repeat Steps 1 through 5 in order to remove the remaining planetary gears from the planetary carrier.

i02501059

Final Drive Planetary Carrier - Assemble

SMCS Code: 4092-016

Assembly Procedure

Table 46

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-0960	Grease Cartridge	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

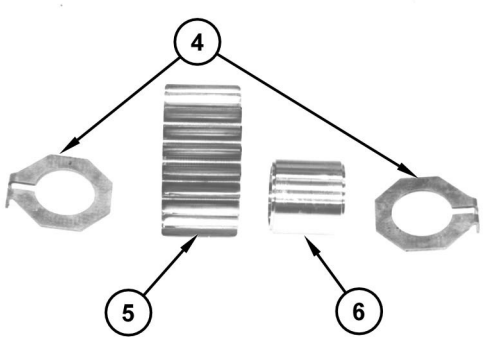


Illustration 781 g01251090

1. Apply Tooling (B) on sleeve bearing (6).

2. Install sleeve bearing (6) into planetary gear (5).

3. Place a thrust washer (4) on each side of planetary gear (5).

4. Install planetary gear (5) and thrust washers (4) in the planetary carrier.

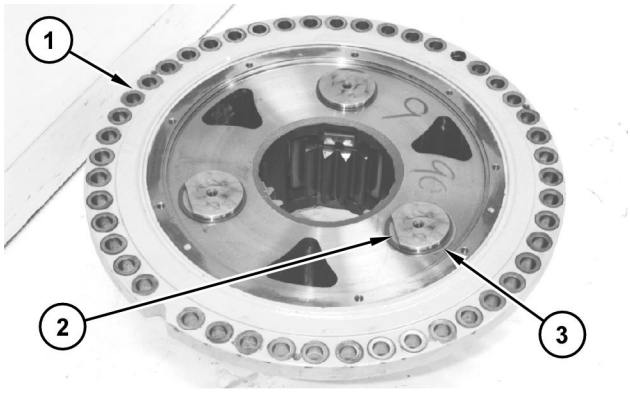


Illustration 782 g01251101

5. Install planetary carrier shaft (2) and retaining ring (3) into carrier housing (1).

6. Turn the planetary carrier shafts until the flat side is facing outward.

7. Repeat Steps 1 through 6 in order to install the remaining planetary gears into the planetary carrier.

End By:

a. Install the final drive planetary carrier. Refer to Disassembly and Assembly, “Final Drive Planetary Carrier - Install”.

i05919361

Final Drive Planetary Carrier - Install

SMCS Code: 4084-012

Installation Procedure

Table 47

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT-0901	Bracket	1
B	FT-0121	Lifting Bracket	1
D	-	Guide Bolt 7/8 - 9 NC	3

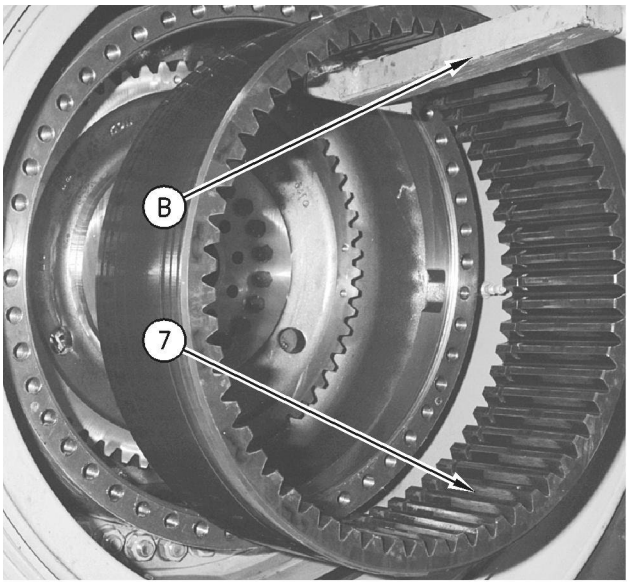


Illustration 783 g00854997

1. Attach Tooling (B) to ring gear (7), as shown.

2. Use Tooling (B) and a suitable lifting device in order to install ring gear (7) to the reaction hub. The weight of ring gear (7) is approximately 107 kg (235 lb).

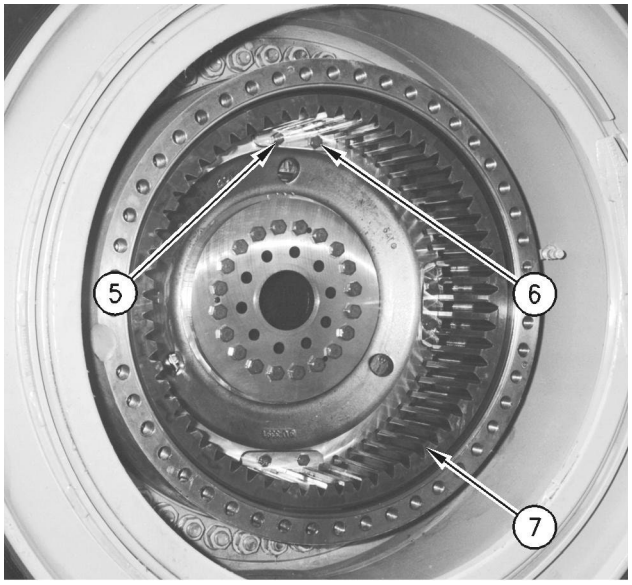


Illustration 784 g00854991

3. Install retainers (6) and bolts (5) to ring gear (7).

4. Install a new O-ring seal to the outside diameter of the final drive planetary carrier.

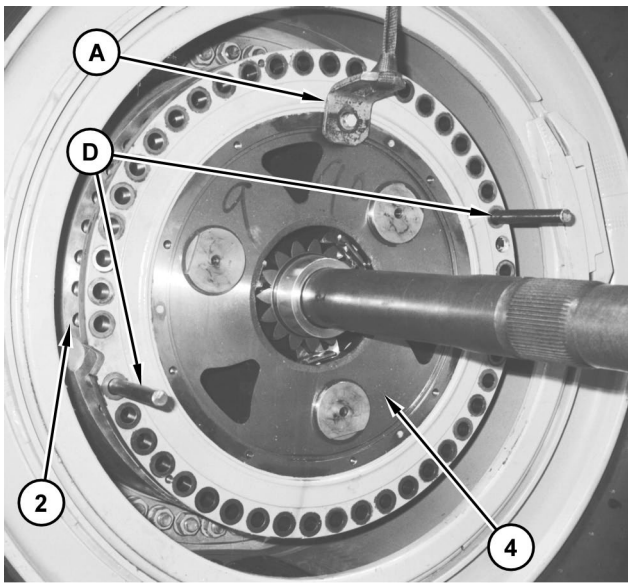


Illustration 785 g01251027

5. Install Tooling (D) into wheel assembly (2), as shown.

6. Attach Tooling (A) to final drive planetary carrier (4).

7. Use the suitable lifting device in order to install the axle shaft with the sun gear in the final drive planetary carrier, as shown.

Note: The axle shaft is used to hold the final drive planetary carrier level during the installation into the ring gear.

8. Use Tooling (A) and a suitable lifting device in order to position final drive planetary carrier (4) onto Tooling (D). The weight of final drive planetary carrier (4) is 284 kg (625 lb).

9. Carefully slide final drive planetary carrier (4) into the ring gear.

10. Use the suitable lifting device in order to remove the axle shaft from the final drive planetary carrier.

11. Remove Tooling (D).

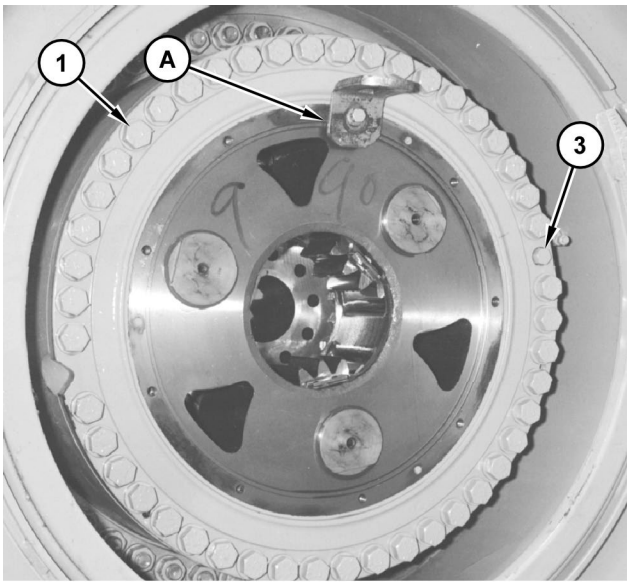


Illustration 786 g01251037

12. Install bolts (1). Tighten bolts (1) to a torque of 400 ± 60 N·m (295 ± 45 lb ft). Rotate bolts (1) for an additional 120 ± 10 degrees (1/3 turn).

13. Install drain plug (3) into the final drive planetary carrier.

14. Remove Tooling (A).

End By:

a. Install the axle shaft. Refer to Disassembly and Assembly Manual, “Axle Shaft - Install”.

i02501202

Final Drive, Brake and Wheel - Remove

SMCS Code: 4008-011

Removal Procedure

Table 48

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-9906	Ratchet Puller	1
B	138-7574	Link Bracket	1
C	138-7575	Link Bracket	3

Start By:

a. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

b. Remove the tire and the rim. Refer to Disassembly and Assembly, “Tire and Rim (Front) - Remove and Install” or refer to Disassembly and Assembly, “Tire and Rim (Rear) - Remove and Install”.

c. Remove the final drive planetary carriers. Refer to Disassembly and Assembly, “Final Drive Planetary Carrier - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Note: Use the same removal procedure in order to remove the final drives, the brakes and the wheels from the front or from the rear. However, the removal procedures for the front tires and for the rear tires are different. Make sure that you use the correct procedure.

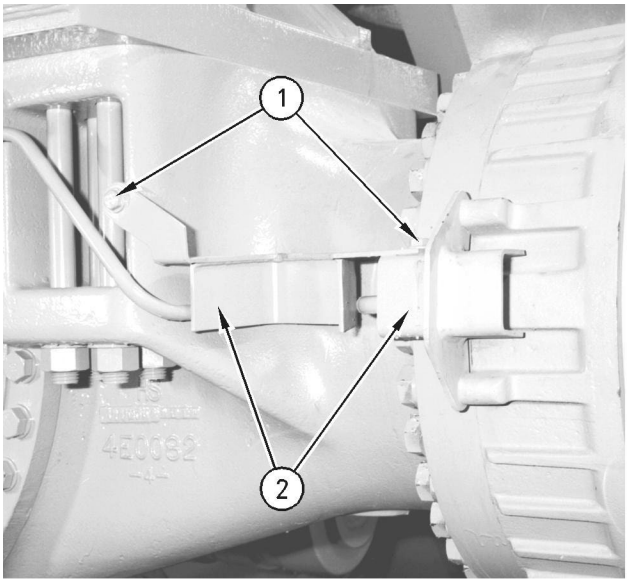


Illustration 787 g00855497

1. Remove bolts (1) and guards (2).

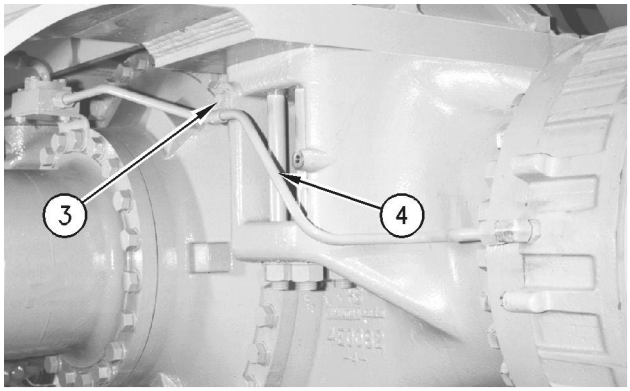


Illustration 788 g00855498

2. Remove clip (3).

3. Remove tube assembly (4).

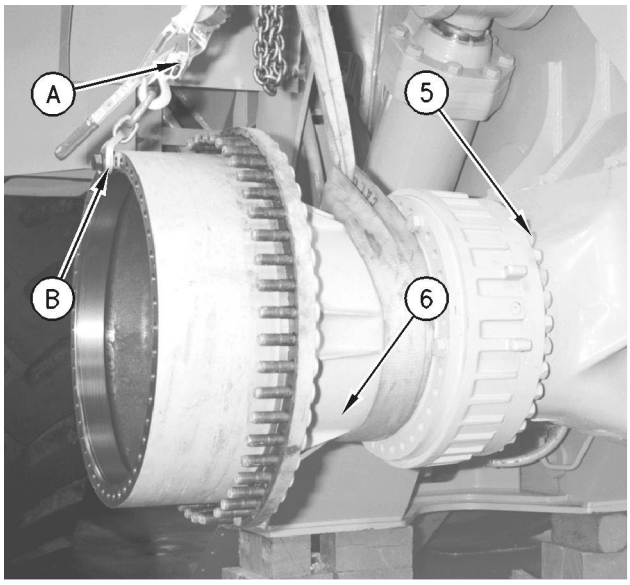


Illustration 789 g00855500

4. Attach Tooling (A), Tooling (B), and a suitable lifting device to final drive and wheel brake assembly (6), as shown.

5. Remove bolts (5).

6. Use Tooling (A), Tooling (B), and a suitable lifting device in order to remove final drive and wheel brake assembly (6). The weight of final drive and wheel brake assembly (6) is approximately 953 kg (2100 lb).

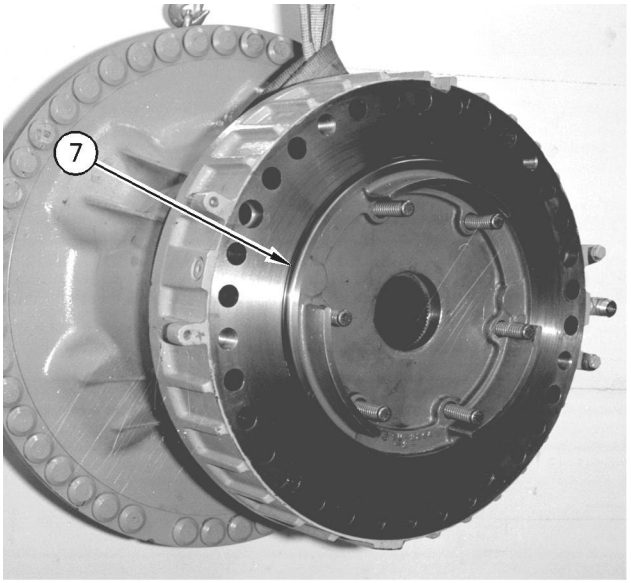


Illustration 790 g00855502

7. Remove O-ring seal (7) from the final drive and wheel brake assembly.

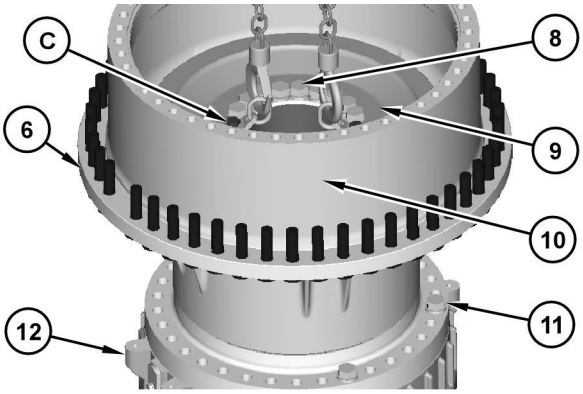


Illustration 791 g01251121

8. Place final drive and wheel brake assembly (6) on suitable blocks.

9. Remove bolts (8) from retainer (9).

10. Install Tooling (C) and a suitable lifting device to final drive (10), as shown.

11. Remove bolts (11) from wheel brake assembly (12).

12. Use Tooling (C) and a suitable lifting device in order to remove final drive (10) from wheel brake assembly (12). The weight of final drive (10) is approximately 749 kg (1650 lb). The weight of wheel brake assembly (12) is approximately 204 kg (450 lb).

i02501205

Final Drive and Wheel - Disassemble

SMCS Code: 4051-015

Disassembly Procedure

Table 49

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	138-7575	Link Bracket	3

Start By:

a. Remove the final drive and wheel brake assembly. Refer to Disassembly and Assembly, "Final Drive, Brake and Wheel - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

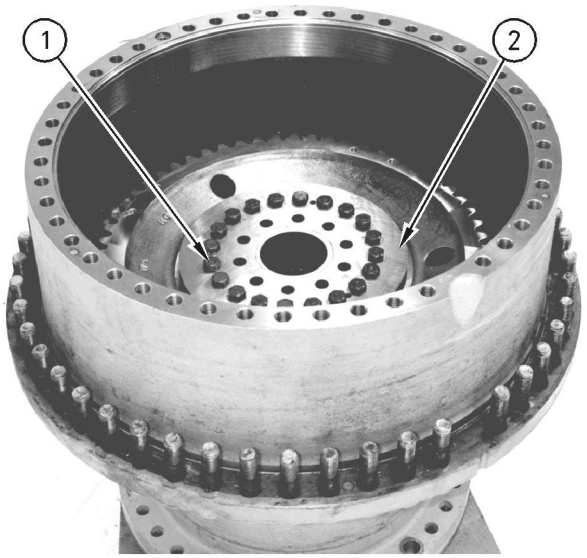


Illustration 792 g00855571

1. Remove bolts (1) and retainer (2) from the spindle.

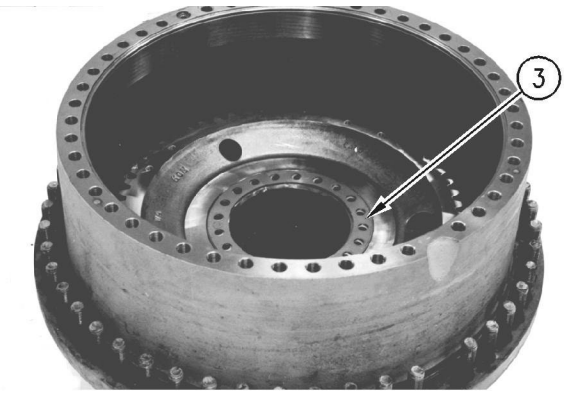


Illustration 793 g00855572

2. Remove shims (3).

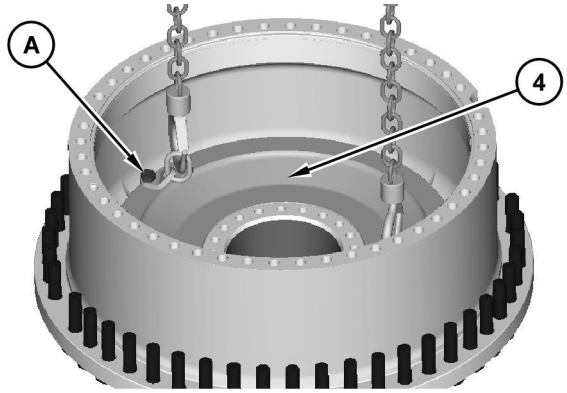


Illustration 794 g01251158

3. Use Tooling (A) and a suitable lifting device in order to remove reaction hub (4) from the spindle. The weight of reaction hub (4) is approximately 77 kg (170 lb).

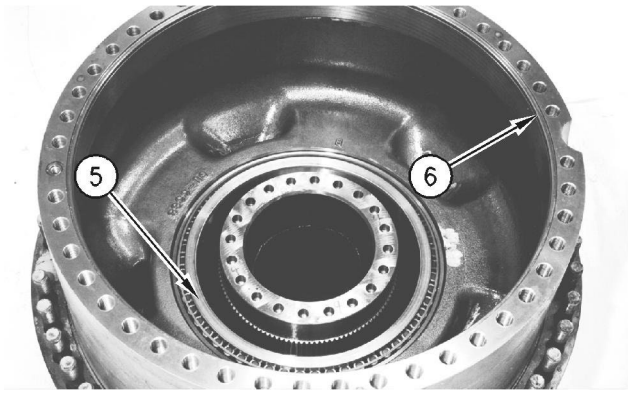


Illustration 795 g00855575

4. Remove bearing cone (5) from wheel housing (6).

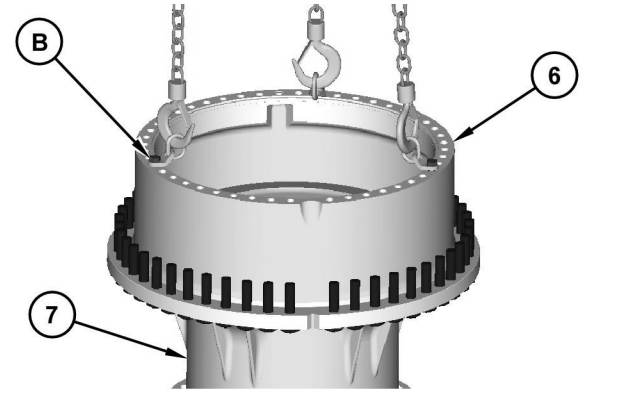


Illustration 796 g01251176

5. Use Tooling (B) and a suitable lifting device in order to remove wheel housing (6) from spindle (7). The weight of wheel housing (6) is approximately 395 kg (870 lb).

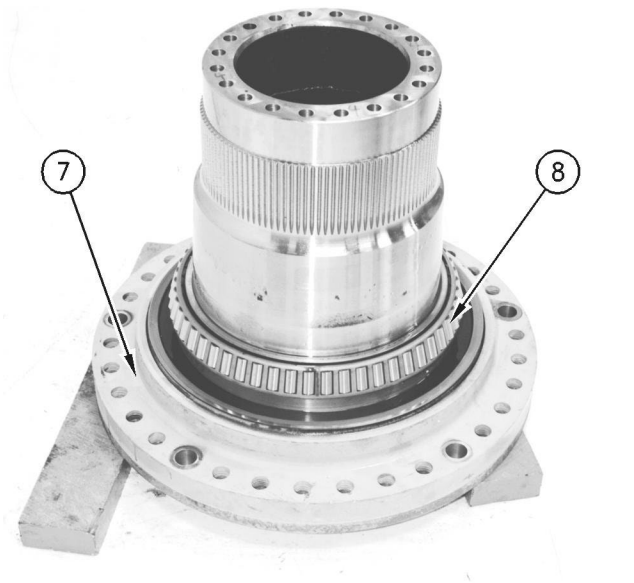


Illustration 797 g00855579

6. Remove bearing cone (8) from spindle (7).

Note: Bearing cone (8) is a slip fit.

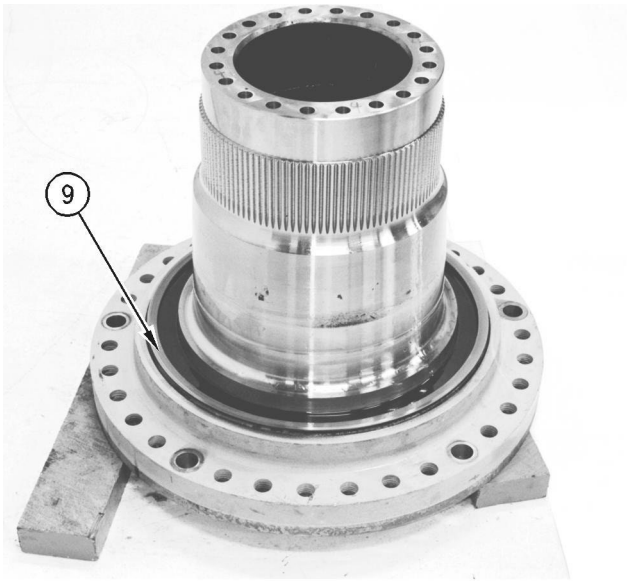


Illustration 798 g00855580

7. Remove Duo-Cone seal (9).

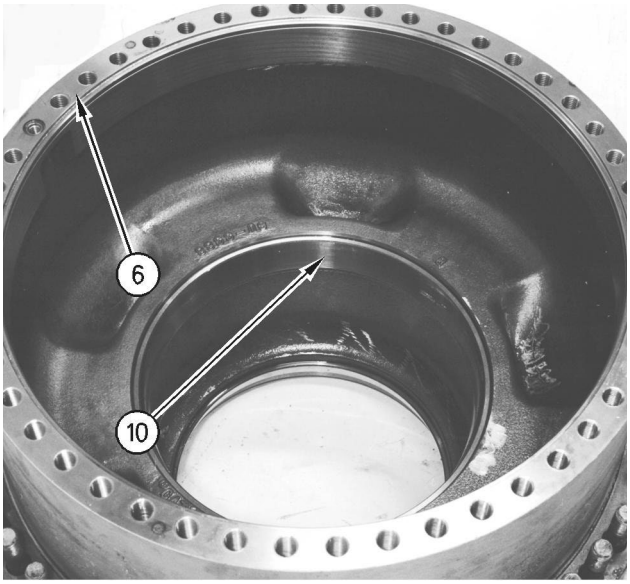


Illustration 799 g00855584

8. Remove bearing cup (10) from wheel housing (6).

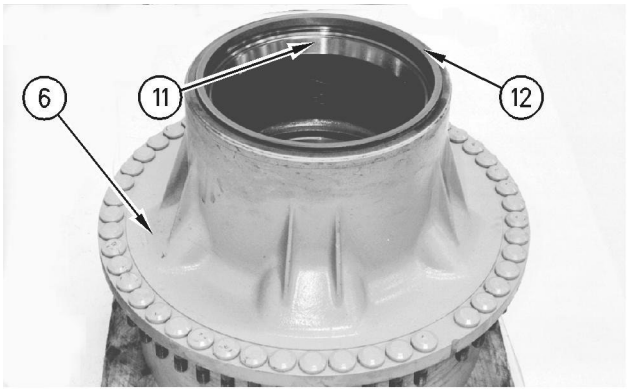


Illustration 800 g00855585

9. Turn over the wheel housing.

10. Place the wheel housing on suitable blocks, as shown.

11. Remove bearing cup (11) and Duo-Cone seal (12) from wheel housing (6).

i01076945

Duo-Cone Conventional Seals - Install

SMCS Code: 7561-012

Installation Procedure

Note: This procedure is only for Duo-Cone conventional seals. This procedure does not pertain to Duo-Cone floating seals.

It is extremely important to follow the correct procedure for installing Duo-Cone seals. Many seal failures are the direct result of mistakes during installation of the seal components.

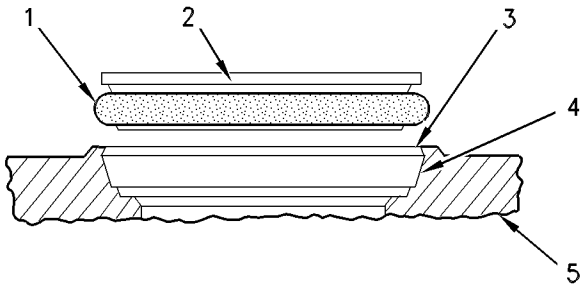


Illustration 801 g00296728

(1) Rubber toric ring. (2) Seal ring. (3) Housing retaining lip. (4) Housing ramp. (5) Seal ring housing.

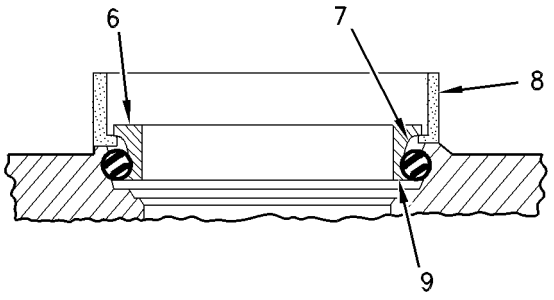


Illustration 802 g00296926

(6) Seal ring face. (7) Seal ring ramp. (8) Installation tool. (9) Seal ring retaining lip.

⚠ WARNING

Use caution when you are using isopropyl alcohol. Avoid prolonged skin contact with isopropyl alcohol.

Vapors may be harmful if inhaled. Use only in a well ventilated area. Do not smoke while using isopropyl alcohol.

Isopropyl alcohol is flammable. Do not use near an open flame or near welding operations. Keep isopropyl alcohol away from heated surfaces exceeding 482°C (900°F).

1. Remove any oily film, dust or other foreign matter from all of the seal components. Use isopropyl alcohol and a clean cloth to wipe the components. (Paper towels may also be used.)

Note: Do not allow oil to contact rubber toric rings (1) or seal ring ramps (7) before both seal rings (2) are assembled in Step 10.

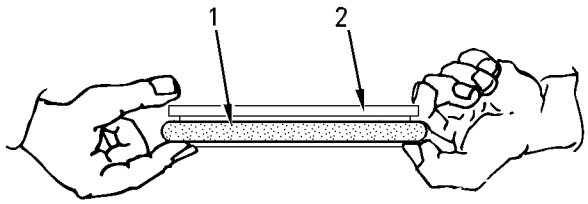


Illustration 803 g00296933

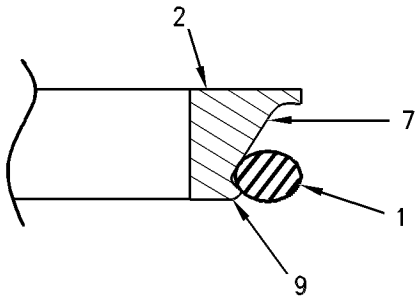


Illustration 804 g00296971

2. Put rubber toric ring (1) on seal ring (2). Make sure that the toric ring is at the bottom of seal ring ramp (7) and against seal ring retaining lip (9).

Note: Make sure that rubber toric ring (1) is straight on seal ring (2). There must not be a twist in the toric ring. Be careful when you are working on the rubber toric ring. Nicks, cuts and scratches can cause leaks.

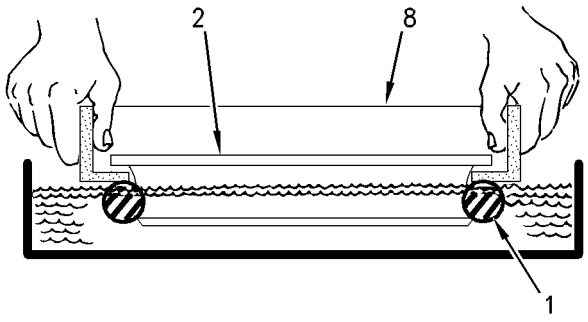


Illustration 805 g00296975

3. Put installation tool (8) on seal ring (2) with rubber toric ring (1). Lower the rings into a container of isopropyl alcohol until all surfaces of rubber toric ring (1) are wet.

Note: Do not use Stanisol or any other liquid that may leave an oily film.

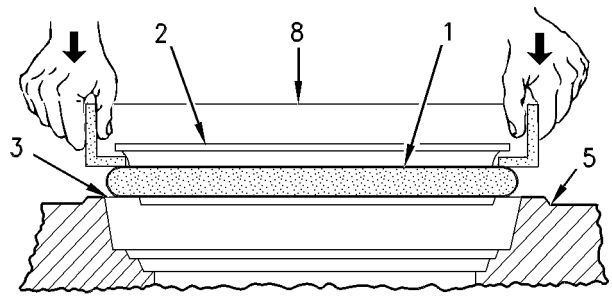


Illustration 806 g00297112

4. While all surfaces of rubber toric ring (1) are still wet, use installation tool (8) to position seal ring (2) and the toric ring squarely against seal ring housing (5), as shown.

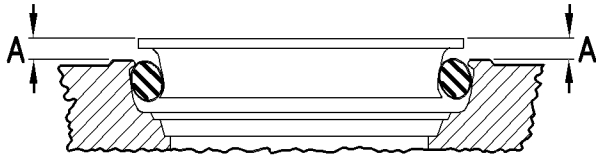


Illustration 807 g00297146

5. Measure dimension (A) from seal ring face (6) to the top surface of seal ring housing (5). Check dimension (A) in at least four places (90 degree intervals). The measurements must not differ by more than 1 mm (.04 inch).

Note: If small adjustments are necessary, do not push on seal ring (2). Use installation tool (8).

6. Rubber toric ring (1) can twist if the toric ring is not completely wet during installation. Burrs on housing retaining lip (3) or on seal ring housing (5) can also cause a twist.

If a twist occurs or if the toric ring is misaligned, repeat Steps 3 through 5.

7. Before further installation, wait for at least two minutes so that the isopropyl alcohol can evaporate. This will prevent slippage on seal ring ramps (7) and on housing ramps (4). The toric ring must roll only on the seal ring ramps and on the housing ramps.

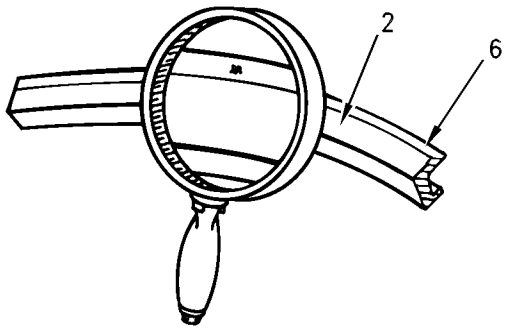


Illustration 808 g00297155

8. Use a clean cloth or a paper towel to wipe off seal ring faces (6).

Note: No particles of any kind can be left on the sealing surfaces. A small piece from a paper towel can cause a leak by keeping the sealing surfaces from contacting each other.

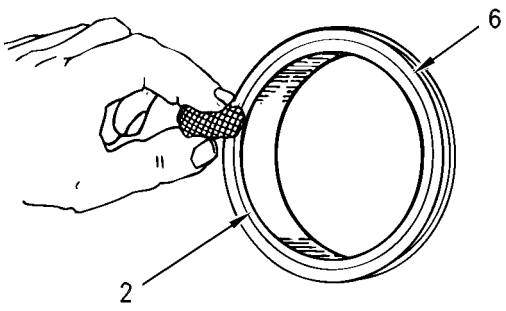


Illustration 809 g00297156

9. Apply a thin film of clean oil on seal ring faces (6). Use an applicator, a disposable tissue or a clean finger to distribute the oil evenly. Be careful so that no oil contacts the toric rings.

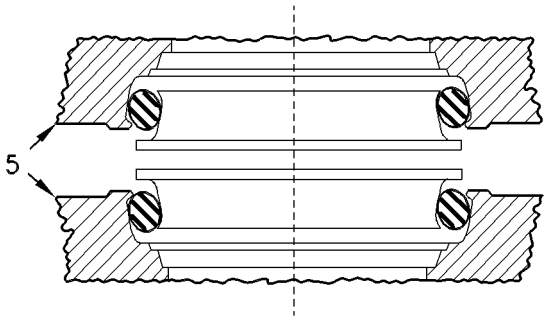


Illustration 810 g00297157

10. Make sure that both seal ring housings (5) are correctly aligned and concentric. Slowly move the seals toward each other.

Note: Do not slam the seals together. High impact can damage the seal components and leakage will occur.

11. When the seals are in place, fasten all of the parts securely.

i02501207

Final Drive and Wheel - Assemble

SMCS Code: 4051-016

Assembly Procedure

Table 50

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
B	138-7574	Link Bracket	3
C	8T-0531	Seal Installer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

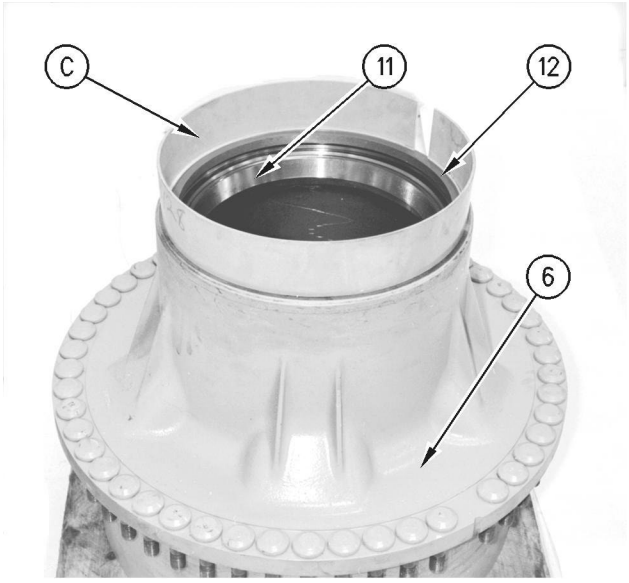


Illustration 811 g00855731

1. Place wheel housing (6) on suitable blocks, as shown.

2. Lower the temperature of bearing cup (11). Make sure that the bearing cup is properly seated.

3. Use Tooling (C) in order to install the Duo-Cone seal (12) in the wheel housing.

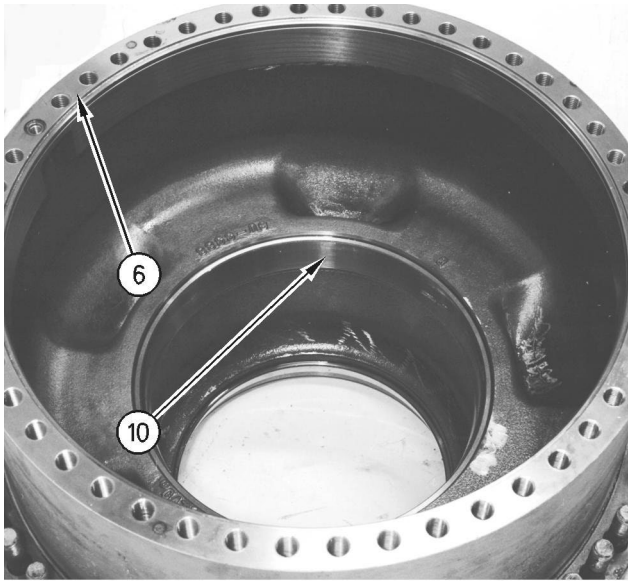


Illustration 812 g00855584

4. Lower the temperature of bearing cup (10). Make sure that the bearing cup is properly seated.

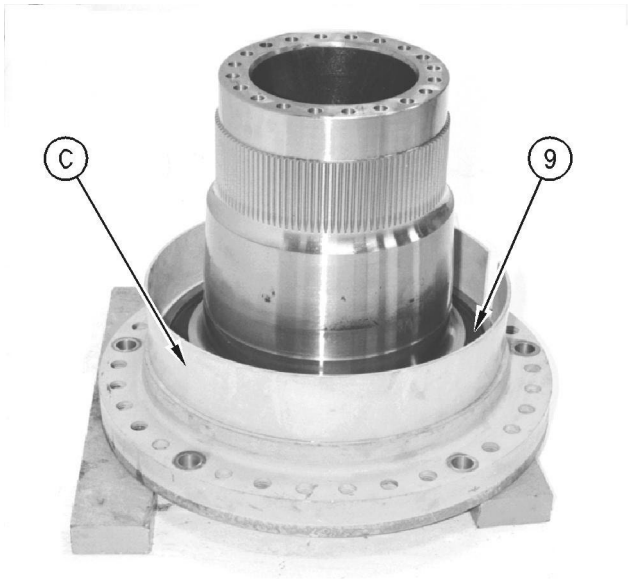


Illustration 813 g00855732

5. Use Tooling (C) in order to install Duo-Cone seal (9). Refer to Disassembly and Assembly, “Duo-Cone Conventional Seals - Install” for the correct procedure. Make sure that all contact surfaces are clean and dry before you install the seal.

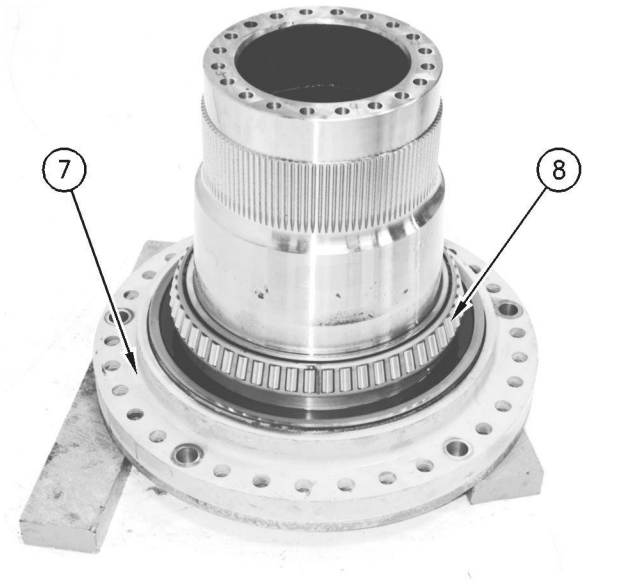


Illustration 814 g00855579

6. Install bearing cone (8) on spindle (7).

Note: Bearing cone (8) is a slip fit.

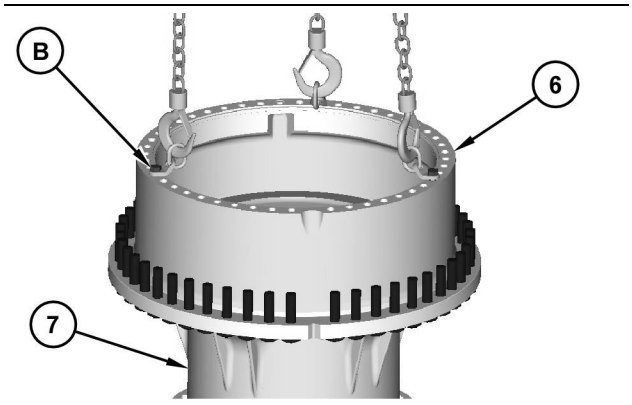


Illustration 815 g01251176

7. Use Tooling (B) and a suitable lifting device in order to install wheel housing (6) on spindle (7). The weight of wheel housing (6) is approximately 395 kg (870 lb).

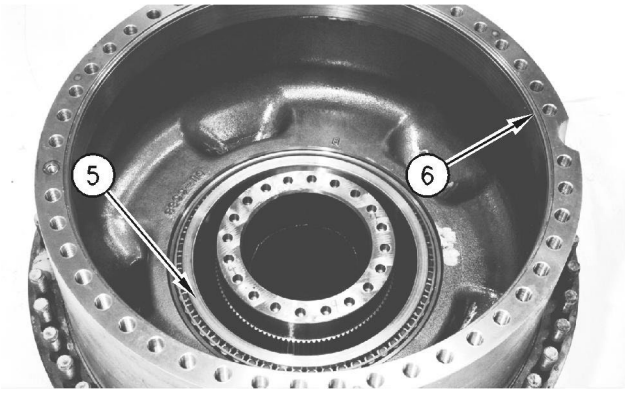


Illustration 816 g00855575

8. Install bearing cone (5) in wheel housing (6).

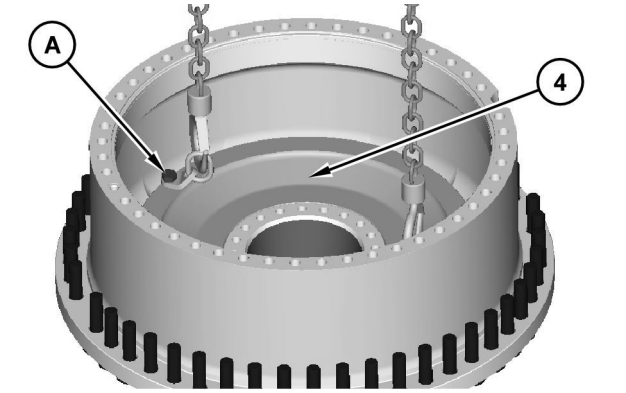


Illustration 817 g01251158

9. Use Tooling (A) and a suitable lifting device in order to install reaction hub (4) on the spindle. The weight of reaction hub (4) is approximately 77 kg (170 lb).

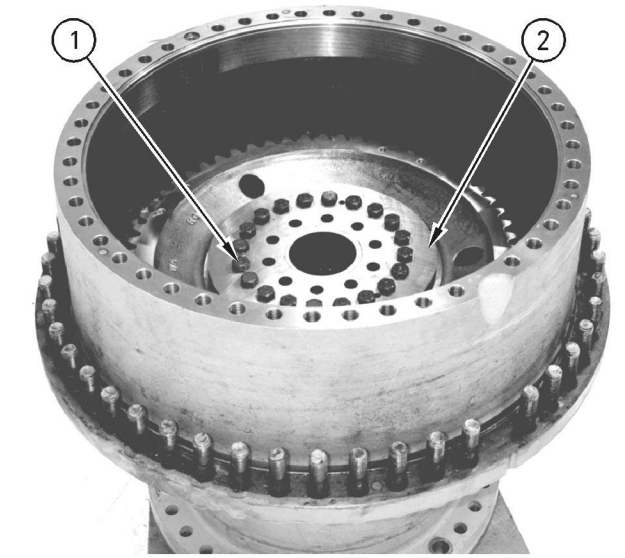


Illustration 818 g00855571

10. Install retainer (2) without the shims.

11. Install bolts (1). Do not tighten bolts (1).

12. Adjust the wheel bearing. Refer to Testing and Adjusting, “Wheel Bearings - Adjust”.

End By:

a. Install the final drive, brake and wheel. Refer to Disassembly and Assembly, “Final Drive, Brake and Wheel - Install”.

i02509690

Service Brake - Disassemble

SMCS Code: 4251-015

Disassembly Procedure

Table 51

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	2H-4010	Bolt	1
	25-3507	Nut	1
	5P-8250	Washer	1
	1U-9895	Puller	1
	FT-2450	Plate	1

Start By:

a. Remove the final drive and brake assemblies from the machine. Refer to Disassembly and Assembly Manual, “Final Drive, Brake and Wheel - Remove”.

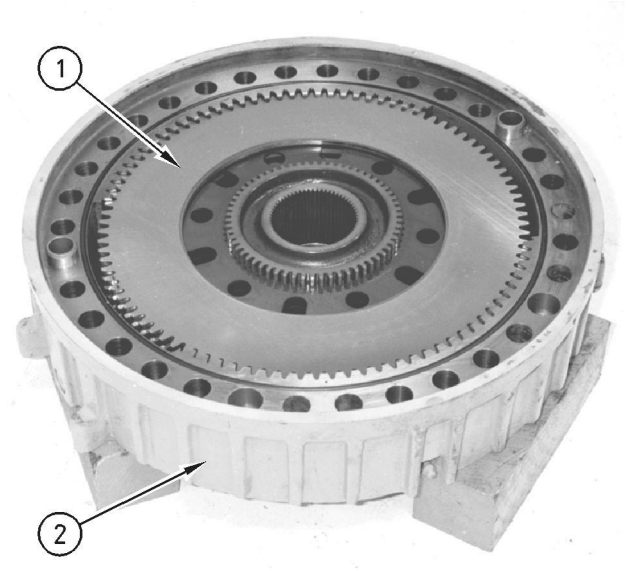


Illustration 819 g00855855

1. Remove five plates and four discs (1) from brake anchor (2).

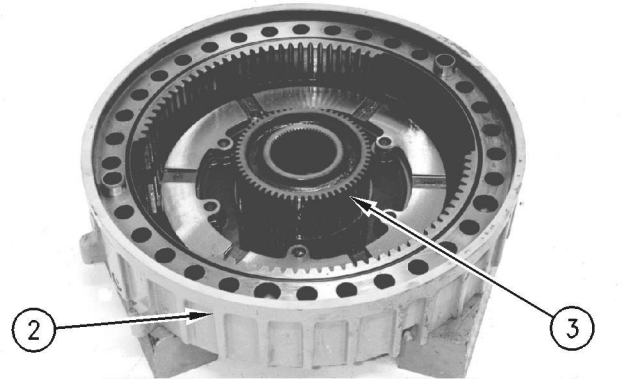


Illustration 820 g00855856

2. Remove hub (3) from brake anchor (2).

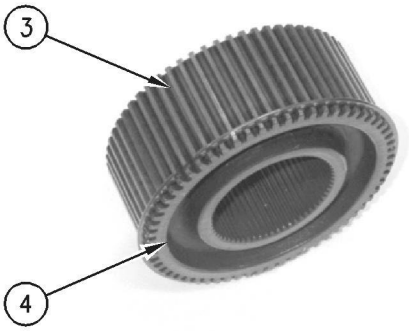


Illustration 821 g00855859

3. Remove retaining ring (4) from hub (3).



Illustration 822 g00855860

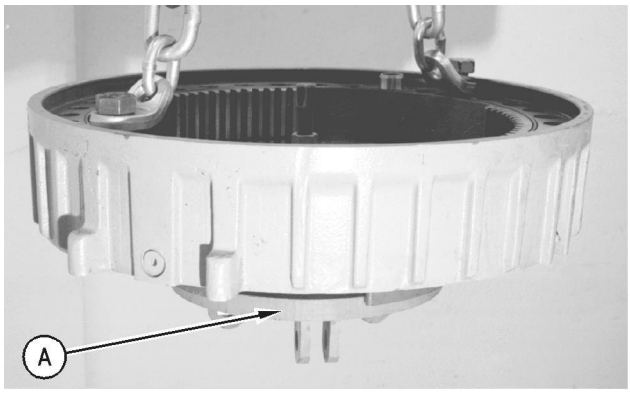


Illustration 823 g00855863

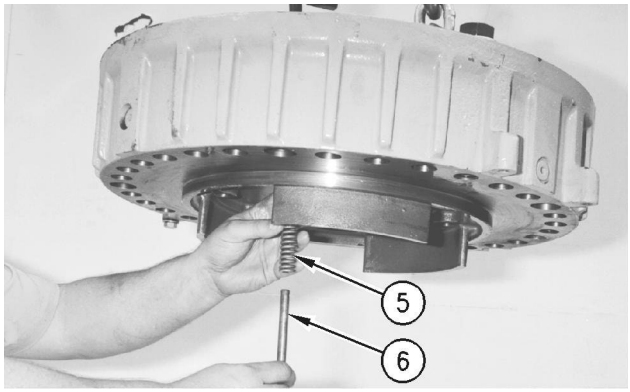


Illustration 824 g00855864

4. Install Tooling (A).

5. Use Tooling (A) in order to compress springs (5) and lift pins (6).

6. Remove horizontal pins (7) from pins (6).

7. Remove Tooling (A), springs (5), and pins (6).

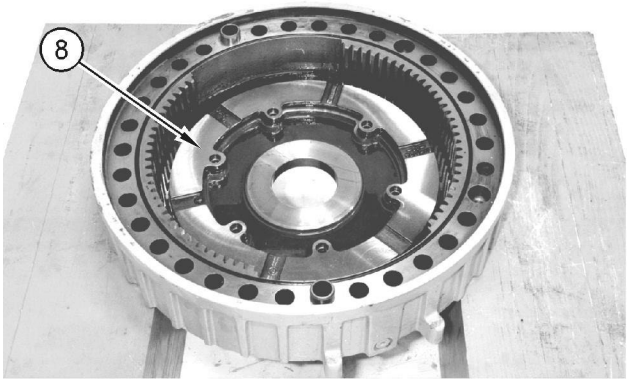


Illustration 825 g00855868

8. Remove piston (8) from brake anchor (2).

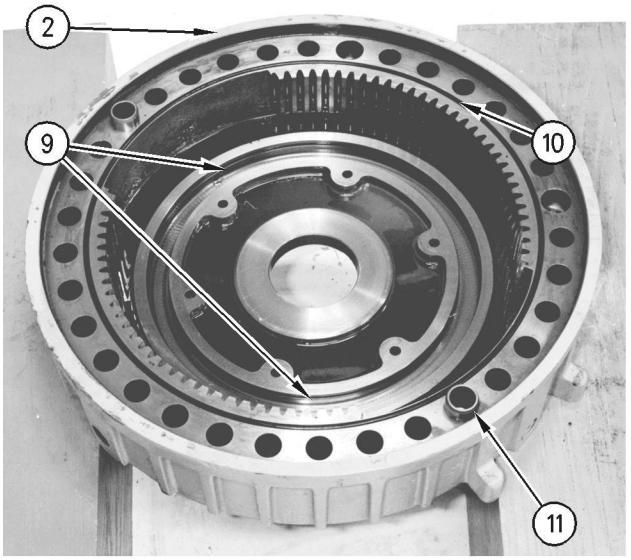


Illustration 826 g00855869

9. Remove piston seals (9) from the bore of piston (8).

10. Remove O-ring seal (10) from the face of brake anchor (2).

11. Remove dowels (11) from brake anchor (2).

i02509692

Service Brake - Assemble

SMCS Code: 4251-016

Assembly Procedure

Table 52

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	2H-4010	Bolt	1
	25-3507	Nut	1
	5P-8250	Washer	1
	1U-9895	Puller	1
	FT-2450	Plate	1

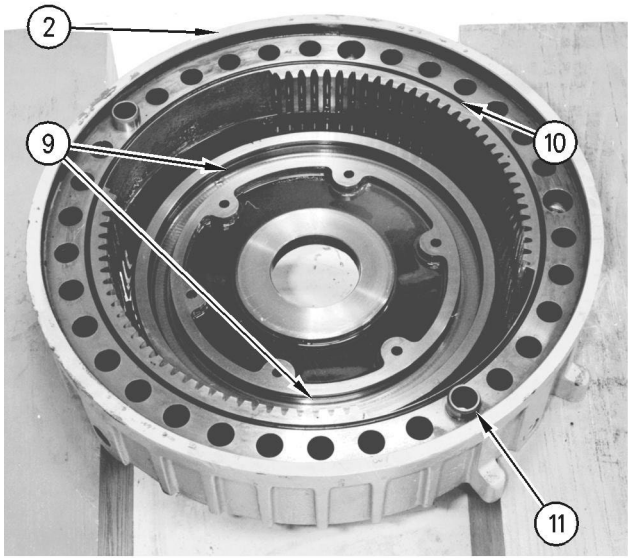


Illustration 827 g00855869

1. Install dowels (11) into brake anchor (2).

2. Install a new O-ring seal (10) in the face of brake anchor (2). Put clean oil on the O-ring seal.

3. Install new piston seals (9) in the bore of piston (8). Put clean oil on the O-ring seal.

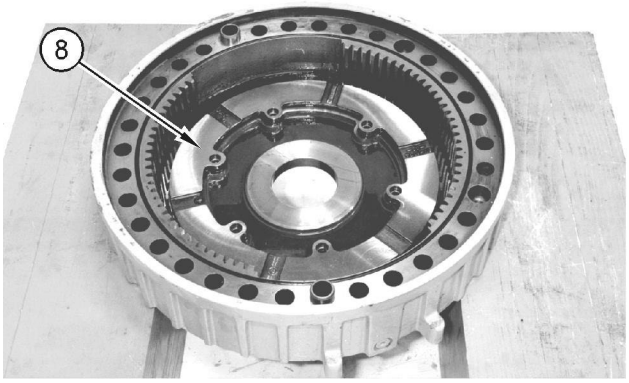


Illustration 828 g00855868

4. Install piston (8) in brake anchor (2).

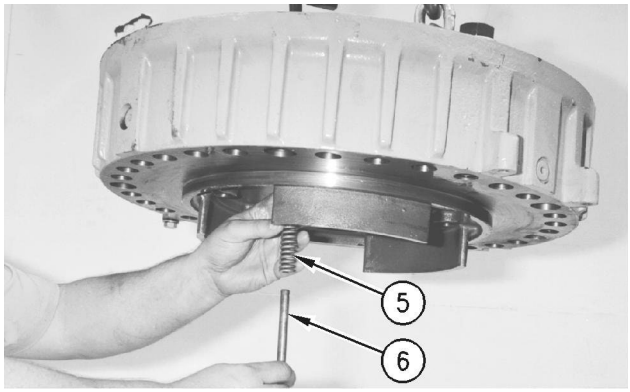


Illustration 829 g00855864

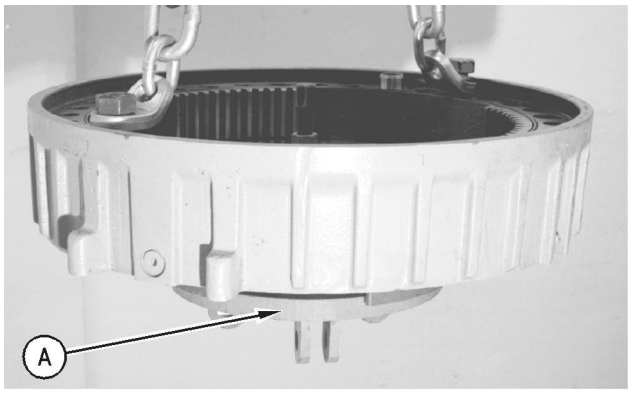


Illustration 830 g00855863



Illustration 831 g00855860

5. Install Tooling (A), as shown.

6. Install springs (5) and pins (6) in brake anchor (2).

7. Use Tooling (A) in order to compress springs (5) and lift pins (6).

8. Install horizontal pins (7) into pins (6).

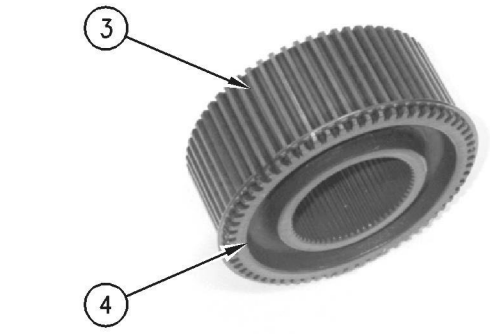


Illustration 832 g00855859

9. Install retaining ring (4) in hub (3).

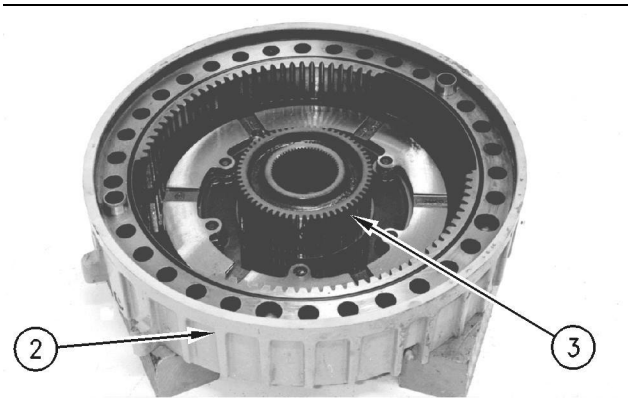


Illustration 833 g00855856

10. Install hub (3) into brake anchor (2).

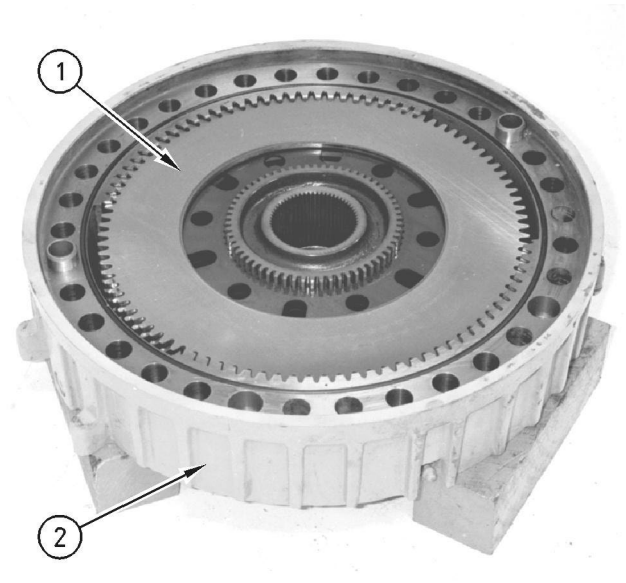


Illustration 834 g00855855

11. Lubricate the faces of five plates and four discs (1) with clean final drive oil prior to assembly.

12. Install five plates and four discs (1) on brake anchor (2) in alternating order. Start with a plate and end with a plate.

End By:

a. Install final drive and brake on the machine. Refer to Disassembly and Assembly, "Final Drive, Brake and Wheel - Install".

i02501204

Final Drive, Brake and Wheel - Install

SMCS Code: 4008-012

Installation Procedure

Table 53

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-9906	Ratchet Puller	1
B	138-7574	Link Bracket	1
C	138-7575	Link Bracket	3

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

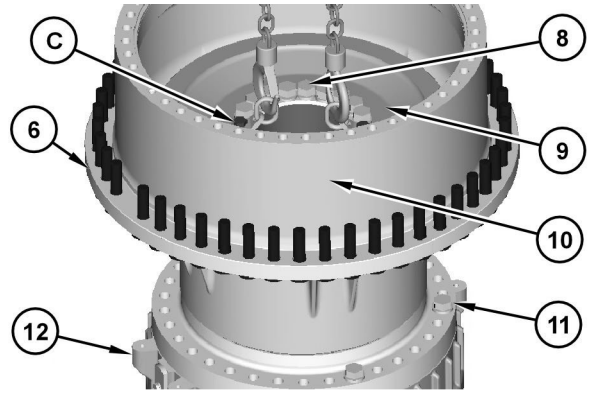


Illustration 835 g01251121

1. Attach Tooling (C) and a suitable lifting device to final drive (10), as shown. The weight of final drive (10) is approximately 749 kg (1650 lb). The weight of wheel brake assembly (12) is approximately 204 kg (450 lb).

2. Use Tooling (C) and the suitable lifting device in order to install final drive (10) to wheel brake assembly (12).

3. Install bolts (11) to wheel brake assembly (12).

4. Remove Tooling (C) from final drive (10).

5. Install bolts (8) to retainer (9).

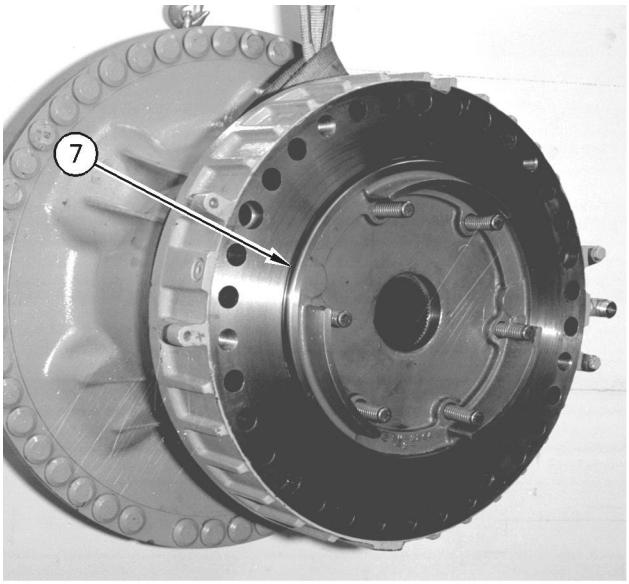


Illustration 836 g00855502

6. Install a new O-ring seal (7) in the final drive and wheel brake assembly.

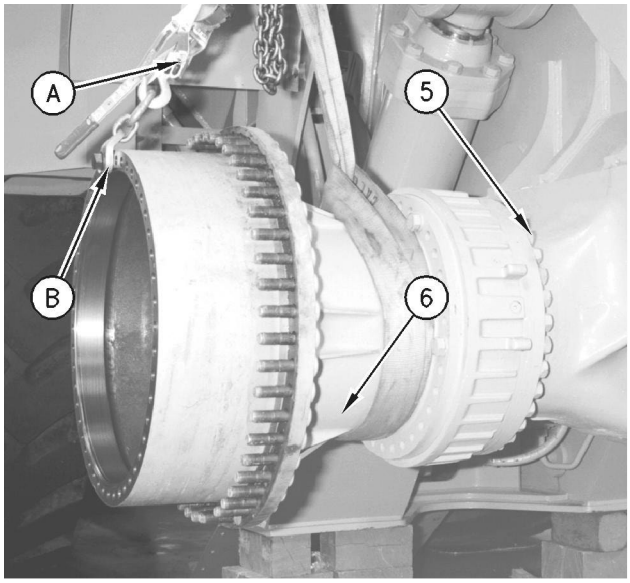


Illustration 837 g00855500

7. Attach Tooling (A), Tooling (B), and a suitable lifting device to final drive and wheel brake assembly (6), as shown. The weight of final drive and wheel brake assembly (6) is approximately 953 kg (2100 lb).

8. Use Tooling (A), Tooling (B), and a suitable lifting device in order to install final drive and wheel brake assembly (6).

9. Install bolts (5). Tighten bolts (5) to a torque of 1150 ± 150 N·m (850 ± 110 lb ft).

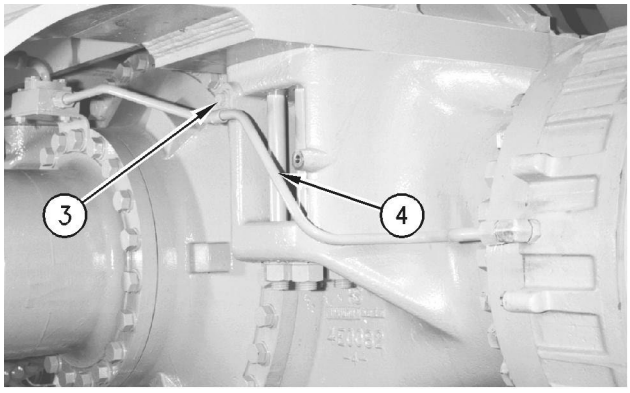


Illustration 838 g00855498

10. Install tube assembly(4). Install clip (3).

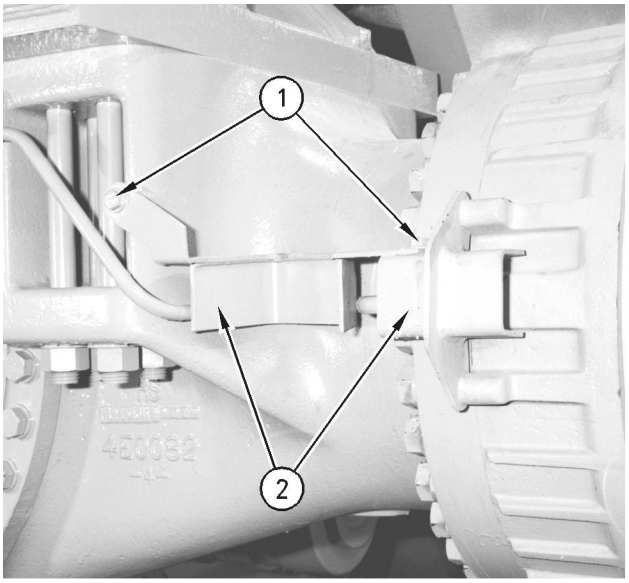


Illustration 839 g00855497

11. Install guards (2) and bolts (1).

End By:

a. Install the final drive planetary carriers. Refer to Disassembly and Assembly, “Final Drive Planetary Carrier - Install”.

b. Install the tire and the rim. Refer to Disassembly and Assembly, “Tire and Rim (Front) - Remove and Install” or refer to Disassembly and Assembly, “Tire and Rim (Rear) - Remove and Install”.

i02502474

Differential and Bevel Gear (Front) - Remove

SMCS Code: 3258-011-FR

Removal Procedure

Table 54

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2
B	138-7576	Link Bracket	3

Start By:

a. Remove the front axle. Refer to Disassembly and Assembly, “Fixed Axle (Front) - Remove”.

b. Remove the axle shafts. Refer to Disassembly and Assembly, “Axle Shaft - Remove”.

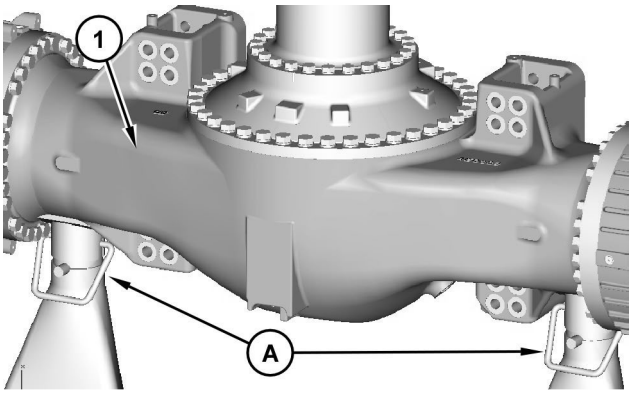


Illustration 840 g01251785

1. Place axle assembly (1) on Tooling (A) with the differential pinion in a vertical position, as shown.

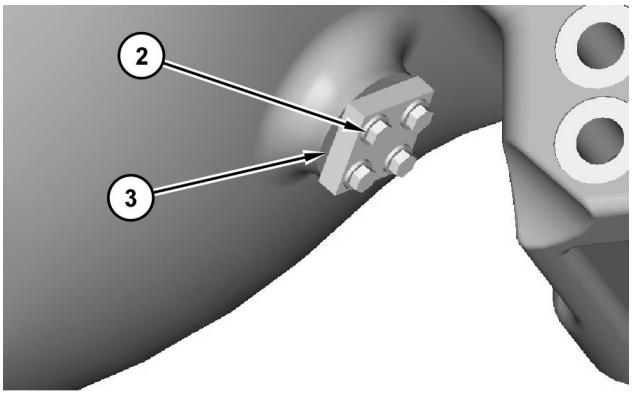


Illustration 841 g01251973

2. Remove bolts (2), cover (3), and the shims.

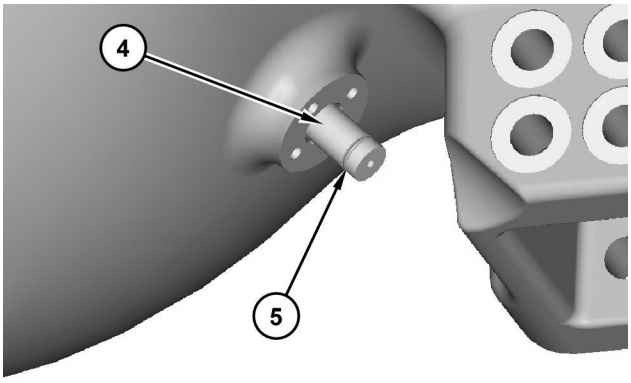


Illustration 842 g01251974

3. Remove pin (4) and O-ring seal (5).

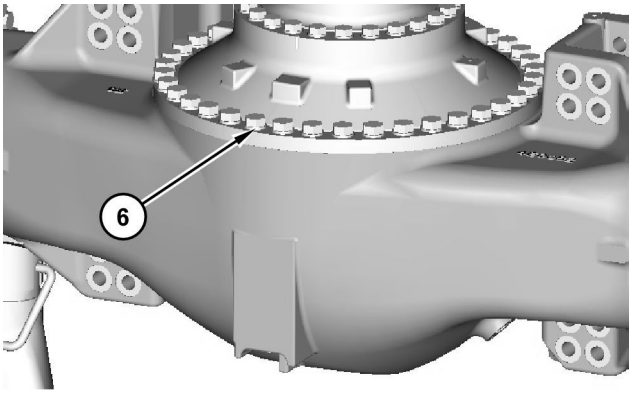


Illustration 843 g01252012

4. Remove bolts (6).

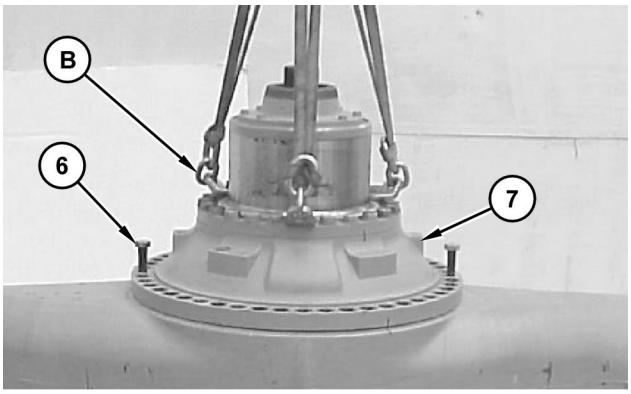


Illustration 844 g01251788
Typical Example

5. Attach Tooling (B) to differential and bevel gear (7), as shown.

6. Install two of bolts (6) in the threaded holes of differential and bevel gear (7). Tighten the bolts evenly in order to separate the differential and bevel gear from the axle housing.

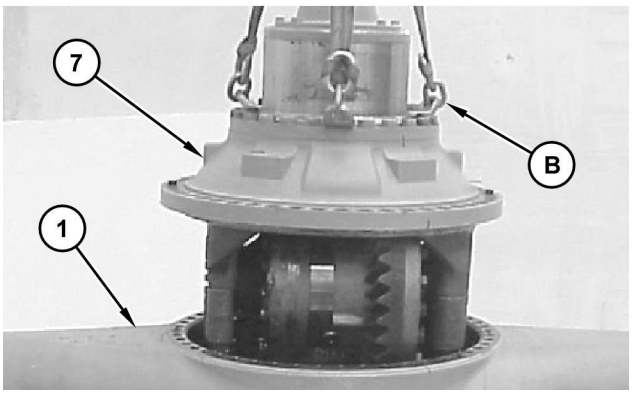


Illustration 845 g01251796
Typical Example

7. Use Tooling (B) and a suitable lifting device in order to remove differential and bevel gear (7). The weight of differential and bevel gear (7) is approximately 842 kg (1856 lb).

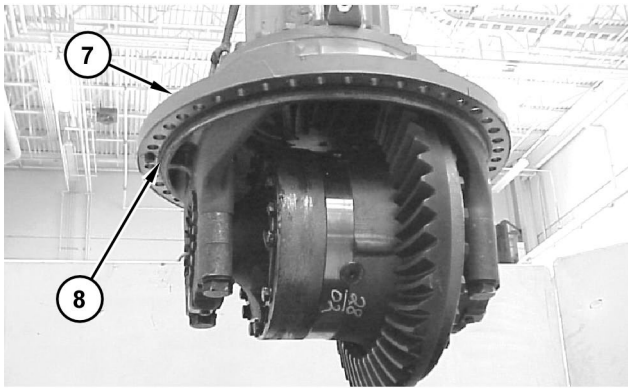


Illustration 846 g01251797
Typical Example

8. Remove O-ring seal (8) from differential and bevel gear (7).

i02502475

Differential and Bevel Gear (Front) - Install

SMCS Code: 3258-012-FR

Installation Procedure

Table 55

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2
B	138-7576	Link Bracket	3
C	1U-7234	Feeler Gauge	1
D	1U-6396	O-Ring Assembly Compound	1

1. Thoroughly clean the mating surfaces of the differential and bevel gear and of the axle housing. Replace O-ring seals with new parts.

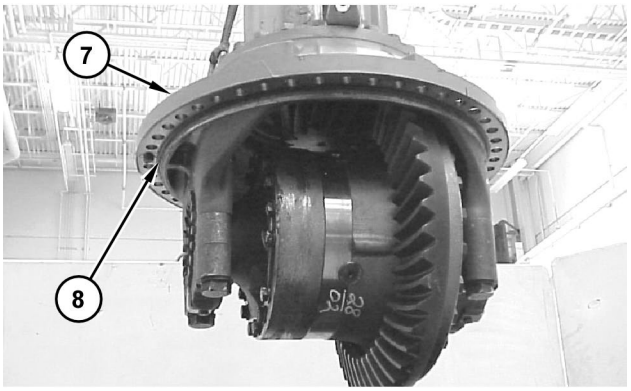


Illustration 847 g01251797
Typical Example

2. Apply Tooling (D) on O-ring seal (8). Install O-ring seal (8) on differential and bevel gear (7).

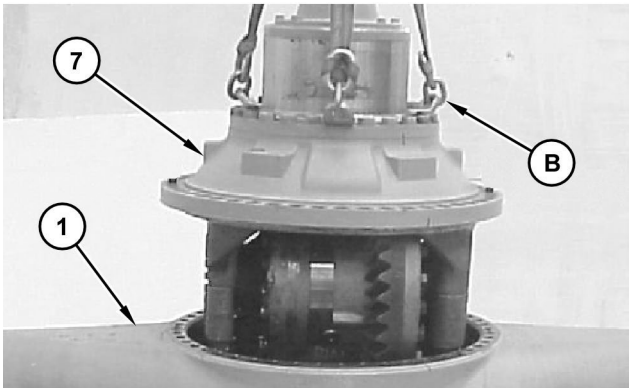


Illustration 848 g01251796

Typical Example

3. Use Tooling (B) and a suitable lifting device in order to lower differential and bevel gear (7) into axle assembly (1). The weight of differential and bevel gear (7) is approximately 842 kg (1856 lb).

4. Remove Tooling (B).

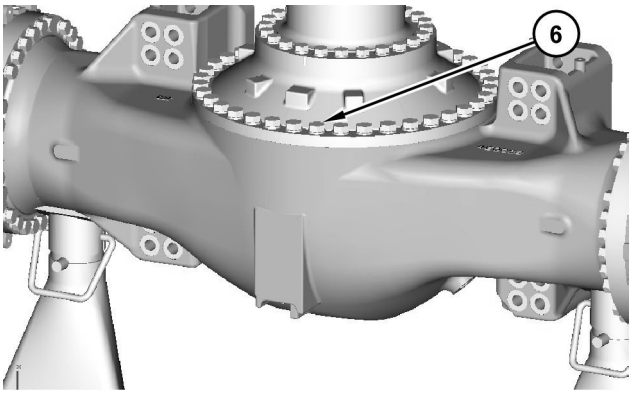


Illustration 849 g01251810

5. Install bolts (6). Tighten bolts (6) to a torque of 750 ± 80 N·m (550 ± 60 lb ft).

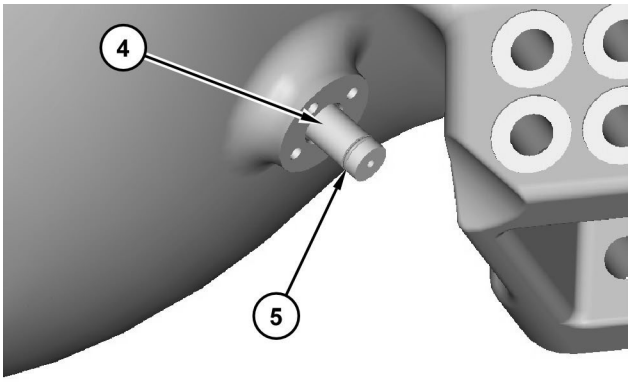


Illustration 850 g01251974

6. Install O-ring seal (5) on pin (4).

7. Lubricate pin (4) and O-ring seal (5) with oil.

8. Install the pin in the axle housing.

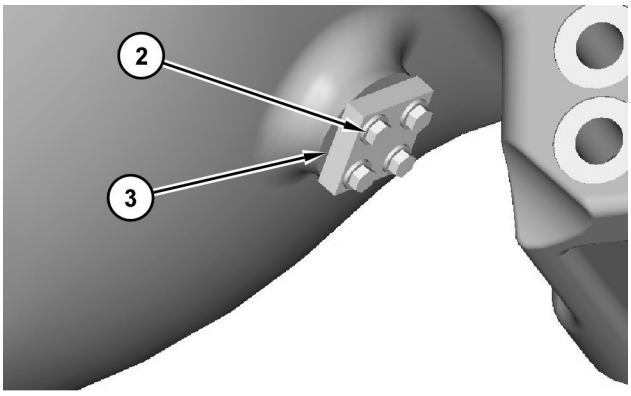


Illustration 851 g01251973

9. Install cover (3) without shims.

10. Install bolts (2). Tighten the bolts enough in order to remove the end play between pin (4) and cover (3).

11. Use Tooling (C) in order to measure the gap between the cover and the axle housing. Record this measurement. Use this measurement in order to determine the correct thickness of required shims.

12. Install a thickness of shims that will establish a −0.03 mm (−0.001 inch) preload to a 0.03 mm (0.001 inch) end play in pin (4).

13. Install cover (3) with the measured amount of shims.

14. Install bolts (2). The torque for bolts (2) is 105 ± 20 N·m (78 ± 15 lb ft).

End By:

a. Install the axle shafts. Refer to Disassembly and Assembly, “Axle Shaft - Install”.

b. Install the front axle. Refer to Disassembly and Assembly, “Fixed Axle (Front) - Install”.

i02502662

Differential and Bevel Gear (Rear) - Remove

SMCS Code: 3258-011-RE

Removal Procedure

Table 56

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6486	Stand	2
	8S-7615	Pin	2
	8S-8048	Saddle	2
	8S-7611	Tube	2
B	138-7576	Link Bracket	3

Start By:

a. Remove the rear axle. Refer to Disassembly and Assembly, “Oscillating Axle (Rear) - Remove”.

b. Remove the axle shafts. Refer to Disassembly and Assembly, “Axle Shaft - Remove”.

c. Remove the front trunnion support of the rear axle. Refer to Disassembly and Assembly, “Trunnion Support (Oscillating Axle, Front) - Remove”.

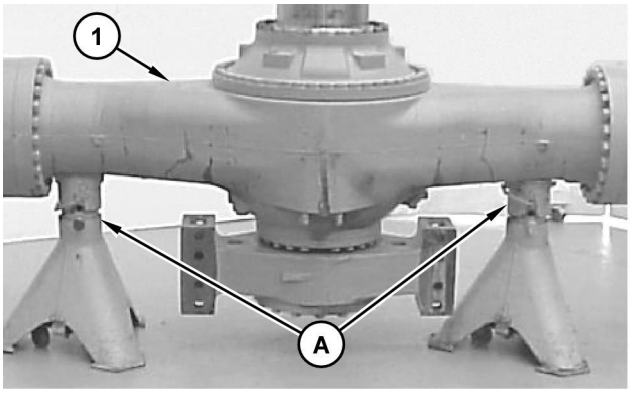


Illustration 852 g01252022

1. Place axle assembly (1) on Tooling (A) with the differential pinion in a vertical position, as shown.

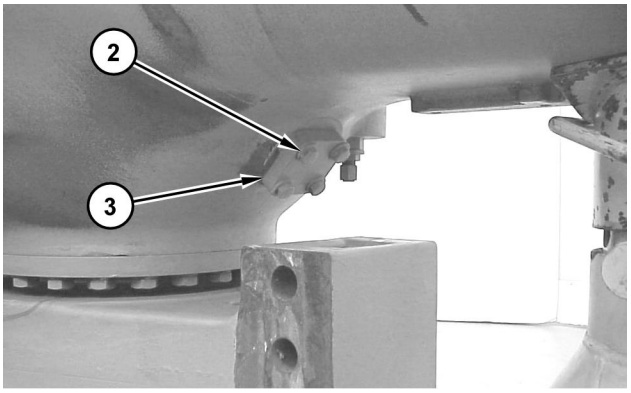


Illustration 853 g01252030

2. Remove bolts (2), cover (3), and the shims.

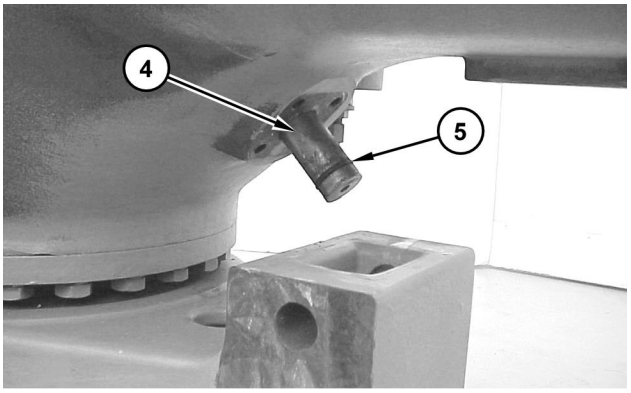


Illustration 854 g01252032

3. Remove pin (4) and O-ring seal (5).

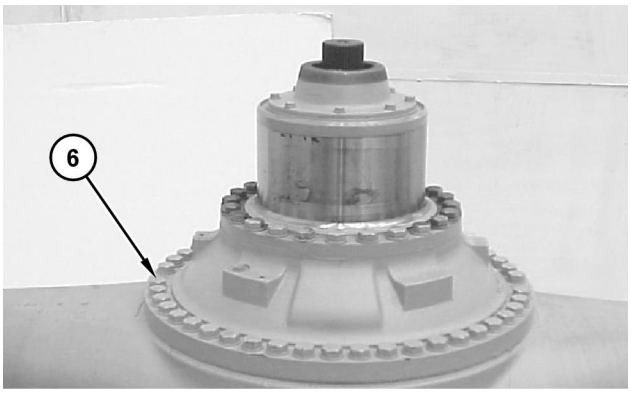


Illustration 855 g01252037

4. Remove bolts (6).

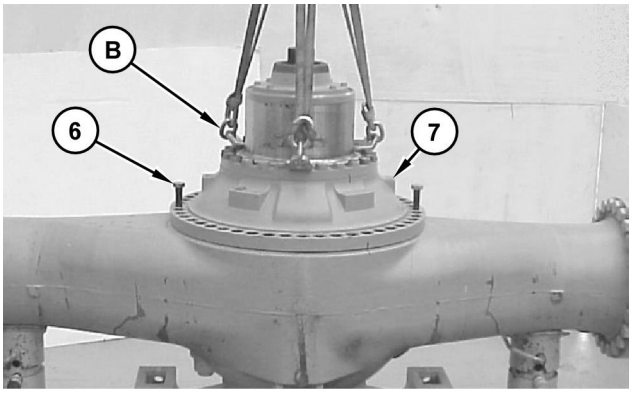


Illustration 856 g01252041

5. Attach Tooling (B) and a suitable lifting device to differential and bevel gear (7), as shown. The weight of differential and bevel gear (7) is approximately 842 kg (1856 lb).

6. Install two bolts (6) in the threaded holes of differential and bevel gear (7). Tighten the bolts evenly in order to separate the differential and bevel gear from the housing.

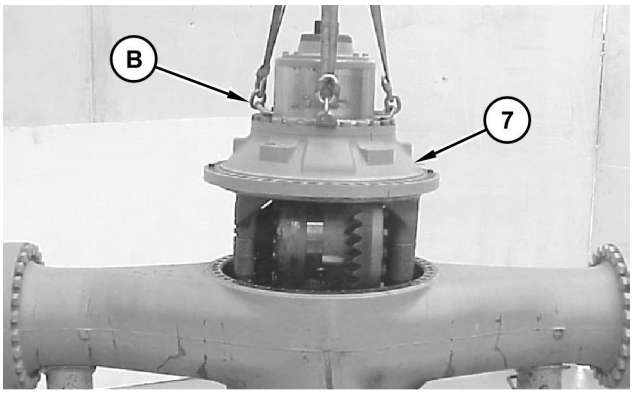


Illustration 857 g01252044

7. Use Tooling (B) and a suitable lifting device in order to remove differential and bevel gear (7).

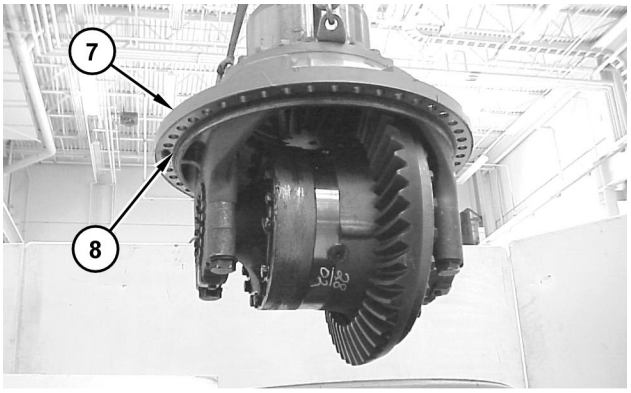


Illustration 858 g01252047

8. Remove O-ring seal (8) from differential and bevel gear (7).

i02509976

Differential and Bevel Gear - Disassemble

SMCS Code: 3258-015

Disassembly Procedure

Table 57

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2420	Transmission Repair Stand	1
B	138-7573	Link Bracket	3
C	125-5723	Socket	1
D	1H-3110	Bearing Puller Assembly	1
E	9U-7399	Spanner	1
F	9U-7398	Spanner	1
G	1H-3110	Bearing Puller Assembly	1
	1H-3107	Puller Group	1
	1P-0520	Driver Group	1

Start By:

a. Remove the differential and bevel gear. Refer to Disassembly and Assembly, “Differential and Bevel Gear (Front) - Remove” or Disassembly and Assembly, “Differential and Bevel Gear (Rear) - Remove” for the machine that is being serviced.

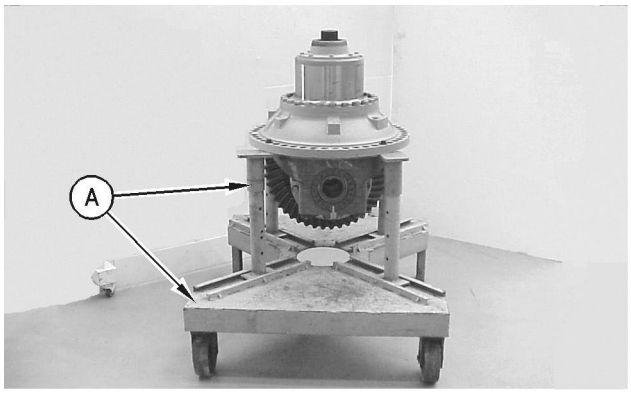


Illustration 859 g00667172

1. Use a suitable hoist in order to position the differential and bevel gear assembly on Tooling (A). The weight of the differential and bevel gear assembly is 794 kg (1750 lb).

2. Use four bolts and four nuts in order to secure the differential and bevel gear assembly to Tooling (A), as shown.

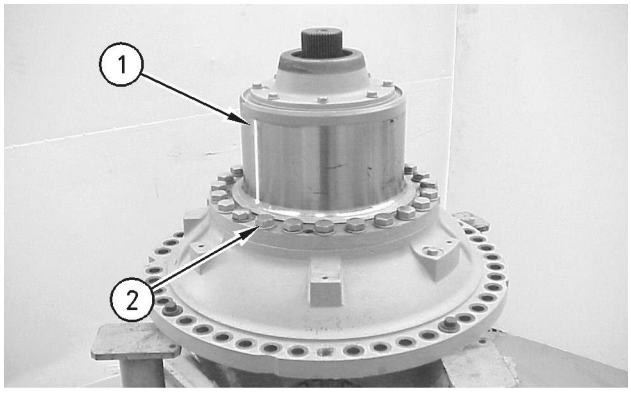


Illustration 860 g00667174

3. Remove 24 bolts (2) that fasten pinion housing (1) to the carrier assembly.

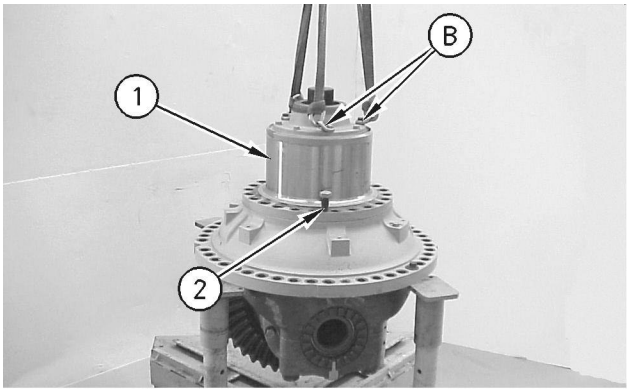


Illustration 861 g00667176

4. Attach Tooling (B) to pinion housing (1).

5. Attach a suitable hoist and lifting slings to Tooling (B).

6. Install two bolts (2) in the threaded holes of the pinion housing. Tighten bolts (2) evenly in order to separate pinion housing (1) from the carrier assembly.

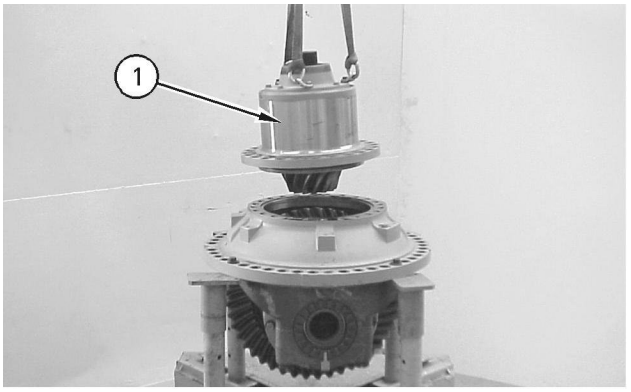


Illustration 862 g00667177

7. Use the hoist in order to remove pinion housing (1). The weight of pinion housing (1) is 170 kg (375 lb).

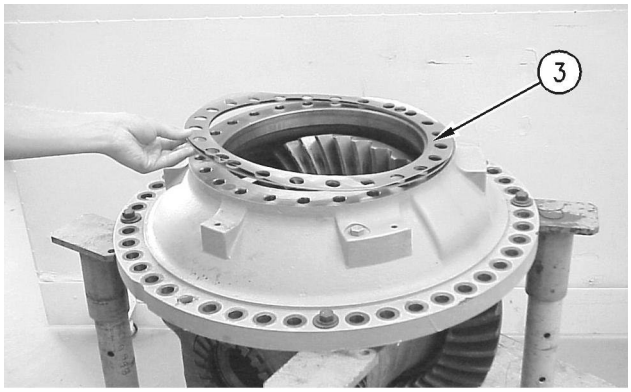


Illustration 863 g00667179

8. Remove shim pack (3).

Note: Steps 9 through 21 are used for the disassembly of the pinion housing.

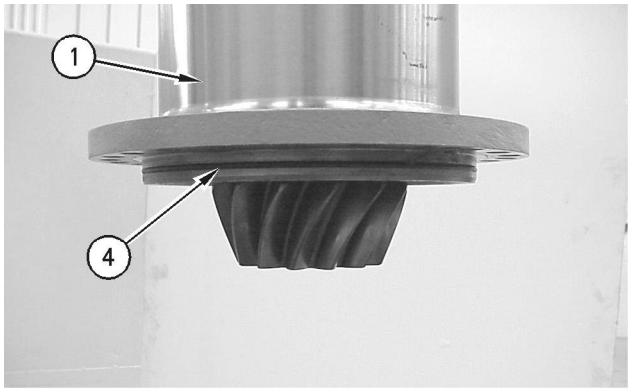


Illustration 864 g00667181

9. Remove O-ring seal (4) from pinion housing (1).

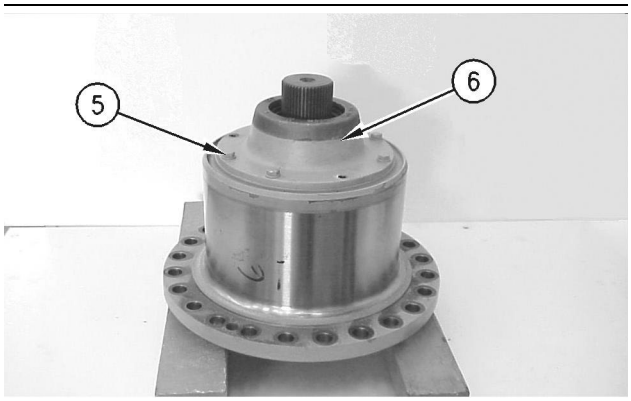


Illustration 865 g00667182

10. Remove Tooling (B) and remaining five bolts (5) that fasten retainer (6) to the pinion housing.

11. Remove retainer (6).

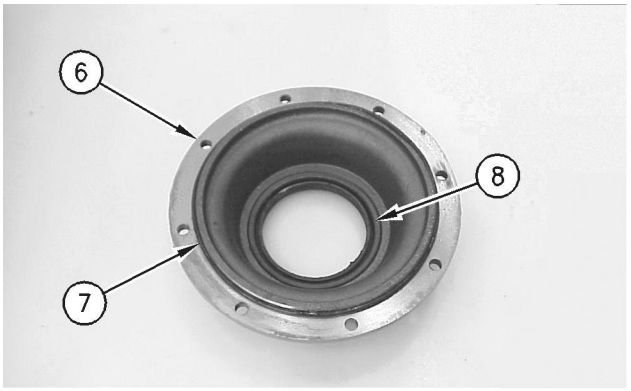


Illustration 866 g00667183

12. Remove O-ring seal (7) and lip seal (8) from retainer (6).

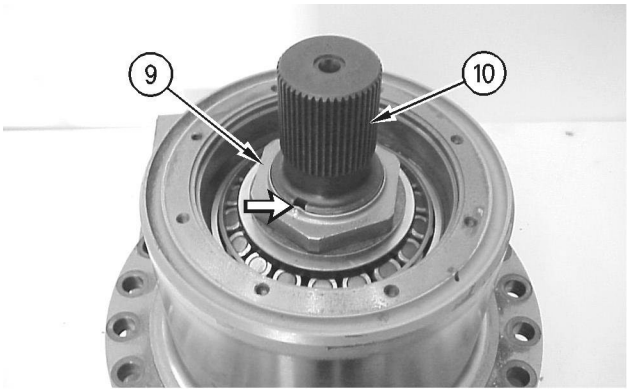


Illustration 867 g00667184

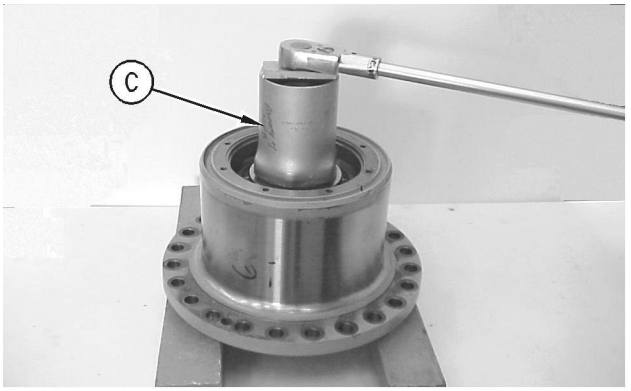


Illustration 868 g00667185

13. Straighten the staked area of retaining nut (9).

14. Use Tooling (C) in order to remove nut (9) from pinion shaft (10).

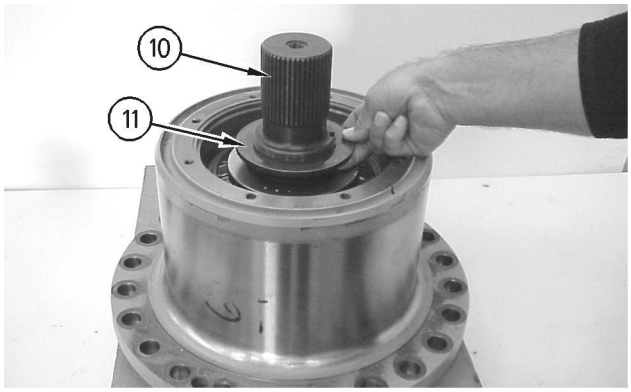


Illustration 869 g00667186

15. Remove washer (11) from shaft (10).

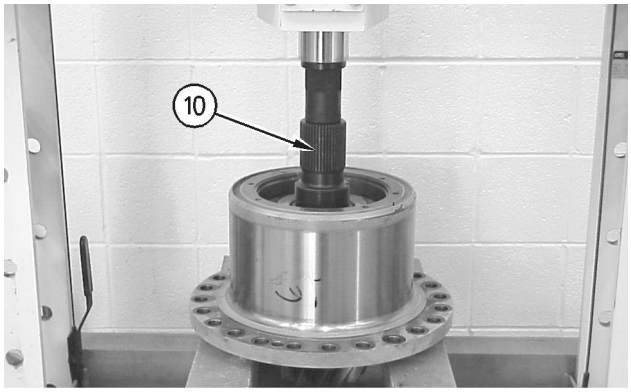


Illustration 870 g00667187

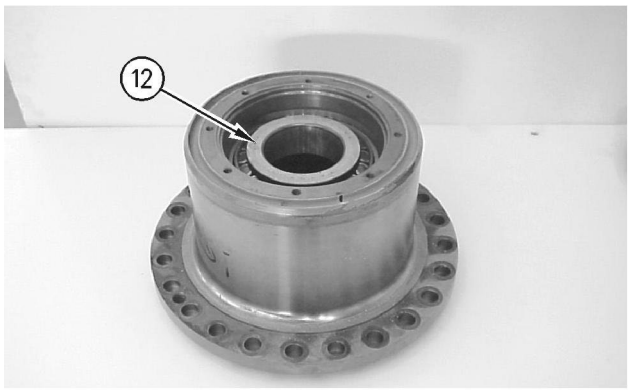


Illustration 871 g00685134

16. Place the pinion housing in a suitable press.

17. Press pinion shaft (10) from bearing cone (12). The weight of the pinion shaft and the gear is 36 kg (80 lb).

18. Remove bearing cone (12) from the pinion housing.

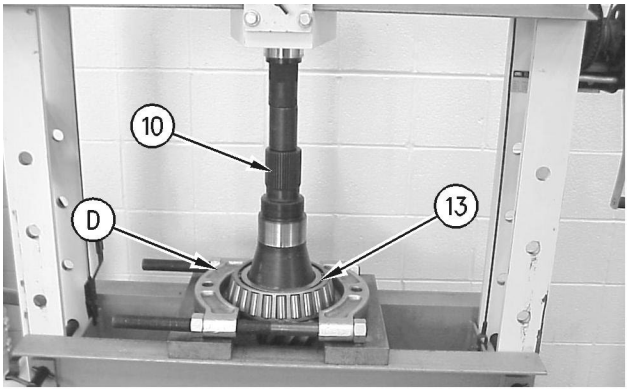


Illustration 872 g00685135

19. Use a suitable press and Tooling (D) in order to remove bearing cone (13) from pinion shaft (10).

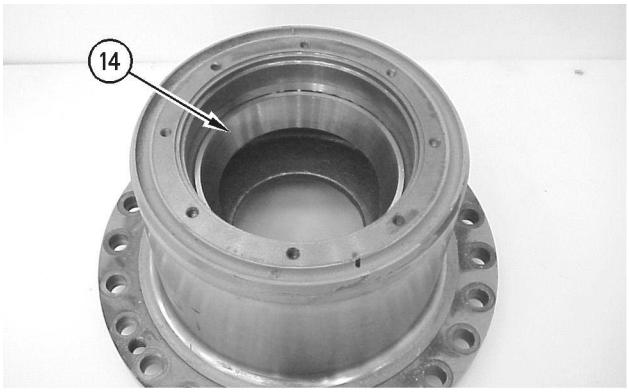


Illustration 873 g00685137

20. Remove bearing cup (14) from the pinion housing.



Illustration 874 g00685139

21. Remove bearing cup (15) from the opposite end of the pinion housing.

Note: Steps 22 through 29 are for the removal of the differential from the carrier.

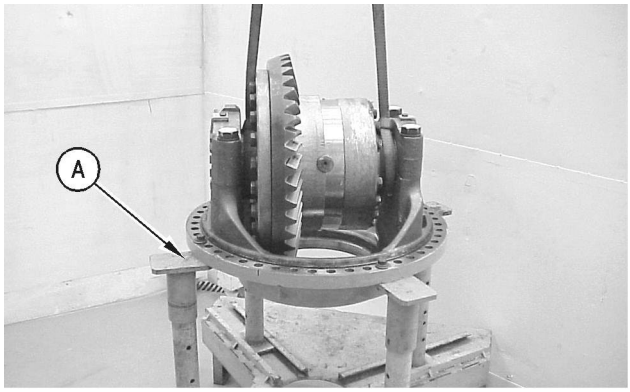


Illustration 875 g00685140

22. Use a suitable hoist and lifting slings in order to position the carrier and the differential assembly on Tooling (A). The combined weight of the carrier and of the differential assembly is 467 kg (1030 lb).

Note: Leave the hoist and lifting slings in position for the removal of the differential.

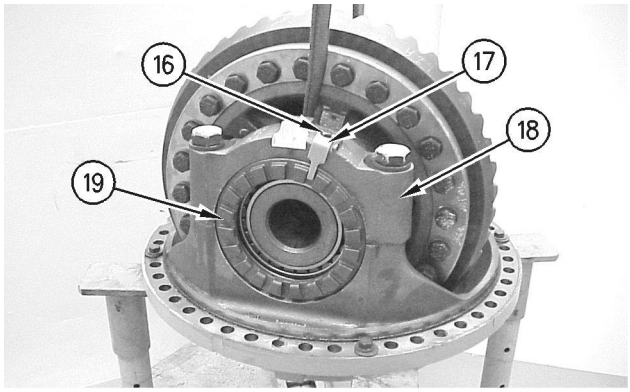


Illustration 876 g00685141

23. Remove bolt (16) and lock (17) from bearing cap (18).

24. Use Tooling (E) in order to remove adjustment nut (19).

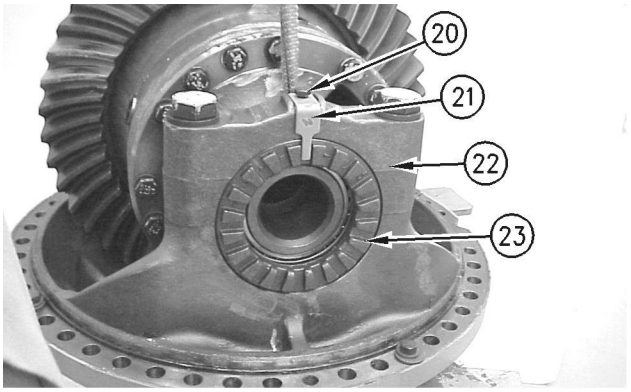


Illustration 877 g00685143

25. Use Tooling (F) in order to remove bolt (20) and lock (21) from bearing cap (22).

26. Remove adjustment nut (23).

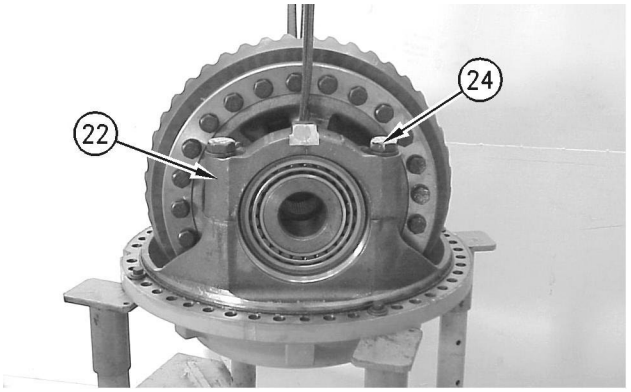


Illustration 878 g00685144

27. Remove two bolts (24) and bearing cap (22). Repeat this procedure for the opposite side.

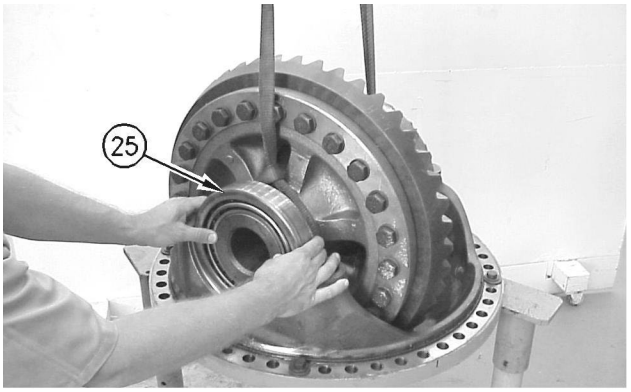


Illustration 879 g00685145

28. Remove bearing cup (25). Repeat this procedure for the opposite side.

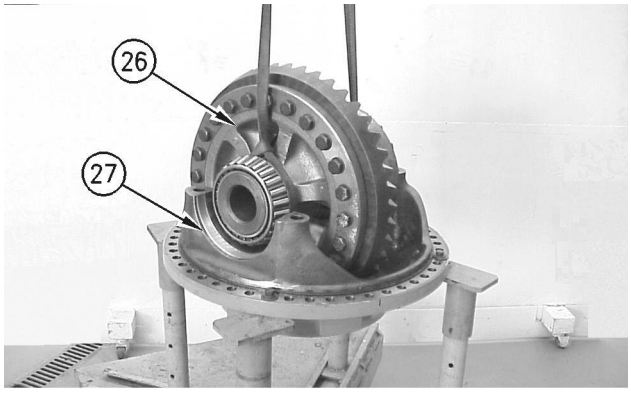


Illustration 880 g00685146

29. Use the hoist in order to remove the differential and bevel gear (26) from carrier (27). The combined weight of the differential and of the bevel gear (26) is 272 kg (600 lb).

Note: Steps 30 through 50 are used for the disassembly of the differential.

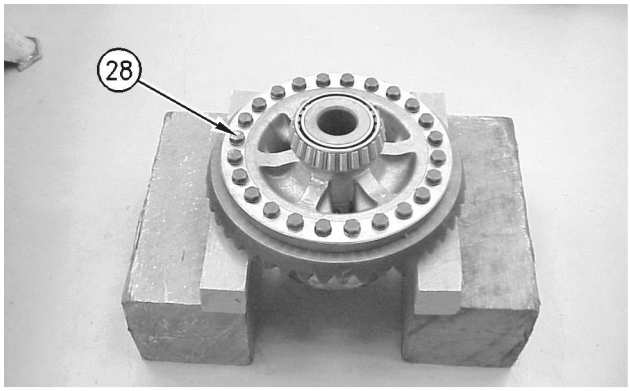


Illustration 881 g00685148

30. Place the differential and the bevel gear on suitable wood blocks, as shown.

31. Remove bolts (28).

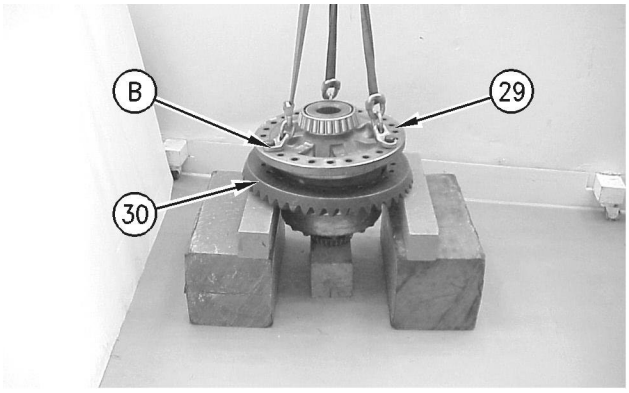


Illustration 882 g00685149

32. Place the differential and bevel gear assembly on a suitable wood block in order to allow bevel gear (30) to be removed.

33. Install Tooling (B).

34. Attach a suitable hoist and lifting slings to Tooling (B).

35. Use the hoist in order to remove differential (29). The weight of differential (29) is 221 kg (490 lb). The weight of the bevel gear is 68 kg (150 lb).

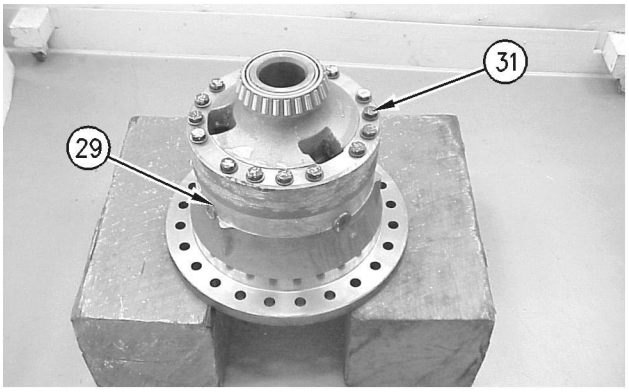


Illustration 883 g00685189

36. Carefully invert the differential (29).

37. Put alignment marks across the differential cases.

38. Remove 14 bolts (31). Do not remove two bolts. The two remaining bolts should be 180 degrees from each other.

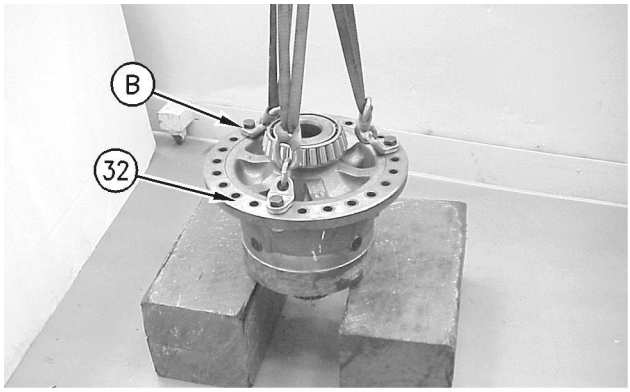


Illustration 884 g00685191



Illustration 885 g00685192

39. Carefully invert the differential.

40. Install Tooling (B).

41. Attach a suitable hoist and lifting slings to Tooling (B).

42. Remove remaining two bolts (31).

43. Remove top differential case (32). The weight of top differential case (32) is 105 kg (230 lb).

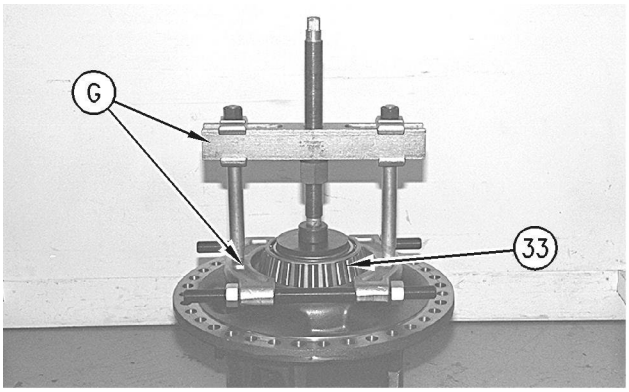


Illustration 886 g00685194

44. Use Tooling (G) in order to remove bearing cone (33) from the top differential case.

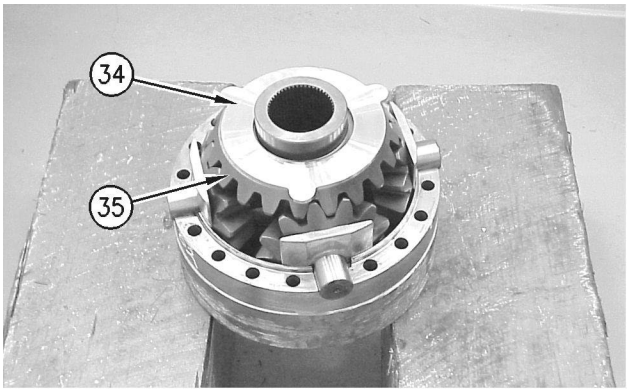


Illustration 887 g00685195

45. Remove spacer (34).

46. Remove gear (35).

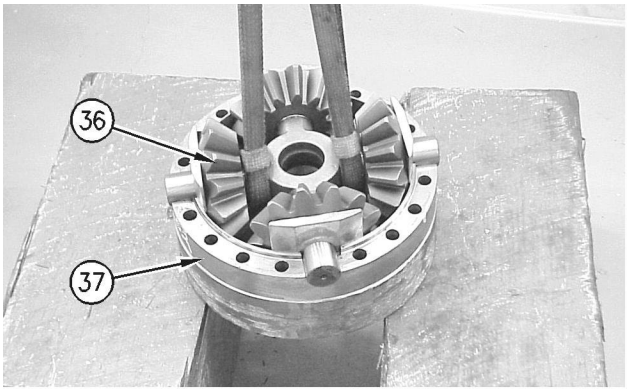


Illustration 888 g00685196

47. Attach a suitable hoist and lifting slings, as shown.

48. Use the hoist in order to remove the spider and pinion gear assembly (36) from case (37). The weight of spider and pinion gear assembly (36) is 32 kg (70 lb).

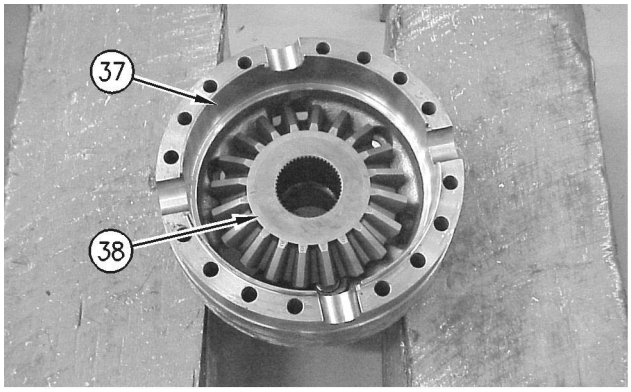


Illustration 889 g00685197

49. Remove gear (38) from differential case (37).

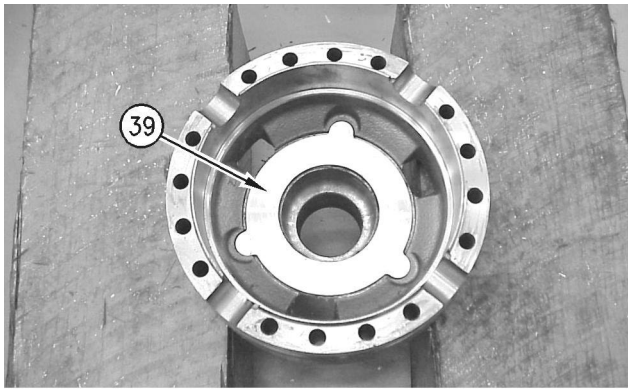


Illustration 890 g00685199

50. Remove thrust washer (39) from the differential case.

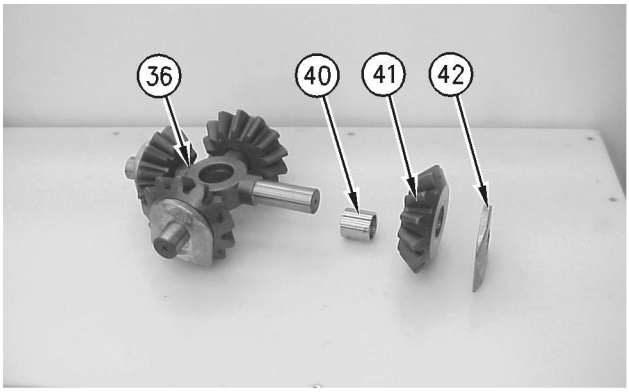


Illustration 891 g00685202

51. Remove spacer (42), pinion gear (41), and sleeve (40) from spider assembly (36). Repeat this procedure for the remaining three pinion gear assemblies.

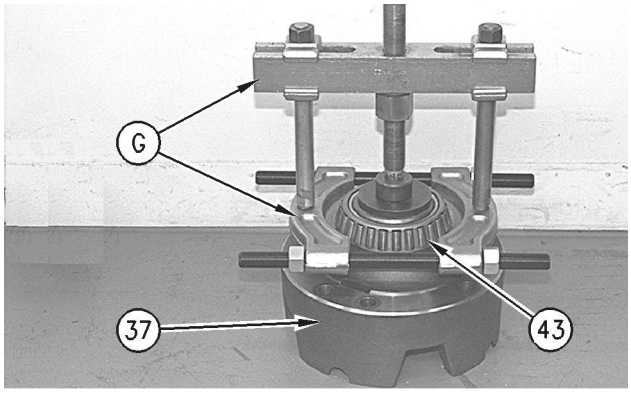


Illustration 892 g00685203

52. Use Tooling (G) in order to remove bearing cone (43) from the differential case (37).

i02509978

Differential and Bevel Gear - Assemble

SMCS Code: 3258-016

Assembly Procedure

Table 58

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2420	Transmission Repair Stand	1
B	138-7573	Link Bracket	3
C	1U-6691	Socket	1
D	1P-0520	Driver Group	1
E	8T-5096	Dial Indicator Group	1
F	9S-7338	Crossblock	1
	8T-0357	Bolt M16X2.0X70MM	3
	8T-1757	Nut M16X2.0	1
	9X-8268	Washer	4

1. Clean all the components of the differential and bevel gear group. Replace all seals and any damaged components with new parts for replacement.

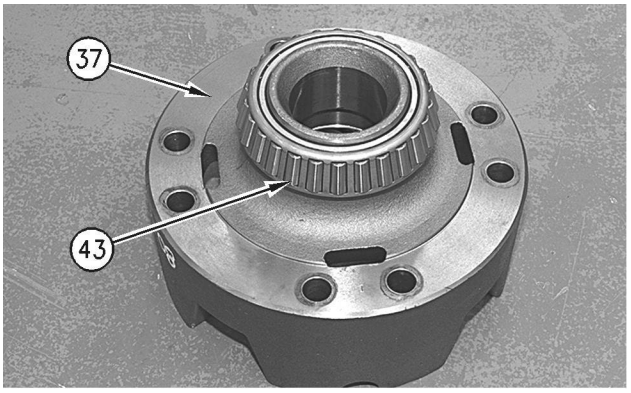


Illustration 893 g00685286

2. Heat bearing cone (43) to a maximum temperature of 135°C (275°F).

3. Use suitable gloves in order to install bearing cone (43) on differential case (37).

Note: Allow the bearing cone and the differential case to reach a uniform temperature.

4. Use a suitable hammer and a suitable punch in order to reset the bearing cone and the differential case around the inside race of the bearing. This will ensure that the bearing cone is seated correctly on the case.

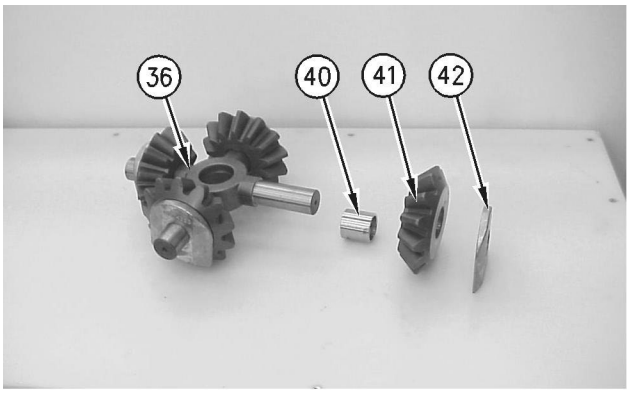


Illustration 894 g00685202

5. Install sleeve (40), pinion gear (41), and spacer (42) onto the spider assembly (36). Repeat this procedure for the three remaining pinion gear assemblies.

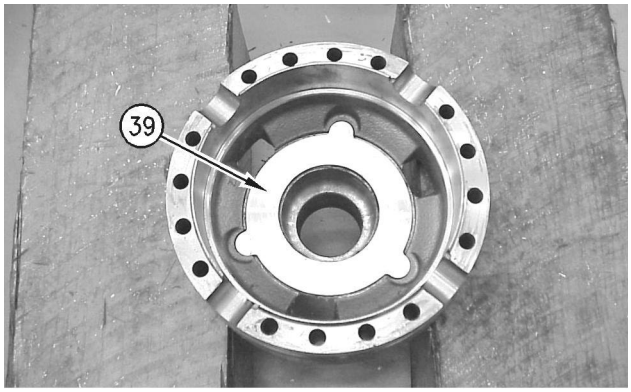


Illustration 895 g00685199

6. Place the bottom differential case on suitable wood blocks, as shown.

7. Install thrust washer (39) into the bottom differential case.

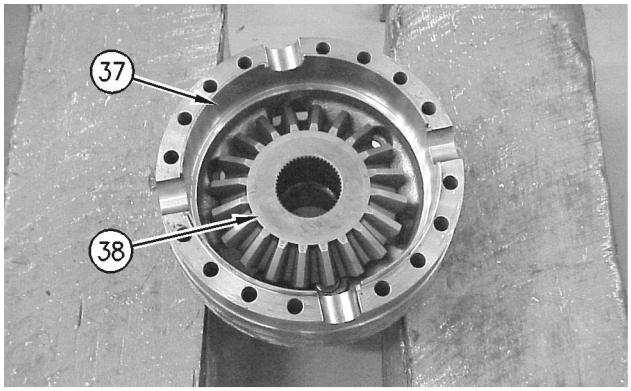


Illustration 896 g00685197

8. Lubricate the thrust face of gear (38) with clean oil.

9. Install gear (38) in differential case (37).

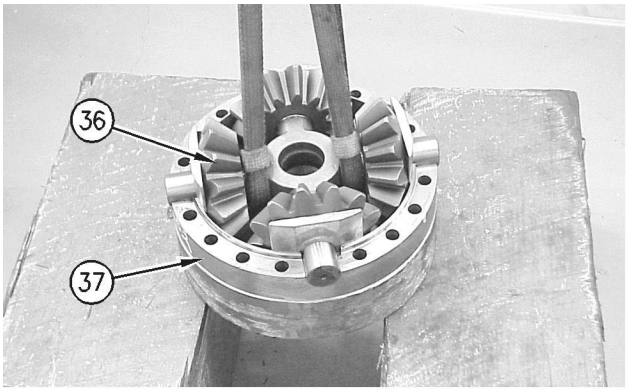


Illustration 897 g00685196

10. Attach a suitable lifting device to the spider and pinion gear assemblies (36), as shown.

11. Use a suitable lifting device in order to install the spider and the pinion gear assemblies in differential case (37). The combined weight of the spider and of the pinion gear assemblies is 32 kg (70 lb).

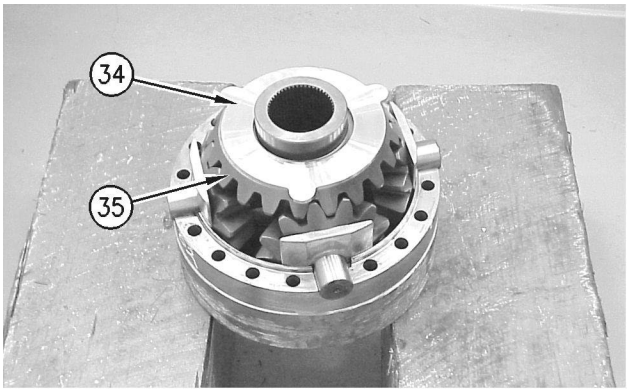


Illustration 898 g00685195

12. Install gear (35) on the pinion gear assemblies. Lubricate the thrust face of gear (35) with clean oil.

13. Install spacer (34).

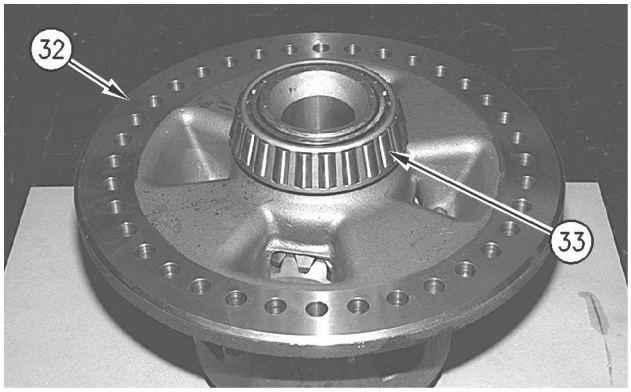


Illustration 899 g00685294

14. Heat bearing cone (33) to a maximum temperature of 135°C (275°F).

15. Use suitable gloves in order to install bearing cone (33) on the top differential case (32).

Note: Allow the bearing cone and the differential to reach a uniform temperature.

16. Use a suitable hammer and a suitable punch in order to reset the bearing cone around the inside race of the bearing.

Note: This will ensure that the bearing cone is seated against the shoulder of the differential.

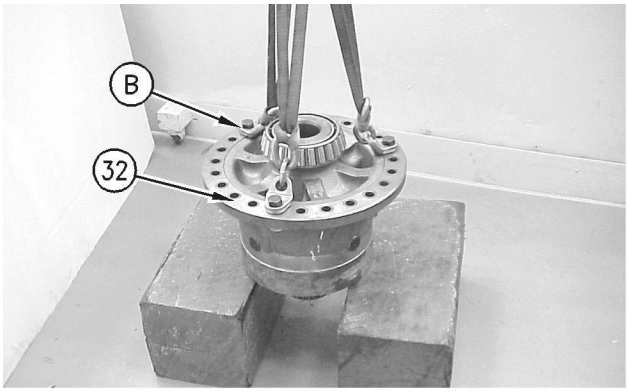


Illustration 900 g00685191



Illustration 901 g00685192

17. Install Tooling (B) to the top differential case (32).

18. Attach a suitable lifting device to Tooling (B).

19. Use the suitable lifting device in order to install top differential case (32) onto the bottom differential case. The weight of top differential case is 170 kg (375 lb).

20. Install two bolts (31).

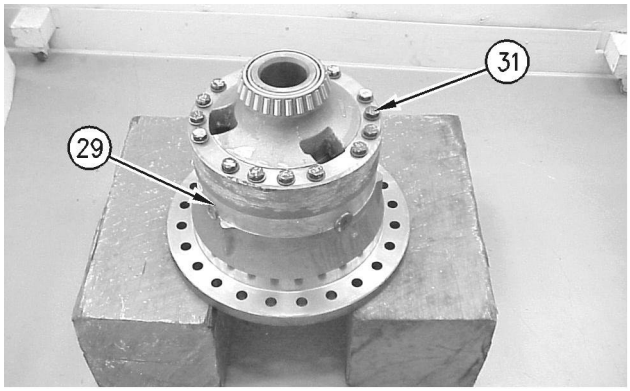


Illustration 902 g00685189

21. Carefully invert differential (29).

22. Install eight new bolts (31) that secure top differential case (32) to differential (29). Tighten bolts (31) to a torque of 460 ± 70 N·m (340 ± 52 lb ft). Turn the bolts by an additional 180 ± 10 degrees after the bolts have been torqued.

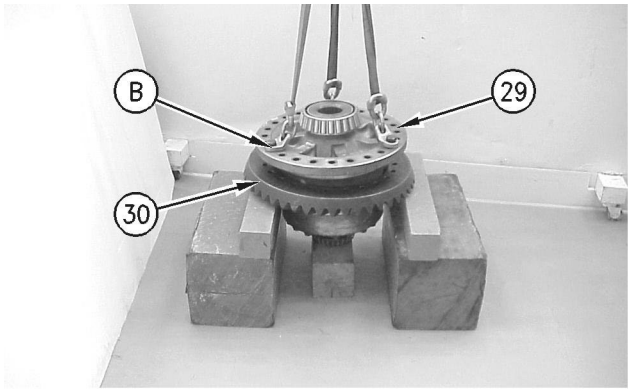


Illustration 903 g00685149

23. Place bevel gear (30) on suitable wood blocks, as shown.

24. Install Tooling (B) to differential assembly (29).

25. Attach a suitable lifting device to Tooling (B).

26. Use the suitable lifting device in order to install differential assembly (29) to bevel gear (30).

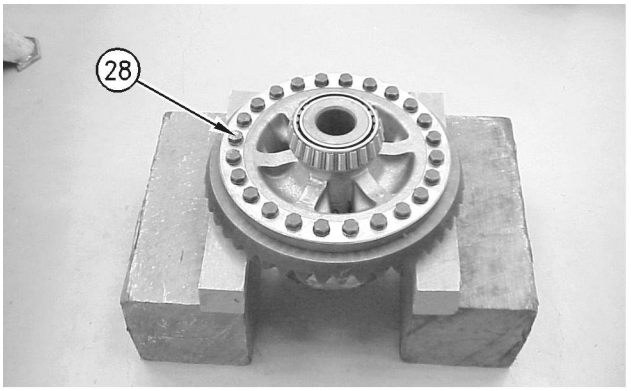


Illustration 904 g00685148

27. Remove Tooling (B).

28. Install bolts (28). Tighten bolts (28) to a torque of 750 ± 80 N·m (550 ± 60 lb ft).

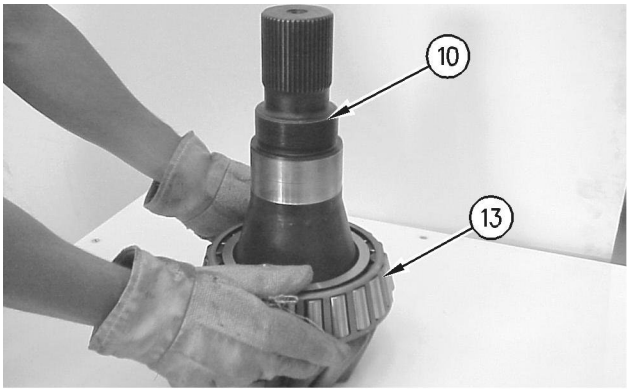


Illustration 905 g00686566

29. Heat bearing cone (13) to a maximum temperature of 135°C (275°F).

30. Use suitable gloves in order to install bearing (13) on pinion shaft (10).

Note: Allow the bearing cone and the pinion shaft to reach a uniform temperature.

31. Use a suitable hammer and a suitable punch in order to reset the bearing cone around the inside race of the bearing.

Note: This will ensure that the bearing cone is seated against the shoulder of the pinion shaft.



Illustration 906 g00685139

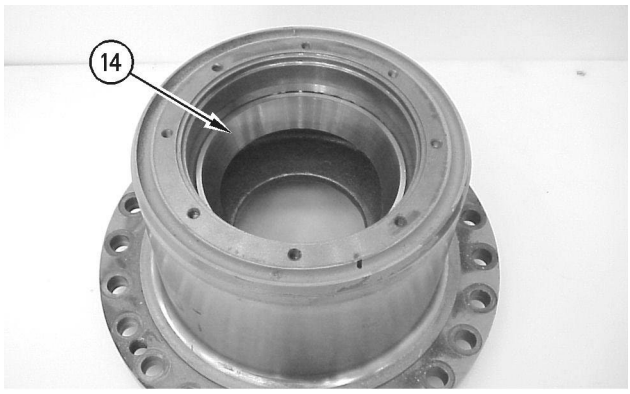


Illustration 907 g00685137

32. Lower the temperature of bearing cups (14) and (15).

33. Use suitable gloves in order to install bearing cup (15) in the pinion housing.

34. Rotate the pinion housing and install bearing cup (14) in the pinion housing.

Note: Allow the bearing cups and the pinion housing to reach a uniform temperature.

35. Use Tooling (D) in order to reset the bearing cups.

Note: This will ensure that the bearing cups are seated against the shoulders of the pinion housing.

36. Lubricate the bearing cups with clean oil.

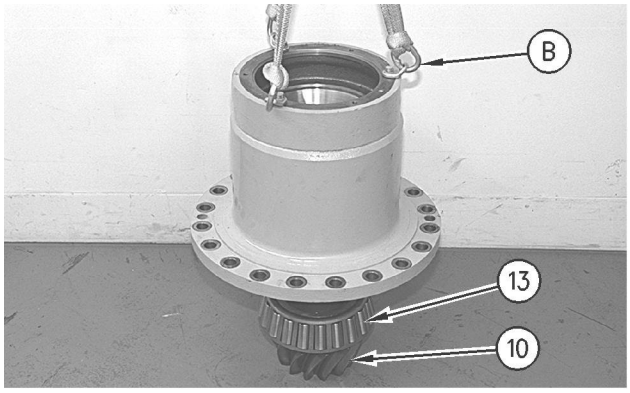


Illustration 908 g00685309

37. Lubricate bearing cone (13) with clean oil.

38. Install Tooling (B) to the pinion housing.

39. Attach a suitable lifting device to Tooling (B).

40. Use the suitable lifting device in order to lower the pinion housing onto pinion shaft (10). The weight of the pinion housing is 170 kg (375 lb).

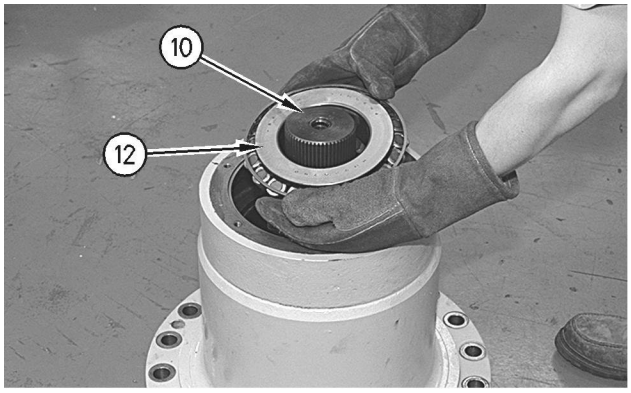


Illustration 909 g00685310

41. Heat bearing cone (12) to a maximum temperature of 135°C (275°F).

42. Use suitable gloves in order to install bearing cone (12) on pinion shaft (10).

Note: Do not reset bearing cone (12) at this time. Allow the bearing cone to cool. Refer to steps 43 through 48 for the procedure to set the bearing load.

43. Lubricate bearing cone (12) with clean oil.

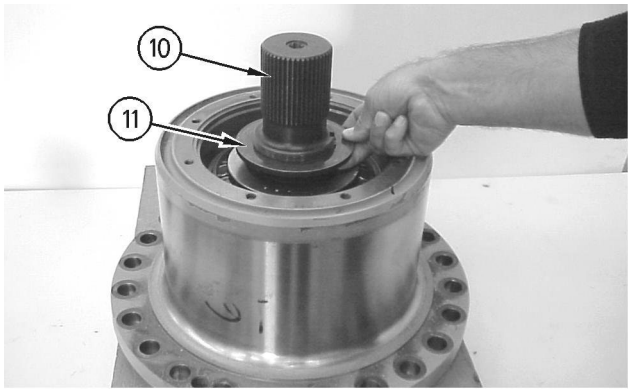


Illustration 910 g00667186

44. Install washer (11) on pinion shaft (10).

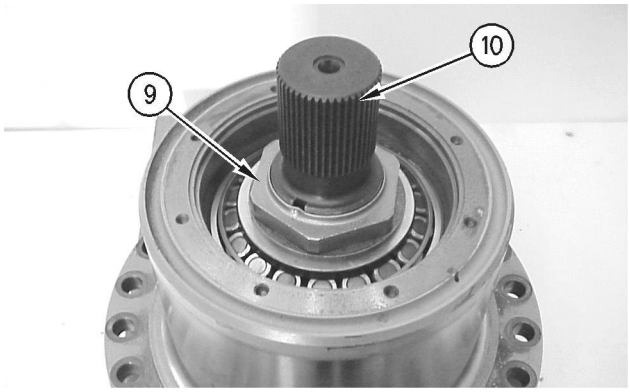


Illustration 911 g00685313

Note: Retaining nut (9) may be reused if the collar was not cracked during removal or during restaking. Otherwise, use a new part for replacement.

45. Install retaining nut (9) on pinion shaft (10).

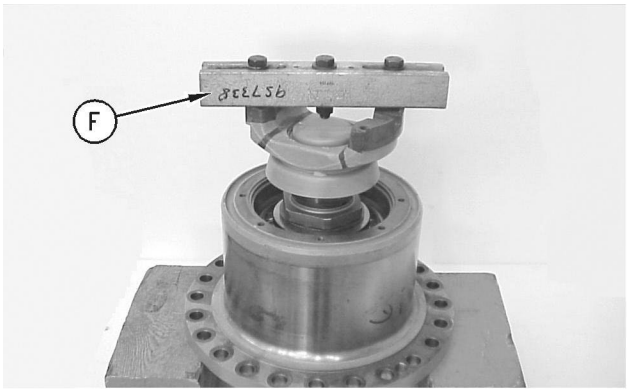


Illustration 912 g00686567

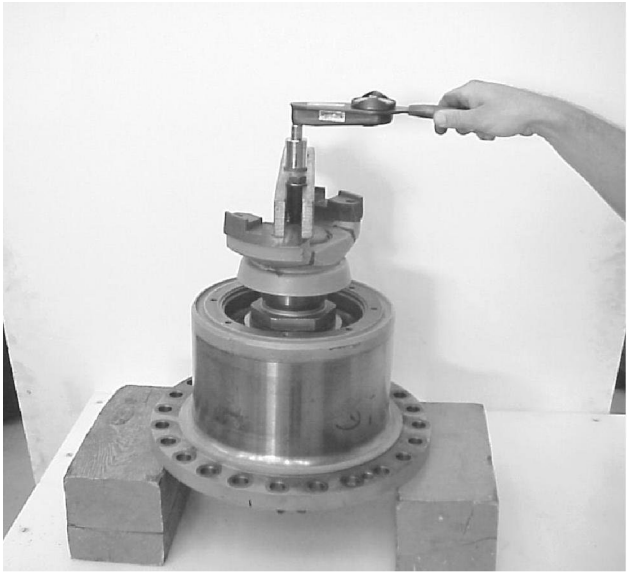


Illustration 913 g00686568

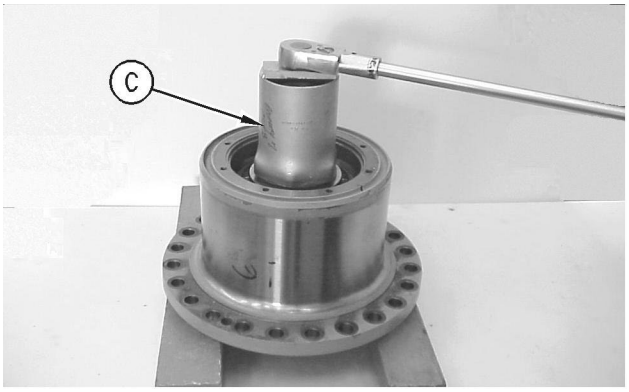


Illustration 914 g00667185

46. Install Tooling (F) in order to the end of the pinion shaft.

47. Use a torque wrench in order to slowly rotate pinion shaft (10). Check the rolling torque. The proper rolling torque is 2.25 N·m to 5.06 N·m (20 lb in to 45 lb in).

Note: Reduce the rolling torque to 1.65 N·m to 4.46 N·m (15 lb in to 39 lb in) for machines with more than 100 hours of operation.

48. Continue to tighten retaining nut (9) until the proper rolling torque is achieved.

Note: If the rolling torque exceeds the specifications, back off the retaining nut by 45 degrees. Reset the bearing in order to relieve the preload. Repeat steps 47 and 48 until the specified preload is achieved.

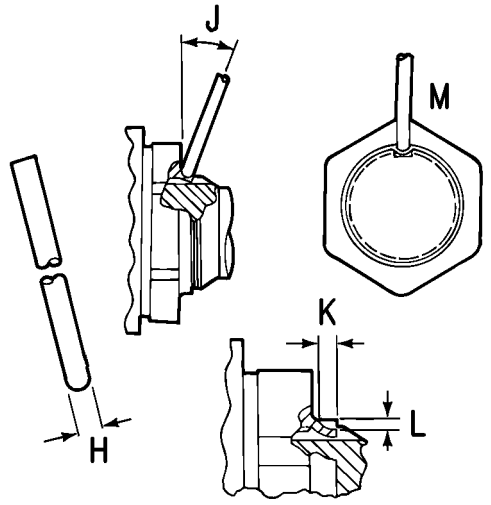


Illustration 915 g00382081

Completed Stake

(H) The spherical radius of the tool for peening must be 7.5 to 8.0 mm (0.295 to 0.315 inch).
(J) The acceptable angle of the tool for peening is 20 ± 10 degrees.
(K) The minimum length of the crimp is 4.7 mm (0.185 inch).
(L) The minimum depth of the crimp is 2.5 mm (0.098 inch).
(M) Top view

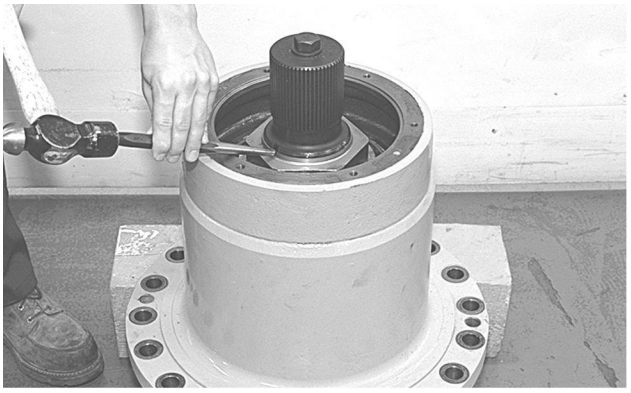


Illustration 916 g00685314

49. Lock retaining nut (9) by peening the collar in the slot on pinion shaft (10).

Note: Before you stake the nut, make sure that the pinion shaft has zero end play.

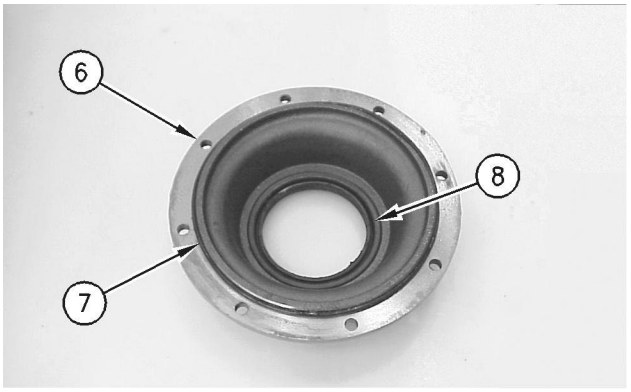


Illustration 917 g00667183

50. Use Tooling (D) in order to install lip seal (8) in retainer (6).

Note: The sealing lip must be facing the inside of retainer (6).

51. Install O-ring seal (7). Lubricate the O-ring seal with clean oil.

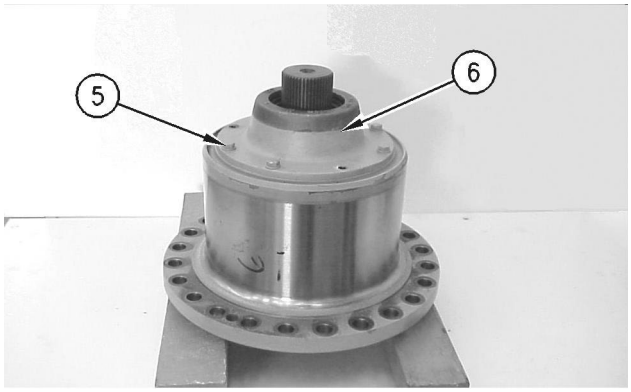


Illustration 918 g00667182

52. Install retainer (6) on the pinion housing.

53. Install bolts (5). The torque for the bolts is 55 ± 10 N·m (40 ± 7 lb ft).

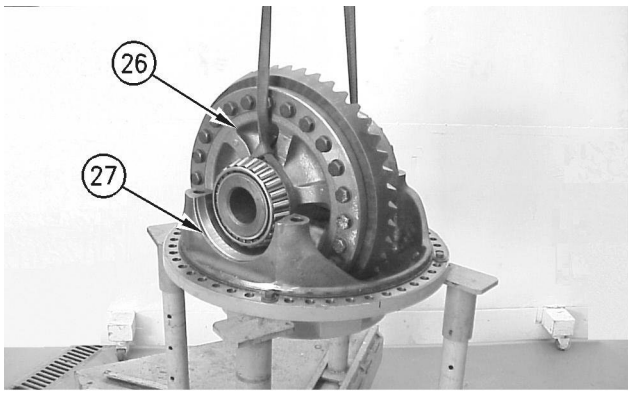


Illustration 919 g00685146

54. Use a suitable lifting device in order to install the differential and bevel gear (26) in carrier (27). The combined weight of the differential and of the bevel gear is 272 kg (600 lb).

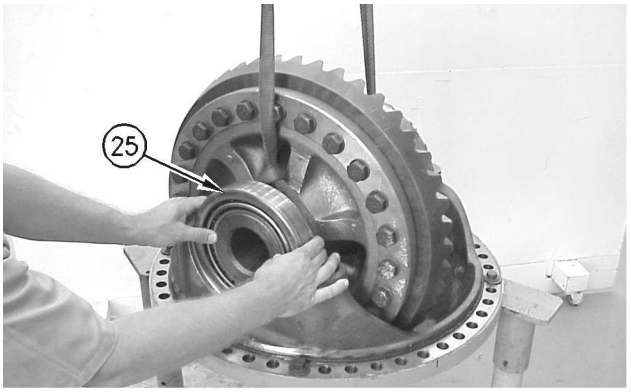


Illustration 920 g00685145

55. Lubricate bearing cup (25) with clean oil. Install bearing cup (25) in the carrier. Repeat this procedure for the opposite side.

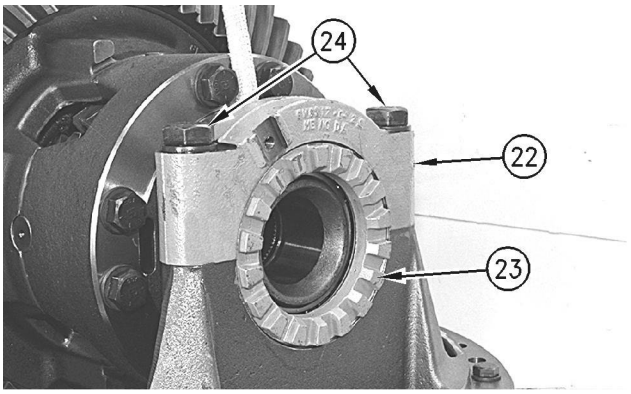


Illustration 921 g00685303

56. Install bearing cap (22) and adjustment nut (23). Make sure that the adjustment nut can turn freely.

57. Install bolts (24) and tighten to a torque of 25 N·m (18 lb ft).

Note: This will allow adjusting nut (23) to move freely.

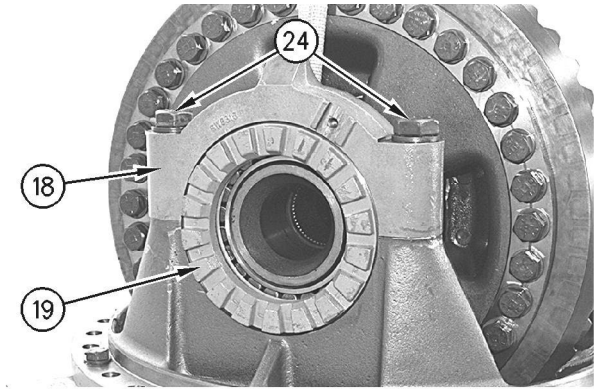


Illustration 922 g00685304

58. Install bearing cap (18) and adjustment nut (19). Make sure that the adjusting nut turns freely.

59. Install bolts (24). Tighten the bolts to a torque of 25 N·m (18 lb ft). This will allow adjusting nut (19) to move freely.

Note: Adjust the bearing preload and the gear backlash after the pinion housing has been installed.

60. Use a suitable lifting device in order to reposition the carrier on Tooling (A). The weight of the carrier and of the differential assembly is 624 kg (1375 lb).

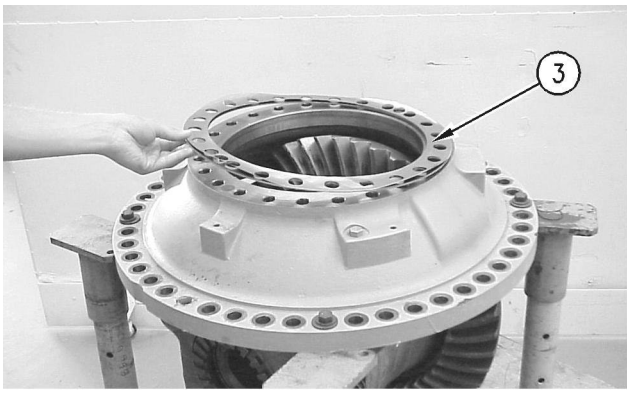


Illustration 923 g00667179

Note: If the pinion housing or the carrier housing are being replaced, install 80 percent of a new shim pack as a starting point for the pinion depth adjustment.

61. Install original shim pack (3) between the carrier and the pinion housing.

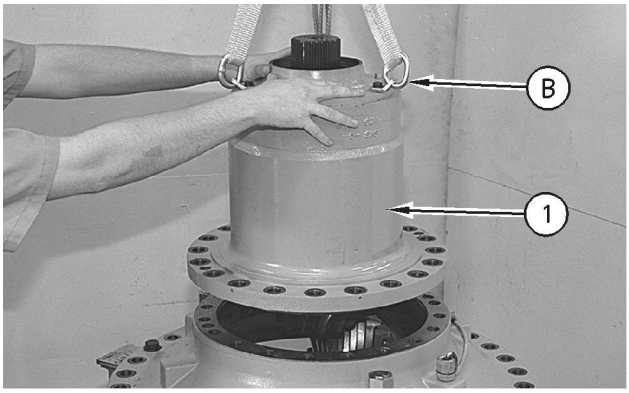


Illustration 924 g00685316

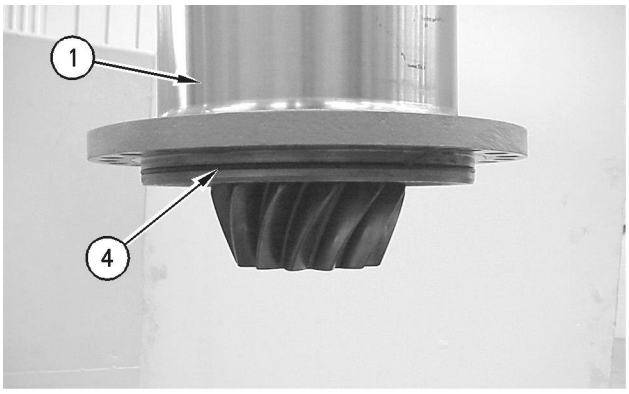


Illustration 925 g00667181

62. Install Tooling (B) to pinion housing (1).

63. Install O-ring seal (4) in the groove of pinion housing (1). Lubricate the O-ring seal with clean oil.

64. Use a suitable lifting device in order to install pinion housing (6) on the carrier, as shown. The weight of pinion housing (1) is 170 kg (375 lb).

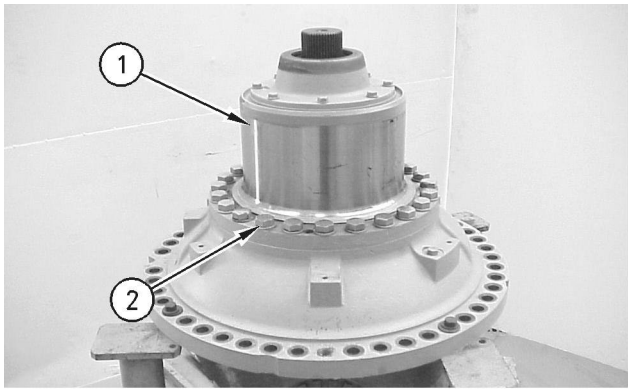


Illustration 926 g00667174

65. Make sure that backlash is present before you secure pinion housing (1) to the carrier. Install bolts (2). The torque for the bolts is 750 ± 80 N·m (550 ± 60 lb ft).

Note: Steps 66 through 77 are for setting the backlash and the pinion depth.

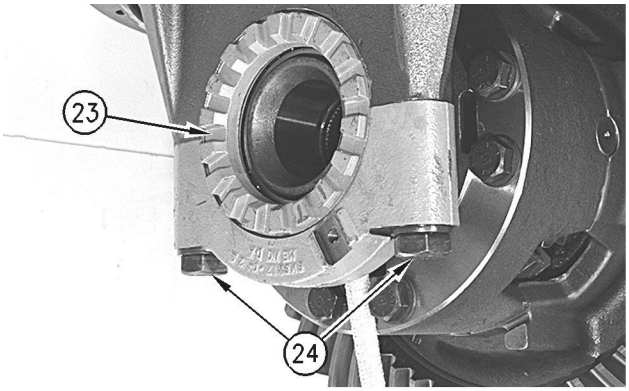


Illustration 927 g00685318

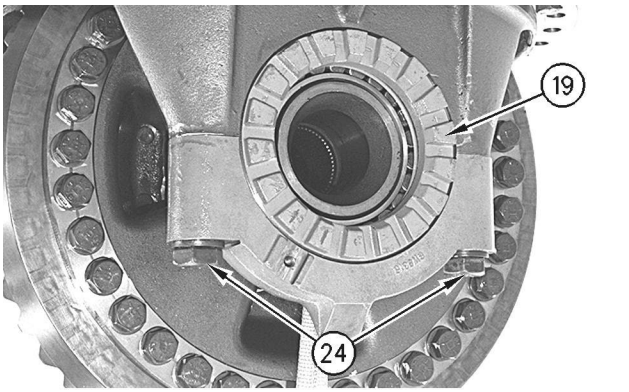


Illustration 928 g00685319

66. Move adjustment nuts (19) and (23) on the carrier to a position that maintains gear backlash and slight bearing end play.

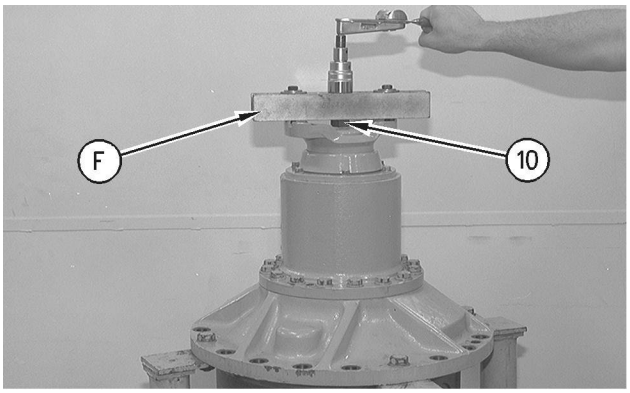


Illustration 929 g00686436

67. Install Tooling (F) on the yoke assembly, as shown. Use a torque wrench in order to slowly turn pinion shaft (10). Check the overall rolling torque with no load on the carrier bearings. Record the measured torque.

68. Oscillate the bevel gear and advance adjustment nut (19). Continue to advance the adjustment nut until there is no backlash. Back off the adjustment nut by 1/2 turn.

69. Advance nut (23) and check the rolling torque on pinion shaft (10). Continue to advance adjustment nut (23) until a torque is registered over the torque that was measured in Step 67. This is the seated position.

70. Advance the adjusting nut (23) while rotating the bevel gear set until the overall rolling torque is 4 N·m to 15 N·m (30 lb in to 130 lb in).

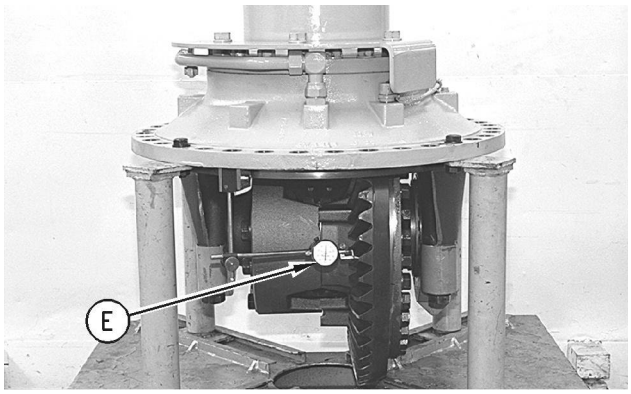


Illustration 930 g00383278
Typical Example

71. Mount Tooling (E) on the carrier, as shown. Measure the backlash at three equally spaced positions around the bevel gear. The backlash must be 0.40 ± 0.12 mm (0.016 ± 0.005 inch).

72. If the backlash does not meet the specification at any one of the three positions, back off one adjusting nut and move the other adjusting nut forward by the same amount. This will maintain the bearing preload.

73. Use a torque wrench and Tooling (F) in order to measure the overall rolling torque at the pinion shaft. The rolling torque must be 4 N·m to 15 N·m (30 lb in to 130 lb in).

74. When proper backlash is obtained, tighten bearing cap bolts (29) and (31) to a torque of 1800 ± 200 N·m (1330 ± 150 lb ft).

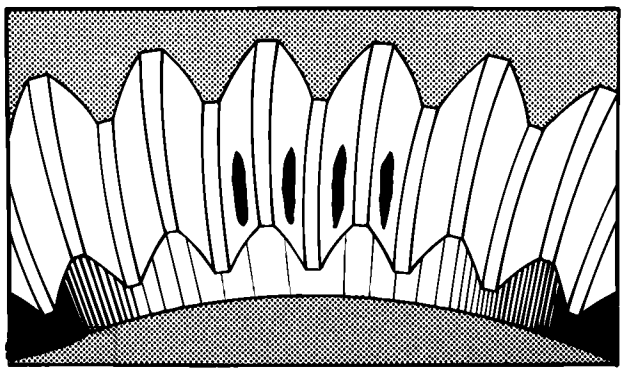


Illustration 931 g00315875

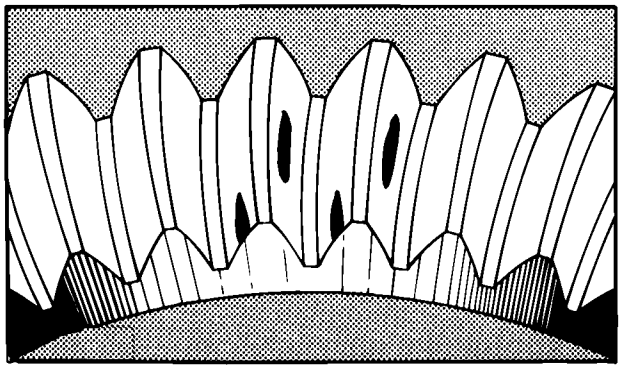


Illustration 932 g00315877

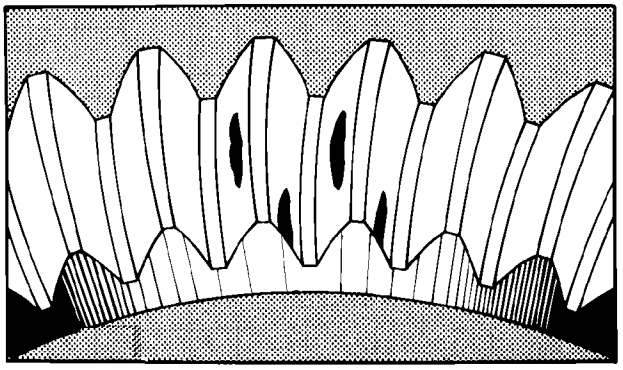


Illustration 933 g00315878

75. After the backlash adjustment and the preload adjustment have been made, the tooth contact between the pinion shaft and the ring gear must be checked. Use the following procedure:

a. Put a small amount of Prussian blue, red lead or paint on the teeth of the ring gear.

b. Rotate the pinion in both directions.

c. The correct area of tooth contact starts near the inside end of the teeth. The contact area should extend to a maximum of 50 percent of the length of the teeth. See Illustration 931 for the correct area of tooth contact.

76. If the area of tooth contact looks like Illustration 932 , use the following procedure:

a. Remove some of shims (8) under the pinion housing.

b. Perform Steps 71 through 74 again.

c. Perform Step 75 again in order to check the area of tooth contact.

77. If the area of tooth contact looks like Illustration 933 , use the following procedure:

a. Add some shims (8) under the pinion housing.

b. Perform Steps 71 through 74 again.

c. Perform Step 75 again in order to check the area of the tooth contact.

Note: Make sure that the backlash adjustment is correct before you adjust the area of the tooth contact. Several adjustments of the backlash and of the tooth contact may be necessary in order to achieve the correct adjustments.

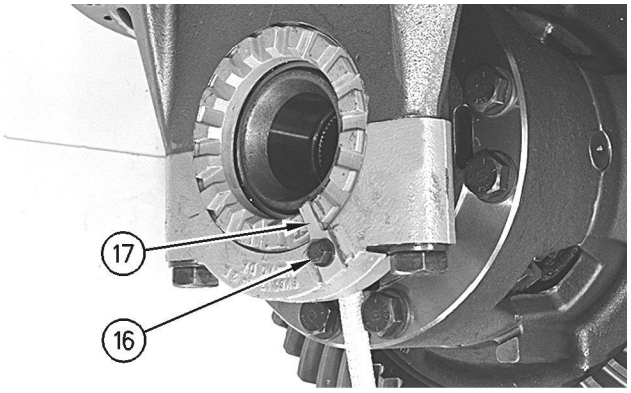


Illustration 934 g00685321

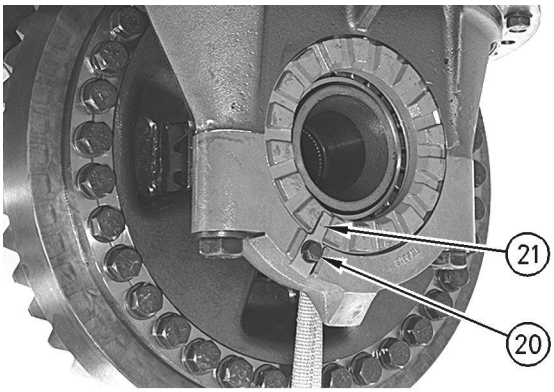


Illustration 935 g00685322

78. Install locks (17) and (21). Secure the locks to the bearing caps with bolts (16) and (20). The torque for bolts (16) is 105 ± 15 N·m (78 ± 11 lb ft).

End By:

a. Install the differential and bevel gear. Refer to Disassembly and Assembly, “Differential and Bevel Gear (Front) - Install” or Disassembly and Assembly, “Differential and Bevel Gear (Rear) - Install” for the machine that is being serviced.

i02502663

Differential and Bevel Gear (Rear) - Install

SMCS Code: 3258-012-RE

Installation Procedure

Table 59

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	**4C-6486**	**Stand**	**2**
	8S-7615	**Pin**	**2**
	8S-8048	**Saddle**	**2**
	8S-7611	**Tube**	**2**
B	138-7576	Link Bracket	3
C	1U-7234	Feeler Gauge	1
D	1U-6396	O-Ring Assembly Compound	1

1. Thoroughly clean the mating surfaces of the differential and bevel gear and of the axle housing. Replace O-ring seals with new parts.

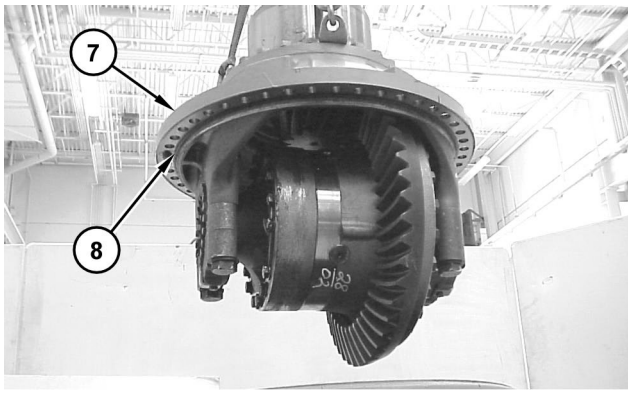


Illustration 936 g01252047
Typical Example

2. Apply Tooling (D) on O-ring seal (8). Install O-ring seal (8) on differential and bevel gear (7).

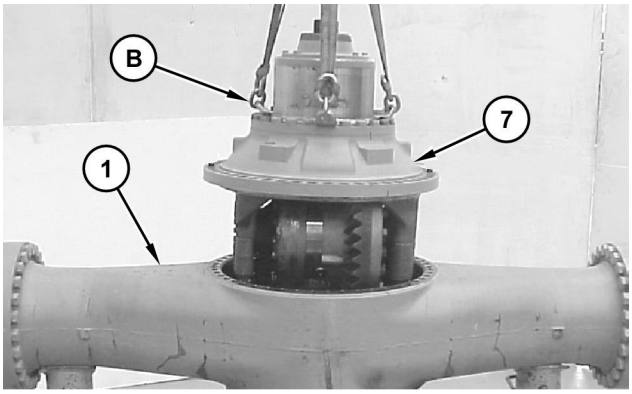


Illustration 937 g01252078
Typical Example

3. Use Tooling (B) and a suitable lifting device in order to install differential and bevel gear (7) in axle assembly (1). The weight of differential and bevel gear (7) is approximately 842 kg (1856 lb).

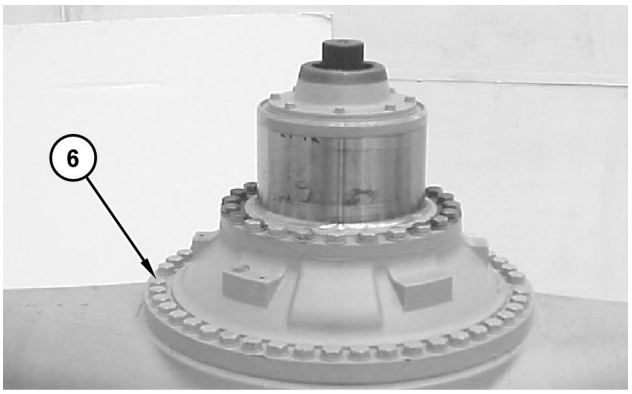


Illustration 938 g01252037

4. Remove Tooling (B).

5. Install bolts (6). The torque for bolts (6) is 750 ± 80 N·m (550 ± 60 lb ft).

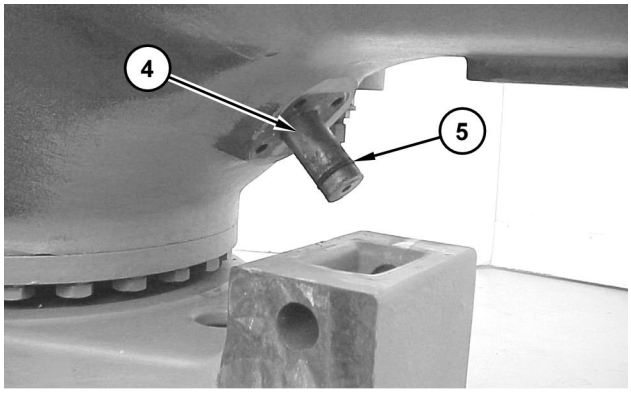


Illustration 939 g01252032

6. Install O-ring seal (5) on pin (4).

7. Lubricate pin (4) and O-ring seal (5) with oil.

8. Install pin (4) in the axle housing.

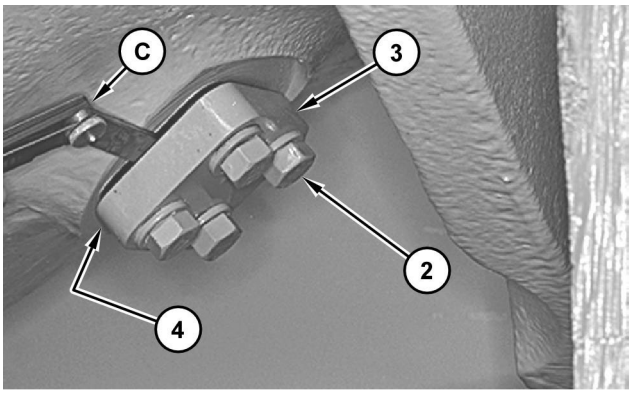


Illustration 940 g01252085

9. Install cover (3) without shims.

10. Install bolts (2). Tighten bolts (2) enough to remove the end play between pin (4) and cover (3).

11. Use Tooling (C) in order to measure the gap between the cover and the axle housing. Record this measurement. Use this measurement in order to determine the correct thickness of required shims.

12. Install a thickness of shims that will establish a −0.03 mm (−0.001 inch) preload to a 0.03 mm (0.001 inch) end play in pin (4).

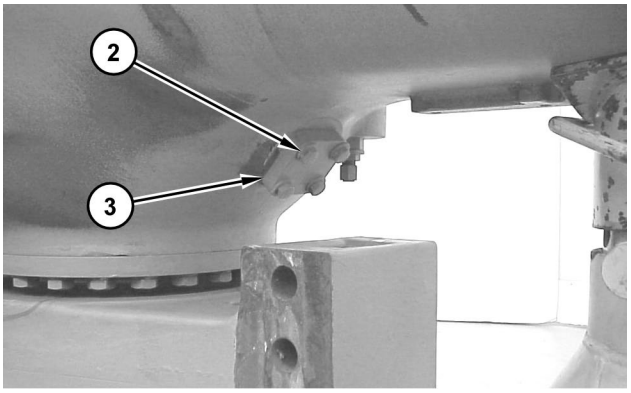


Illustration 941 g01252030

13. Install cover (3) with the measured amount of shims.

14. Install bolts (2). The torque for bolts (2) is 105 ± 20 N·m (78 ± 15 lb ft).

End By:

a. Install the front trunnion support of the rear axle. Refer to Disassembly and Assembly, “Trunnion Support (Oscillating Axle, Front) - Install”.

b. Install the axle shafts. Refer to Disassembly and Assembly, “Axle Shaft - Install”.

c. Install the rear axle. Refer to Disassembly and Assembly, “Oscillating Axle (Rear) - Install”.

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RENR8808-01 (en-us)
November 2020

Disassembly and Assembly

844H Wheel Dozer and , 990H Wheel Loader
Engine Supplement

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

NOTICE

When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

Disassembly and Assembly Section

i02468992

Steering Frame Lock - Separate and Connect

SMCS Code: 7506-029

Connection Procedure

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine. Secure clevis pin with locking pin.

Before operating the machine, fasten the steering frame lock link into the stored position and secure the clevis pin with locking pin.

Failure to lock into the stored position before operating can result in loss of steering.

1. Move the machine to a hard, level surface. Park the machine in the straight ahead position and engage the parking brake.

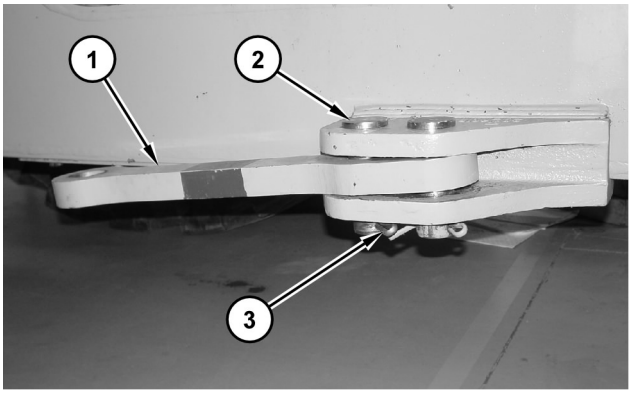


Illustration 1 g01231240

2. Remove cotter pin (3) from pin (2).

3. Remove pin (2) from the rear frame.

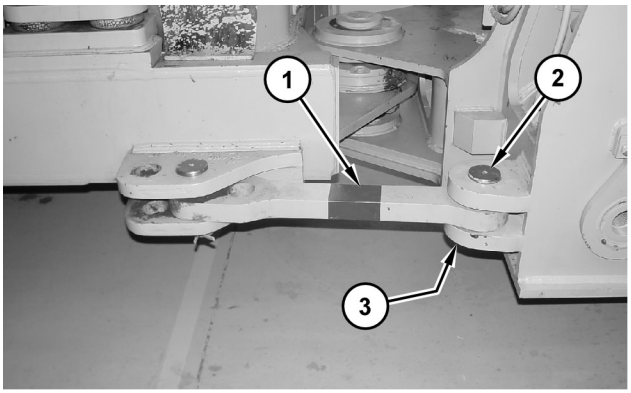


Illustration 2 g01231236

4. Move steering frame lock (1) in position to the front frame. Install pin (2) and cotter pin (3).

Note: In order to align the pin bores, steer the machine left or steer the machine right.

Separation Procedure

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine. Secure clevis pin with locking pin.

Before operating the machine, fasten the steering frame lock link into the stored position and secure the clevis pin with locking pin.

Failure to lock into the stored position before operating can result in loss of steering.

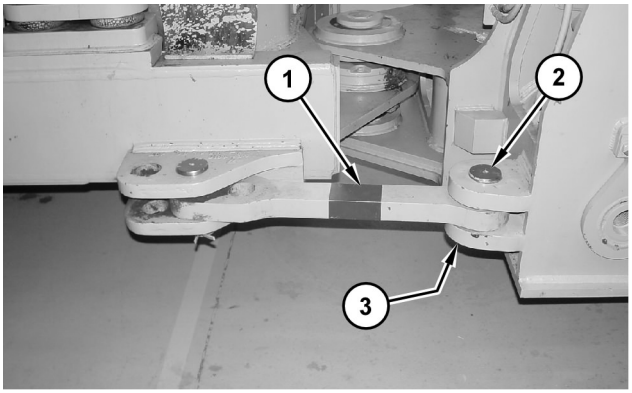


Illustration 3 g01231236

1. Remove cotter pin (3) and pin (2).

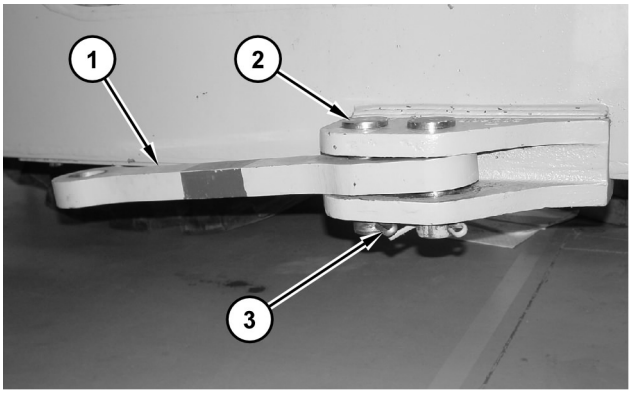


Illustration 4 g01231240

2. Move steering frame lock (1) to the storage position.

3. Install pin (2) and cotter pin (3).

i04166051

System Pressure - Release

SMCS Code: 4250-553-PX; 4300-553-PX; 5050-553-PX

Release Procedure (Implement System)

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

1. If the machine is equipped with a ride control system, move the ride control switch to the ON position.

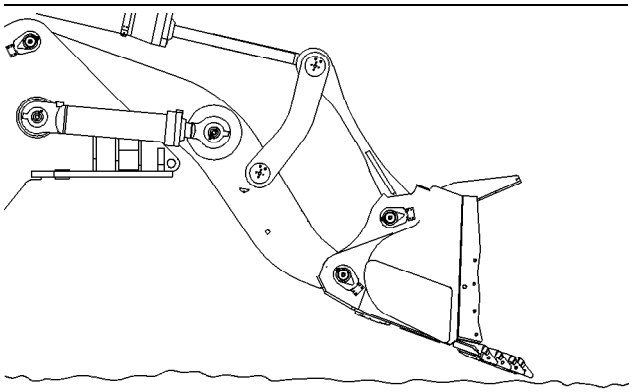


Illustration 5 g02009358

2. Position the bucket or the work tool just above the ground at a slight downward angle in order to ensure that the head end of the lift cylinders is pressurized.

3. Turn the engine start switch to the OFF position.

4. When the engine has stopped, turn the engine start switch back to the ON position so the pilot oil can reach the main valve.

5. Move the implement lockout switch to the UNLOCKED position.

6. Move the lift control lever to the FLOAT position and the tilt control lever to the TILT BACK position at the same time. This action allows the bucket or the work tool to tilt back while the boom is lowered.

The bottom of the bucket or the work tool should rest flat on the ground and the weight of the linkage should be supported by the ground. The pressure from the head end of the lift cylinders and from the ride control accumulator is now vented to the hydraulic tank.

7. When the bucket or the work tool has settled to the ground, move both control levers to the HOLD position. Then, cycle the control levers through all positions in order to purge any remaining pressure from the implement hydraulic system.

8. Turn the engine start switch to the OFF position.

9. Slowly loosen the hydraulic tank filler cap in order to release the pressure from the hydraulic tank.

10. After all of the pressure has been released, tighten the hydraulic tank filler cap. The hydraulic system pressure has now been released. Hydraulic lines and components can now be removed.

Release Procedure (Steering System and Braking System)

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

Note: Make sure that the parking brake is engaged.

1. Straighten the machine and install the steering link.

2. Lower the bucket to the ground and stop the engine.

3. Move the STIC steering and transmission lock control to the LOCKED position.

4. In order to release the pressure from steering cylinders, the machine must not be operated for a minimum of 1 hour. This will allow sufficient time for the pressure in the steering system to dissipate.

5. Depress the brake pedal repeatedly in order to release any pressure in the braking system.

6. Slowly loosen the hydraulic tank filler cap in order to release the pressure from the hydraulic tank.

7. After all of the pressure has been released, tighten the hydraulic tank filler cap. The hydraulic system pressure has now been released. Hydraulic lines and components can now be removed.

Dead Electronics

1. If the electronics fail, it may not be possible to relieve all stored hydraulic oil pressure. The following precautions should be taken.

2. Turn the engine OFF.

3. The machine should be secured with a lockout.

4. Use the appropriate stand or blocks to prevent undesired drift of implements.

5. Barriers should be used in order to prevent personnel from entering areas that implement drift or movement could be hazardous.

6. To lower lift arms and the ripper onto the ground or onto the appropriate supports, open the 112-1817 Manual Valve Gp.

7. Do not open or disassemble any hydraulic circuits until the electronic controls are required to relieve stored hydraulic pressure.

i02504167

Hood Panels (Front and Rear) - Remove

SMCS Code: 7251-011-VP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	4
B	140-7742	Sleeve	2

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

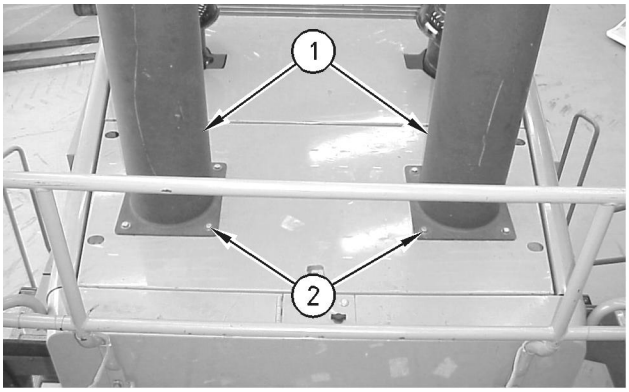


Illustration 6 g00839858

1. Remove bolts (2). Remove exhaust stacks (1).

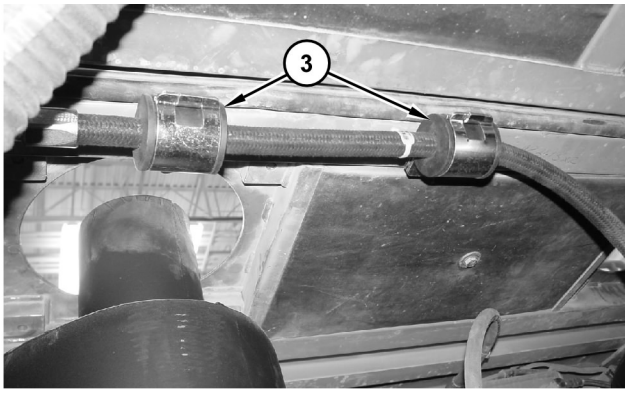


Illustration 7 g01231540

2. Remove clamps (3).

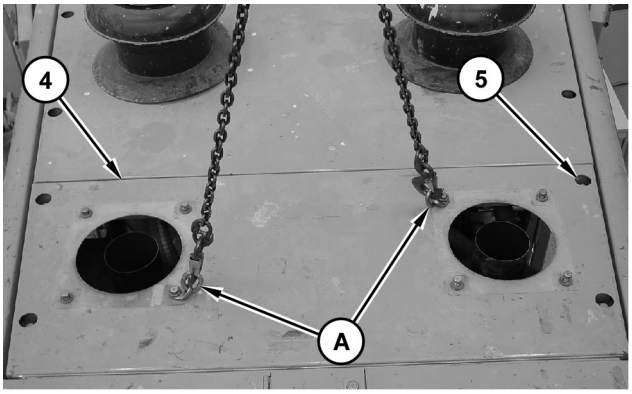


Illustration 8 g01231541

3. Install Tooling (A) onto hood panel (4). Remove bolts (5) and remove hood panel (4). The weight of hood panel (4) is approximately 54 kg (120 lb).

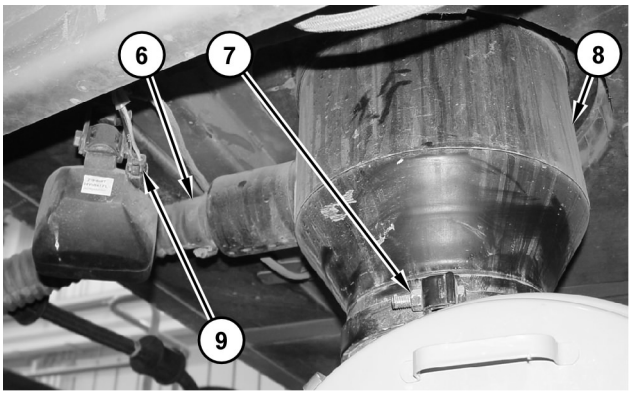


Illustration 9 g01231543

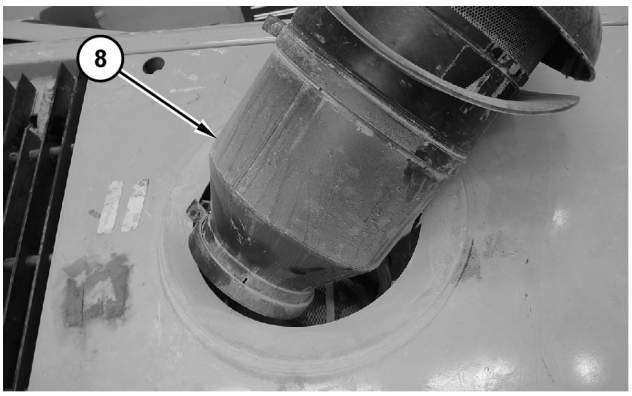


Illustration 10 g01231581

4. Disconnect hose (6). Loosen clamp (7) from precleaner (8). Disconnect harness assembly (9) from the lights and the hood. Remove precleaner (8).

5. Repeat Step 4 for the remaining precleaner.

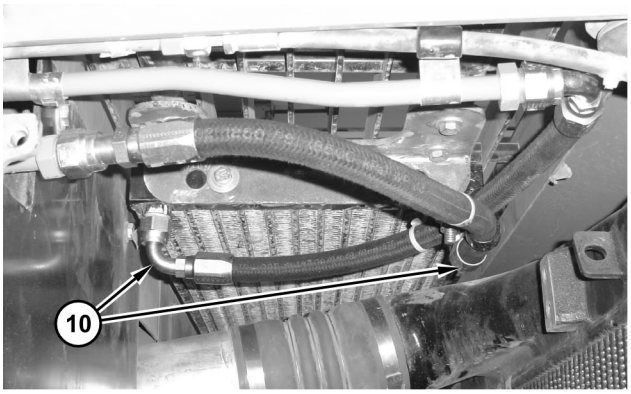


Illustration 11 g01231545

6. Disconnect hose assemblies (10).

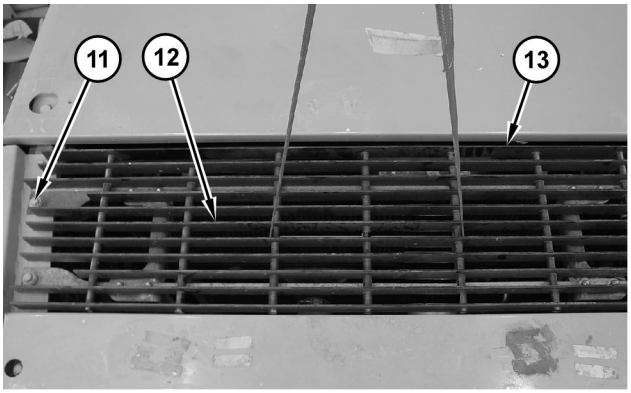


Illustration 12 g01231600

7. Remove bolts (11). Attach a suitable lifting device in order to remove grate (12) and fuel cooler (13) together. The weight of grate (12) and fuel cooler (13) is approximately 61 kg (135 lb).

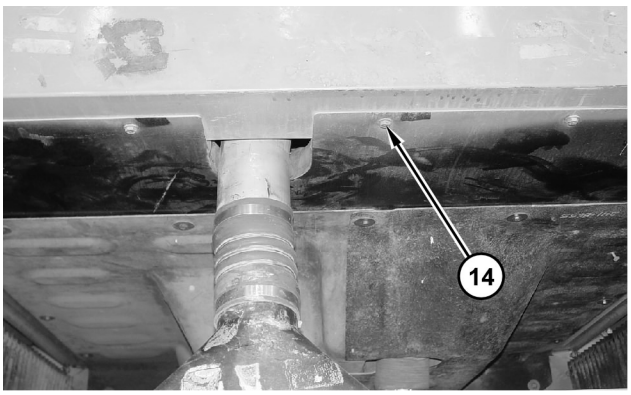


Illustration 13 g01231605

8. Remove bolts (14).

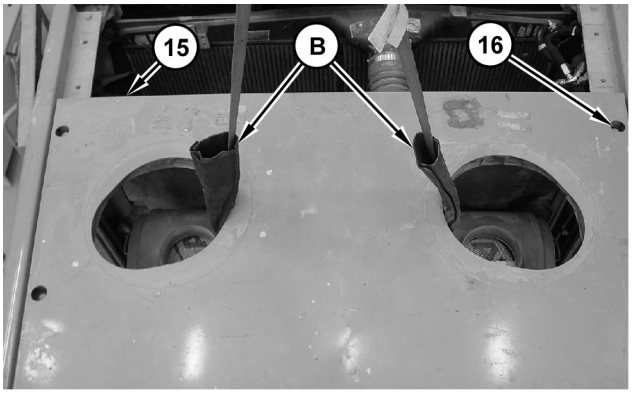


Illustration 14 g01231626

9. Attach Tooling (B) and a suitable lifting device to panel assembly (15). Remove bolts (16). Remove panel assembly (15). The weight of panel assembly (15) is approximately 64 kg (140 lb).

i02504213

Hood Panels (Front and Rear) - Install

SMCS Code: 7251-012-VP

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138 - 7575	Link Bracket	4
B	140 - 7742	Sleeve	2

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

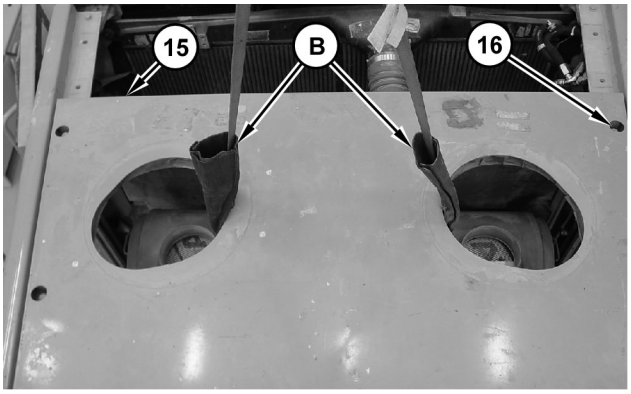


Illustration 15 g01231626

1. Attach Tooling (B) and a suitable lifting device to panel assembly (15). Install panel assembly (15). The weight of panel assembly (15) is approximately 64 kg (140 lb). Install bolts (16).

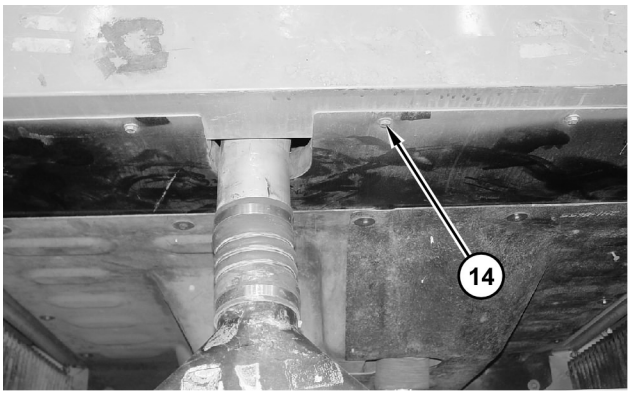


Illustration 16 g01231605

2. Install bolts (14).

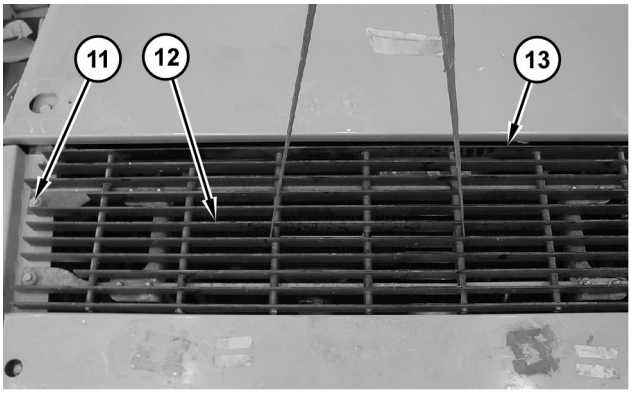


Illustration 17 g01231600

3. Attach a suitable lifting device in order to install grate (12) and fuel cooler (13) together. The weight of grate (12) and fuel cooler (13) is approximately 61 kg (135 lb). Install bolts (11).

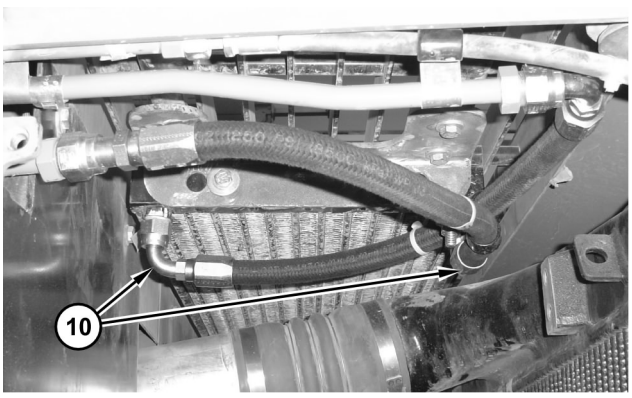


Illustration 18 g01231545

4. Connect hose assemblies (10).

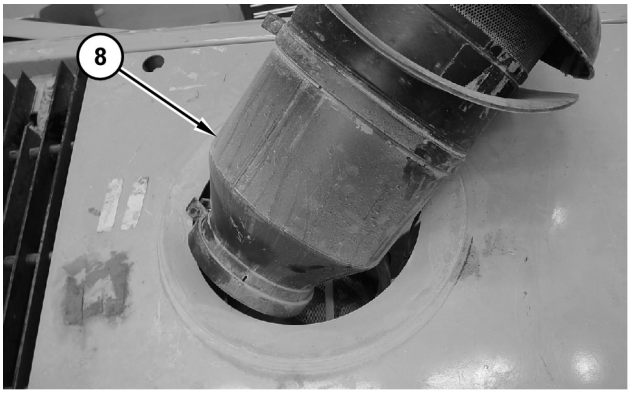


Illustration 19 g01231581

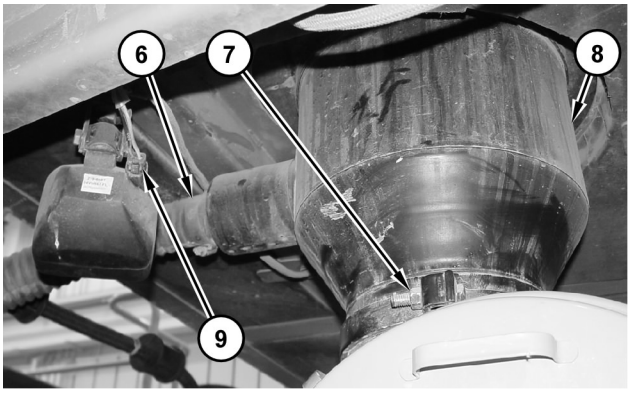


Illustration 20 g01231543

5. Install precleaner (8). Connect harness assembly (9) to the lights and the hood. Tighten clamp (7) onto precleaner (8). Connect hose (6).

6. Repeat Step5 for the remaining precleaner.

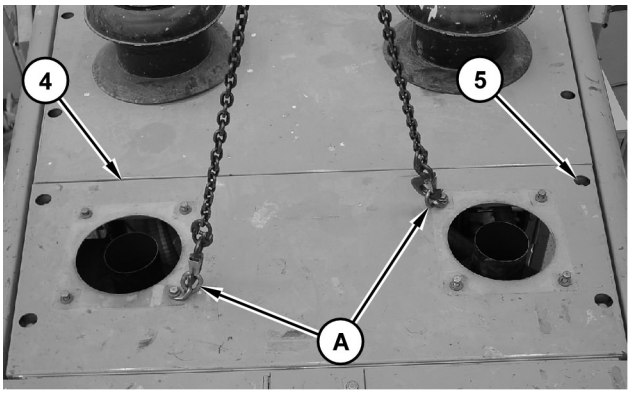


Illustration 21 g01231541

7. Install Tooling (A) onto hood panel (4). Install hood panel (4). The weight of hood panel (4) is approximately 54 kg (120 lb). Install bolts (5).

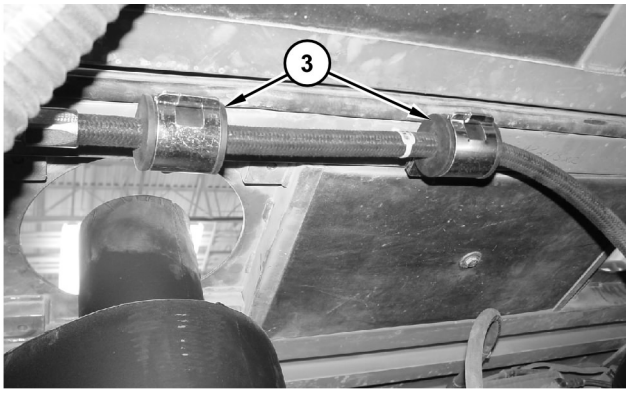


Illustration 22 g01231540

8. Install clamps (3).

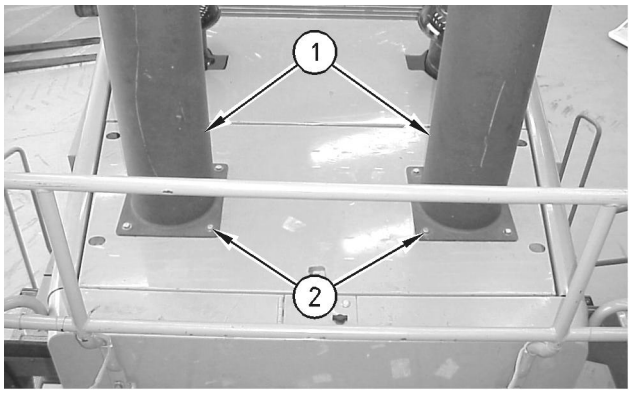


Illustration 23 g00839858

9. Install exhaust stacks (1). Install bolts (2).

i02504209

Hood Side Panels and Side Doors - Remove

SMCS Code: 7251-011-RY; 7267-011-SI

Removal Procedure

Table 3

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	4

Start By:

a. Remove the front and rear hood panels. Refer to Disassembly and Assembly, "Hood Panels (Front and Rear) - Remove".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

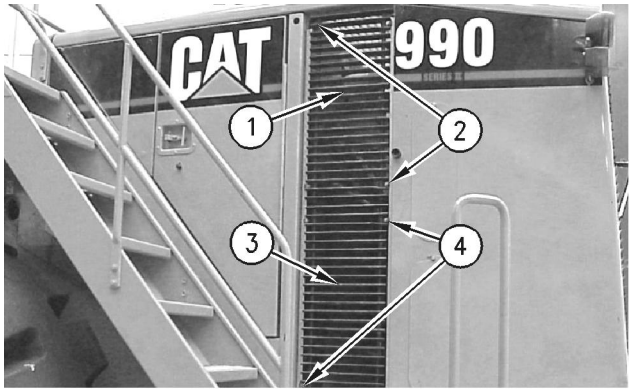


Illustration 24 g00840392

1. Remove bolts (2) and upper grill assembly (1).

2. Remove bolts (4) and lower grill assembly (3).

3. Repeat Steps 1 and 2 for the opposite side.

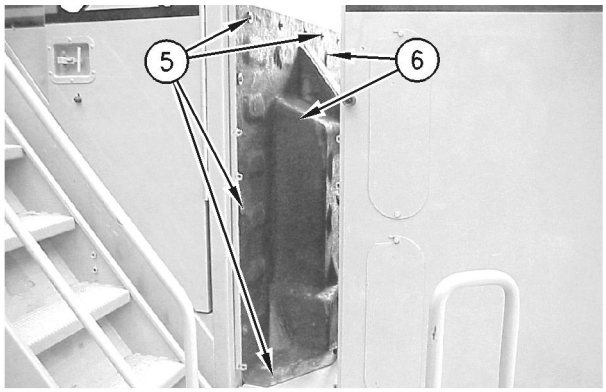


Illustration 25 g00840410

4. Remove bolts (5).

5. Remove baffles (6).

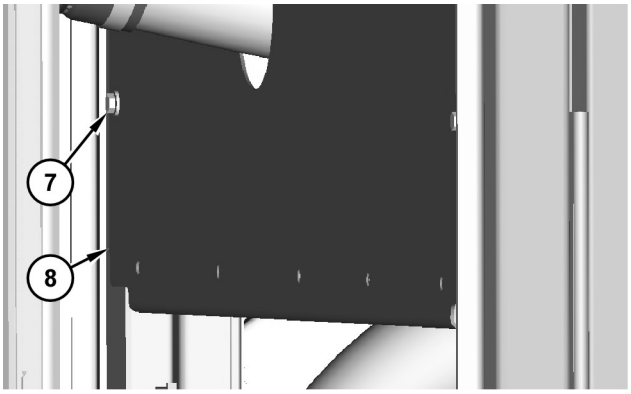


Illustration 26 g01247075

6. Remove bolts (7). Use two people in order to remove panel (8). The weight of panel (8) is approximately 27 kg (60 lb).

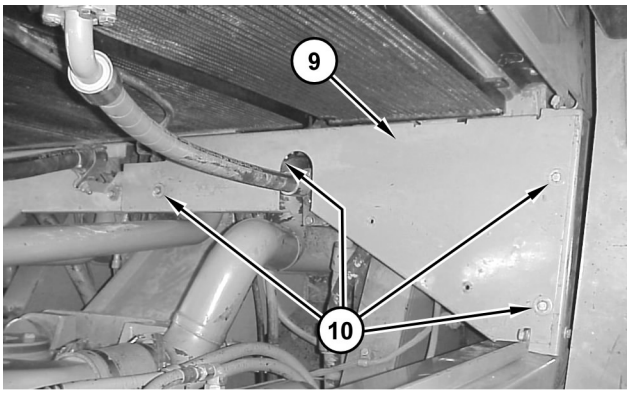


Illustration 27 g01247082

7. Remove bolts (10) and floor panel (9). Repeat this procedure for the opposite side.

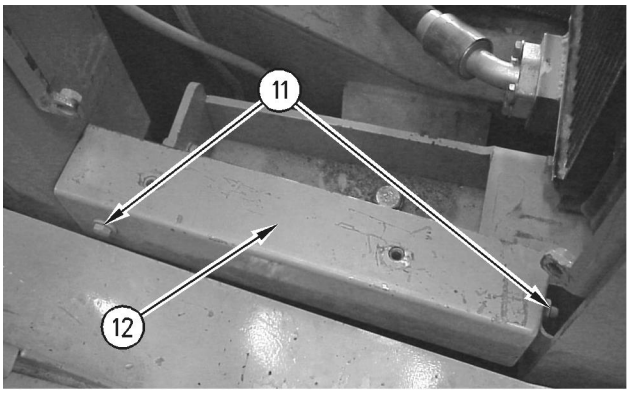


Illustration 28 g00840483

8. Remove bolts (11) and panel (12). Repeat this procedure for the opposite side.

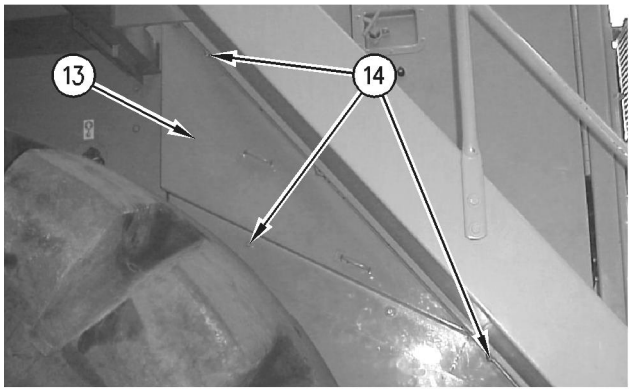


Illustration 29 g00840524

9. Remove bolts (14).

10. Use two people in order to remove panel (13). The weight of panel (13) is approximately 27 kg (60 lb).

11. Repeat Steps 9 and 10 for the opposite side.

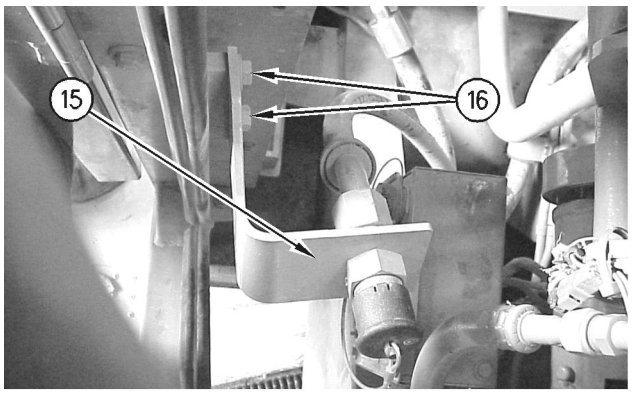


Illustration 30 g00840770

Right side panel

12. Remove bolts (16).

13. Position high speed oil change arrangement (15) out of the way.

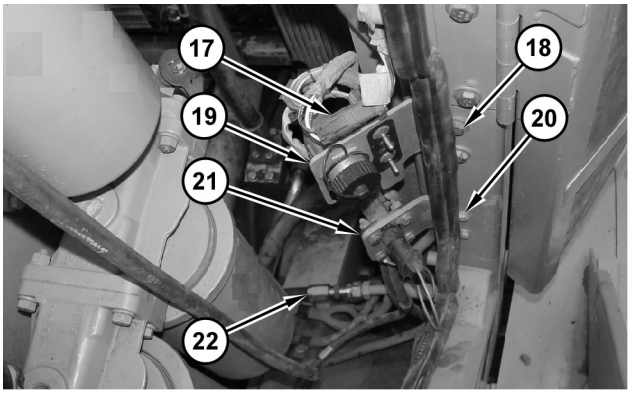


Illustration 31 g01239831

14. Disconnect harness assembly (17). Remove bolts (18) and position switch panel (19) out of the way.

15. Remove bolts (20) and the clips from the side panel in order to position receptacle (21) out of the way.

16. Disconnect hose assembly (22).



Illustration 32 g01239910

Right side panel

17. Disconnect tube assembly (23).

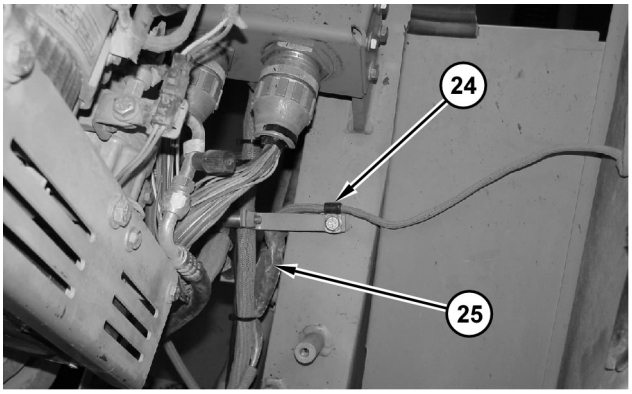


Illustration 33 g01239850

18. Remove clip (24). Disconnect harness assembly (25).

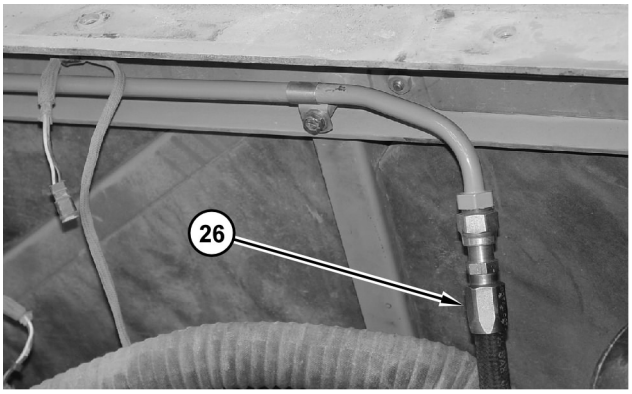


Illustration 34 g01239857

19. Disconnect hose assembly (26).

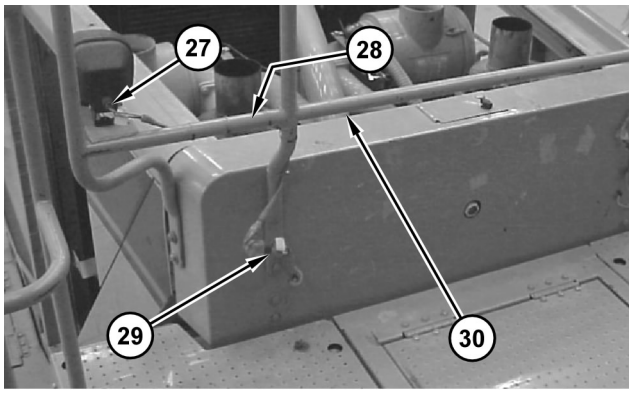


Illustration 35 g01241110

20. Disconnect harness assembly (27). Remove clip (28). Repeat the procedure for the opposite side.

21. Remove bolts (29).

22. Use a suitable lifting device in order to remove handhold (30). The weight of handhold (30) is approximately 34 kg (75 lb).

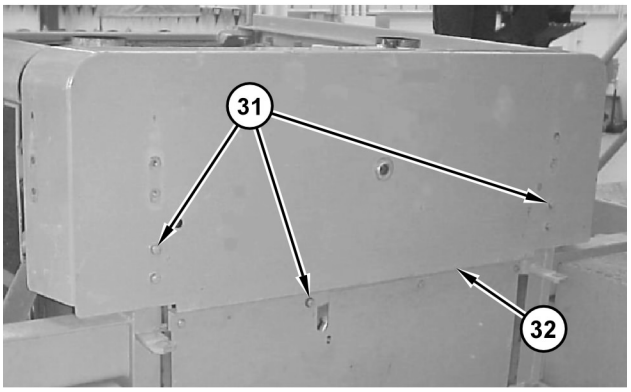


Illustration 36 g01241106

Note: Floor panels have been removed for photographic purposes.

23. Remove bolts (31).

24. Use two people in order to remove panel assembly (32). The weight of panel assembly (32) is approximately 27 kg (60 lb).

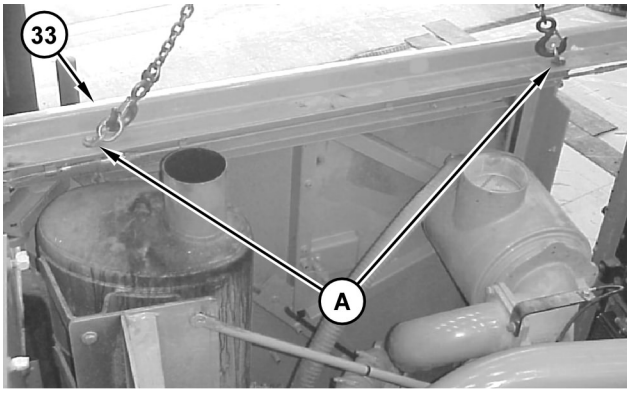


Illustration 37 g01239894

25. Attach Tooling (A) and a suitable lifting device onto side panel (33), as shown. The weight of side panel (33) is approximately 163 kg (360 lb).

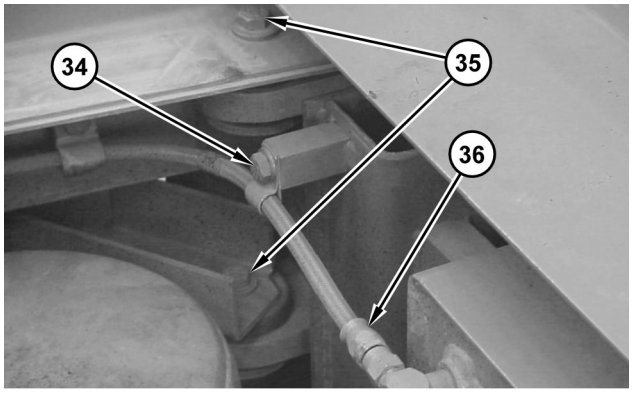


Illustration 38 g01239889

26. Remove clip (34) and disconnect hose assembly (36).

27. Remove bolts (35).

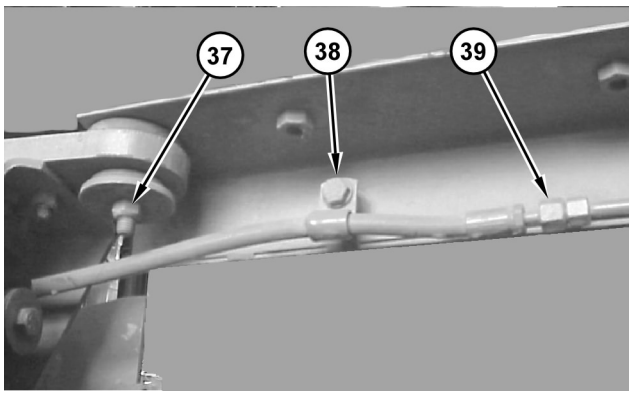


Illustration 39 g01239886

28. Remove bolt (37) and clip (38).

29. Disconnect hose assembly (39).

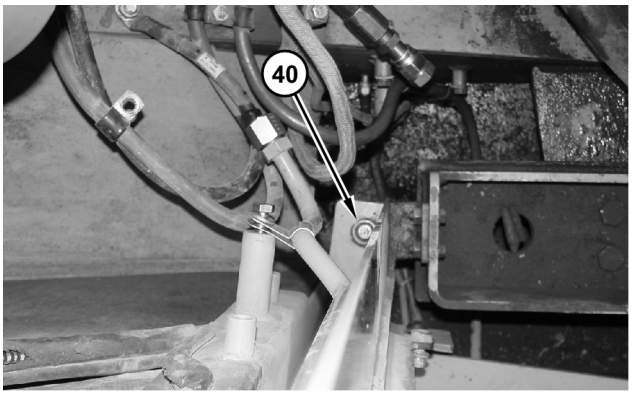


Illustration 40 g01239867

30. Remove bolt (40) from the bottom of the side panel.



Illustration 41 g01239881

31. Remove side panel (33).

32. Repeat Steps 25 through 31 for the opposite side.

i02504211

Hood Side Panels and Side Doors - Install

SMCS Code: 7251-012-RY; 7267-012-SI

Installation Procedure

Table 4

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 42 g01239881

1. Use Tooling (A) and a suitable lifting device in order to position side panel (33), as shown. The weight of side panel (33) is approximately 250 kg (550 lb).

2. Install side panel (33).

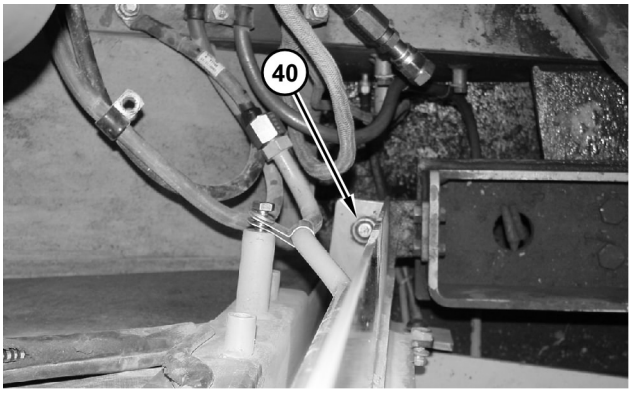


Illustration 43 g01239867

3. install bolt (40) onto the bottom of the side panel.

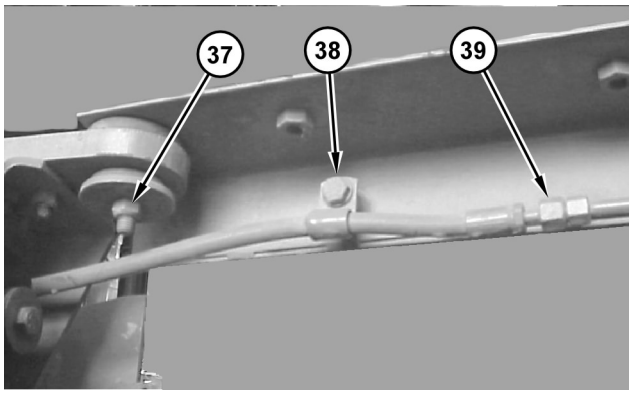


Illustration 44 g01239886

4. Connect hose assembly (39).

5. Install clip (38) and install bolt (37).

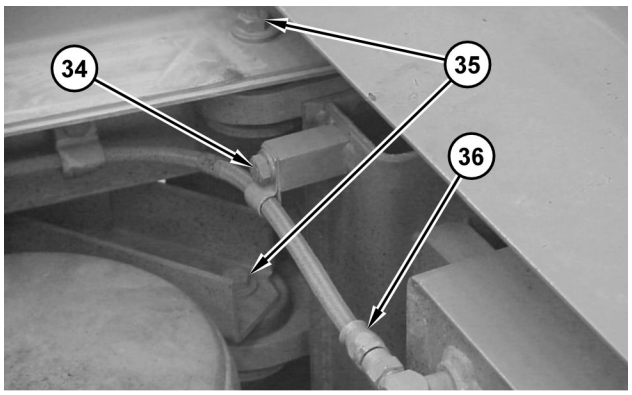


Illustration 45 g01239889

6. Install bolts (35).

7. Connect hose assembly (36). Install clip (34).

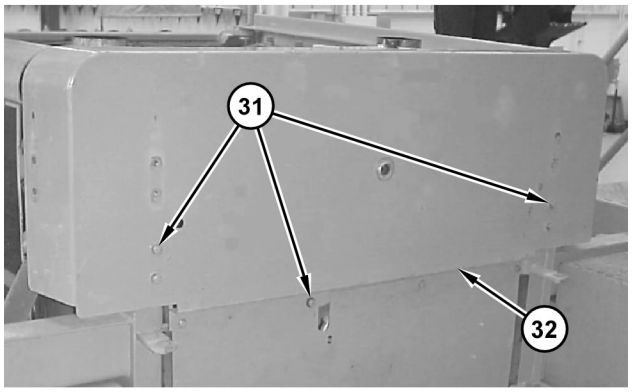


Illustration 46 g01241106

8. Use two people in order to position panel assembly (32). The weight of panel assembly (32) is approximately 27 kg (60 lb).

Note: Floor panels have been removed for photographic purposes.

9. Install bolts (31).

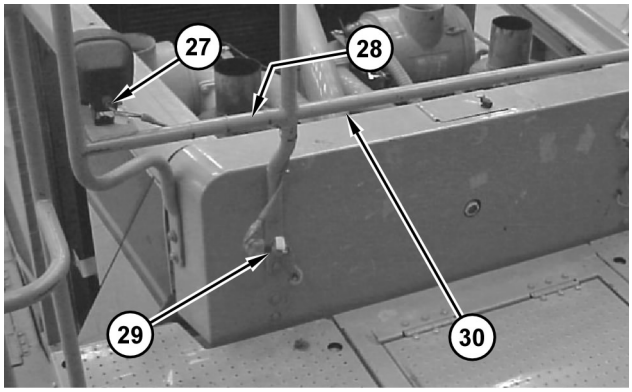


Illustration 47 g01241110

10. Use a suitable lifting device in order to position handhold (30). The weight of handhold (30) is approximately 34 kg (75 lb).

11. Install bolts (29).

12. Connect harness assembly (27). Install clip (28). Repeat the procedure for the opposite side.

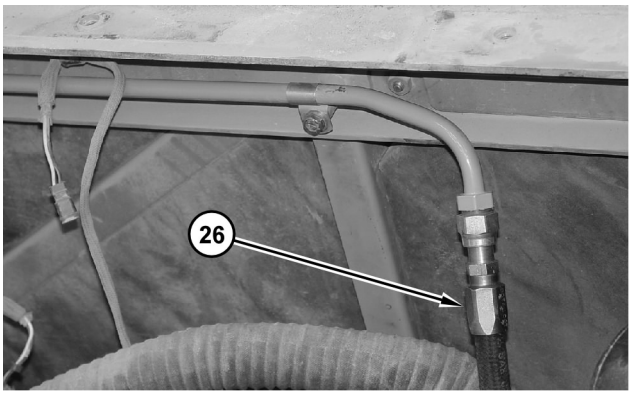


Illustration 48 g01239857

13. Connect hose assembly (26).

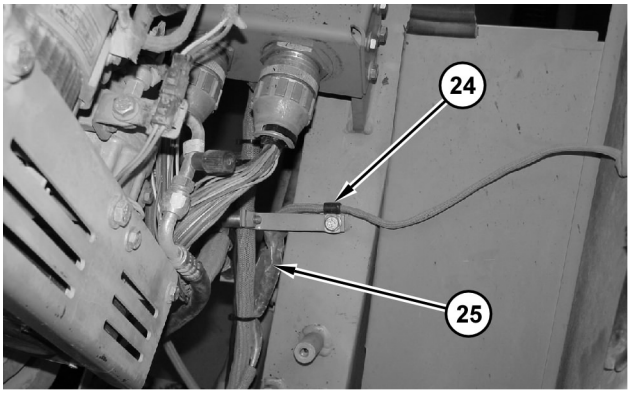


Illustration 49 g01239850

14. Connect harness assembly (25). Install clip (24).

15. Repeat Steps 1 through 25 for the remaining side panel.



Illustration 50 g01239910

Right side panel

16. Connect tube assembly (23).

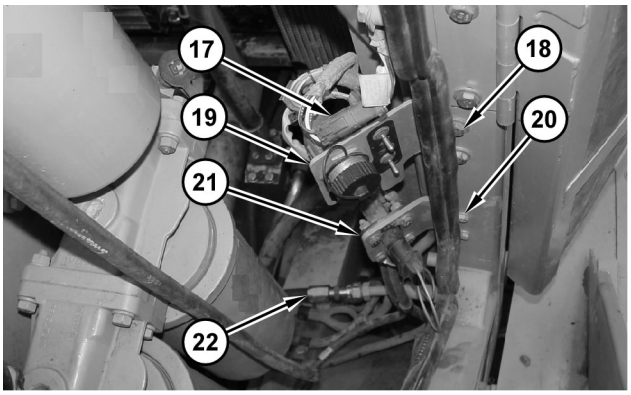


Illustration 51 g01239831

17. Connect hose assembly (22).

18. Position receptacle (21). Install bolts (20) and clips onto the side panel.

19. Position switch panel (19). Install bolts (18). Connect harness assembly (17).

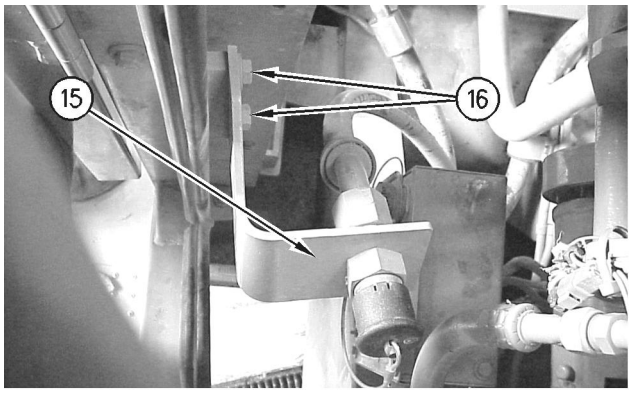


Illustration 52 g00840770

Right side panel

20. Install high speed oil change arrangement (15).

21. Install bolts (16).

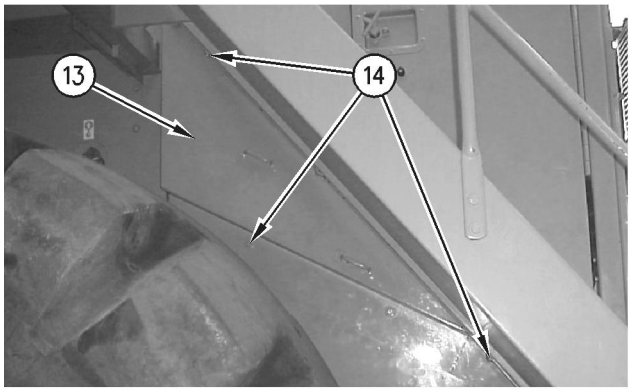


Illustration 53 g00840524

22. Use two people in order to install panel (13). The weight of panel (13) is approximately 27 kg (60 lb).

23. Install bolts (14).

24. Repeat Steps 22 and 23 for the opposite side.

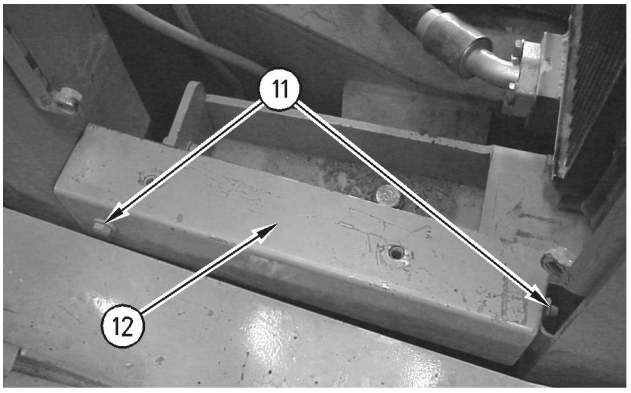


Illustration 54 g00840483

25. Install panel (12) and install bolts (11). Repeat this procedure for the opposite side.

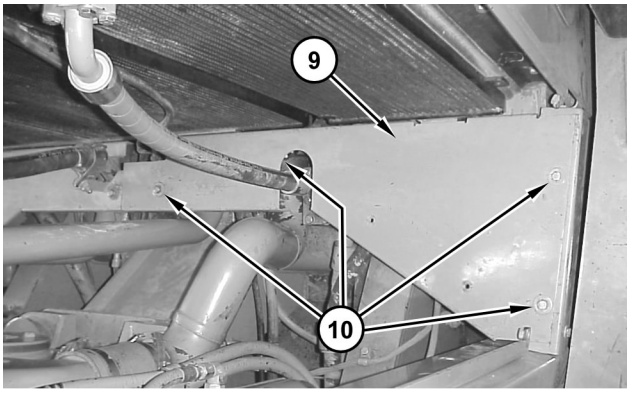


Illustration 55 g01247082

26. Install floor panel (9) and install bolts (10). Repeat this procedure for the opposite side.

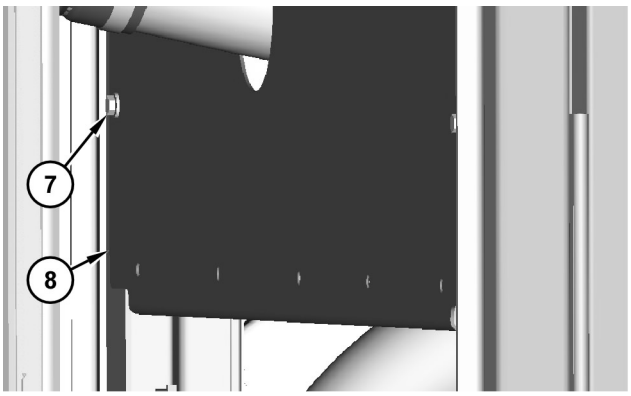


Illustration 56 g01247075

27. Use two people in order to position panel (8) and install bolts (7). The weight of panel (8) is approximately 27 kg (60 lb).

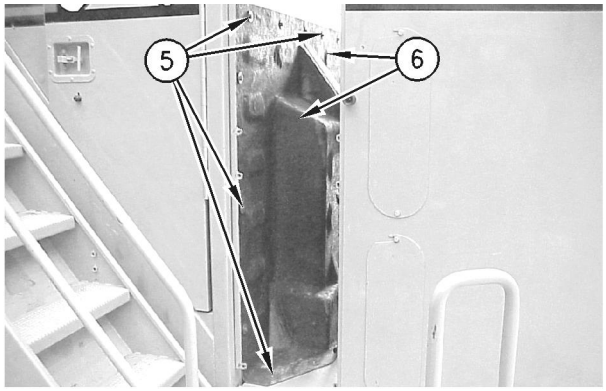


Illustration 57 g00840410

28. Install baffles (6).

29. Install bolts (5).

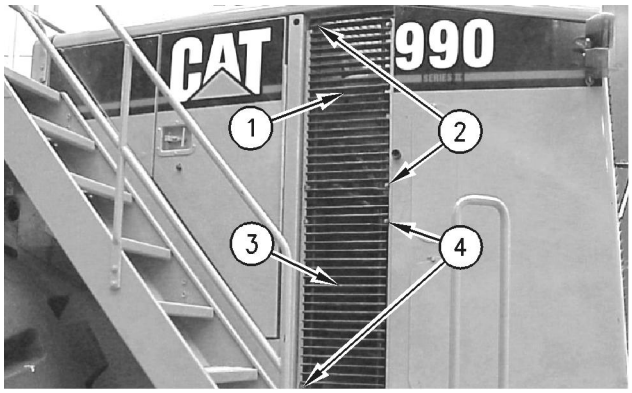


Illustration 58 g00840392

30. Install lower grill assembly (3) and bolts (4).

31. Install upper grill assembly (1) and bolts (2).

32. Repeat Steps 30 and 31 for the opposite side.

End By:

a. Install the front and rear hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Install”.

i02469677

Alternator - Remove
(Engine in Machine)

SMCS Code: 1405-011

Removal Procedure

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all wires for installation purposes.

1. Turn the disconnect switch to the OFF position.

2. Remove the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

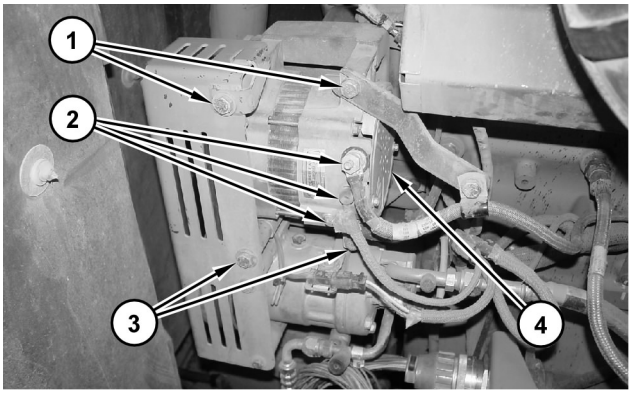


Illustration 59 g01231725

3. Disconnect harness assemblies (2). Remove bolts (1). Remove bolts (3). Remove alternator (4).

i02469680

Alternator - Install
(Engine in Machine)

SMCS Code: 1405-012

Installation Procedure

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all wires for installation purposes.

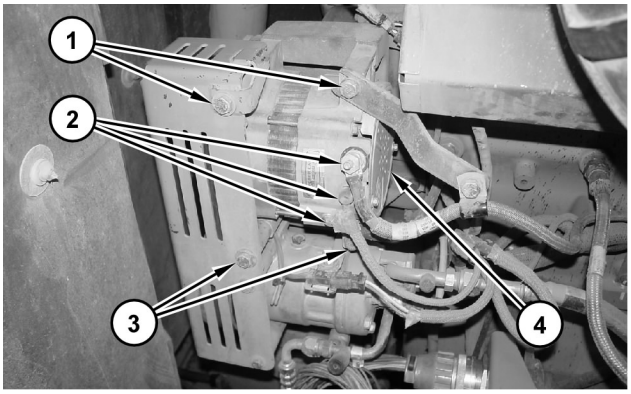


Illustration 60 g01231725

1. Position alternator (4). Install bolts (3). Install bolts (1). Connect harness assembly (2).

2. Install the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

3. Turn the disconnect switch to the ON position.

i02473471

Electric Starting Motor - Remove
(Engine in Machine)

SMCS Code: 1453-011

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

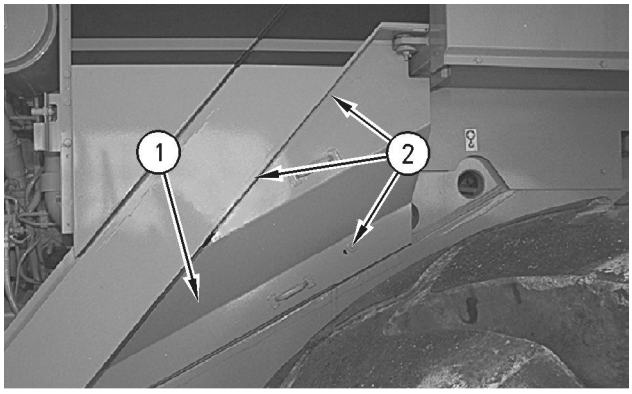


Illustration 61 g00841337

1. Remove bolts (2) and panel (1) from the right side of the machine.

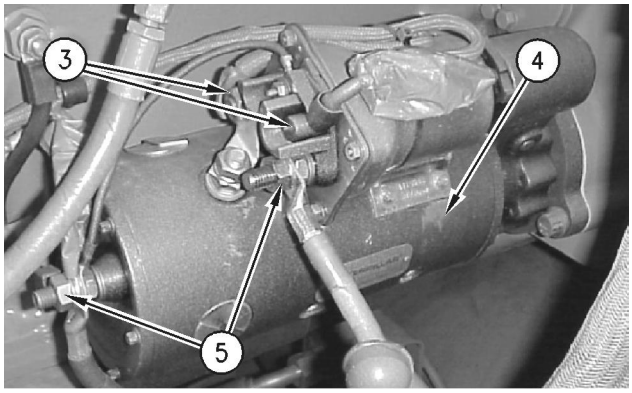


Illustration 62 g00841347

2. Disconnect harness assemblies (3) from electric starting motor (4). Cut the cable straps, as needed.

3. Disconnect cable assemblies (5).

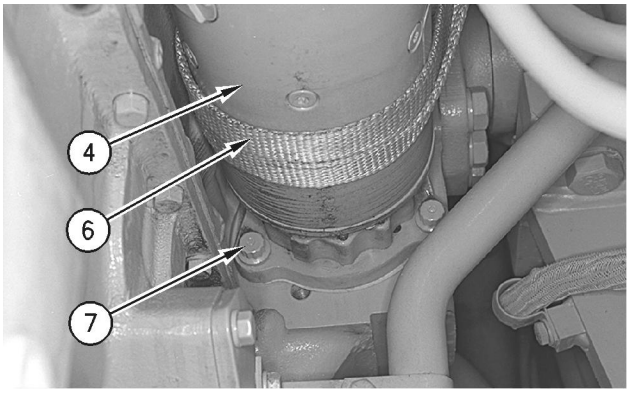


Illustration 63 g00841357

4. Attach a suitable lifting device (6) to electric starting motor (4), as shown.

5. Remove bolts (7).

6. Use the suitable lifting device in order to remove electric starting motor (4). The weight of starting motor (4) is approximately 36 kg (80 lb).

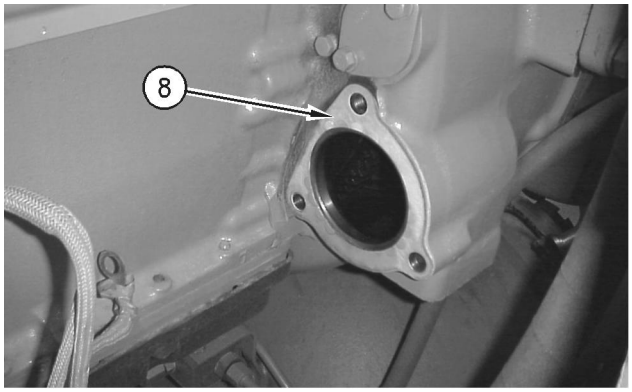


Illustration 64 g00841426

7. Remove gasket (8).

i02473475

Electric Starting Motor - Install (Engine in Machine)

SMCS Code: 1453-012

Installation Procedure

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

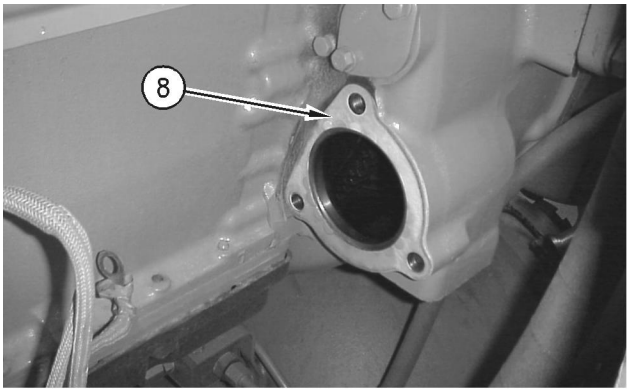


Illustration 65 g00841426

1. Install gasket (8).

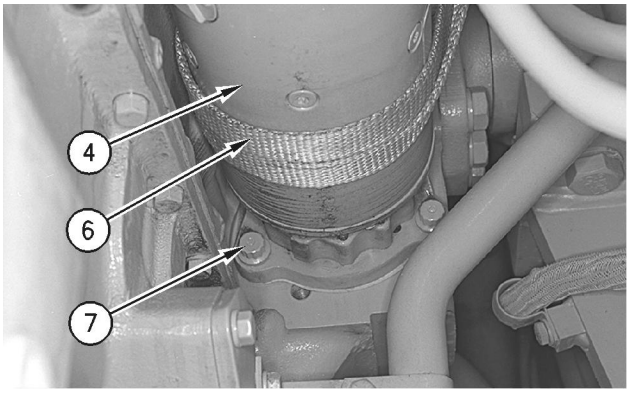


Illustration 66 g00841357

2. Attach a suitable lifting device (6) to electric starting motor (4), as shown.

3. Use the suitable lifting device in order to install electric starting motor (4). The weight of electric starting motor (4) is approximately 36 kg (80 lb).

4. Install bolts (7).

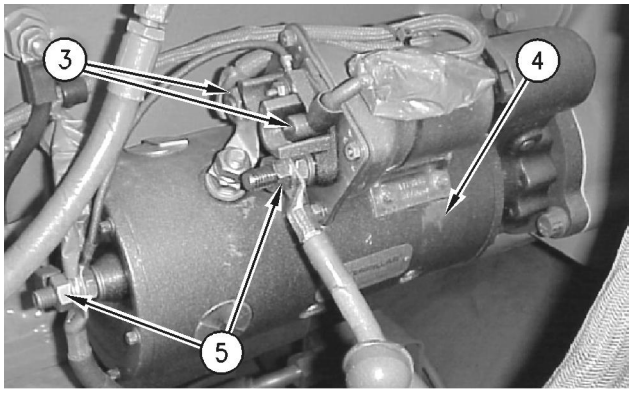


Illustration 67 g00841347

5. Connect harness assemblies (3) to electric starting motor (4). Tighten the nuts for the harness assemblies (3) to a torque of 2.25 ± 0.25 N·m (20 ± 2 lb in).

6. Install cable assemblies (5) to starting motor (4). Tighten the nuts for the cables to a torque of 30.5 ± 3.5 N·m (270 ± 30 lb in).

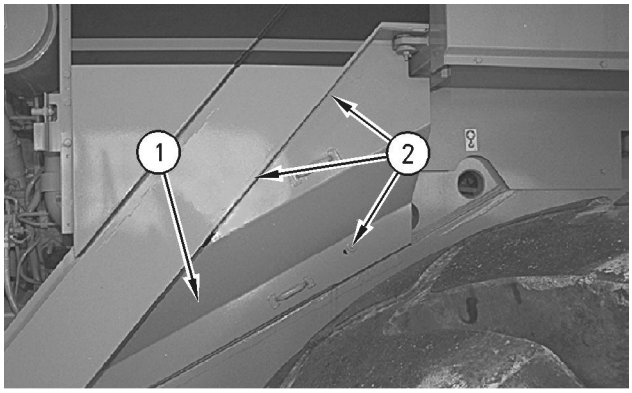


Illustration 68 g00841337

7. Install panel assembly (1) and bolts (2).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02471502

Crankshaft Front Seal - Remove

SMCS Code: 1160-011

Removal Procedure

Table 5

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	**138-7575**	**Link Bracket**	**1**
B	1U-7600	Slide Hammer Puller	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

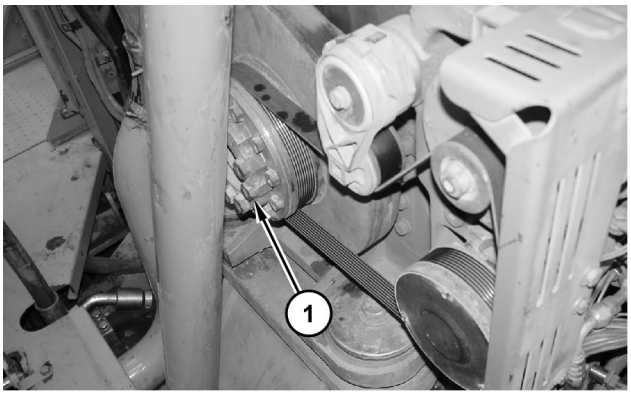


Illustration 69 g01232671

1. Remove the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

2. Remove eleven of bolts (1).

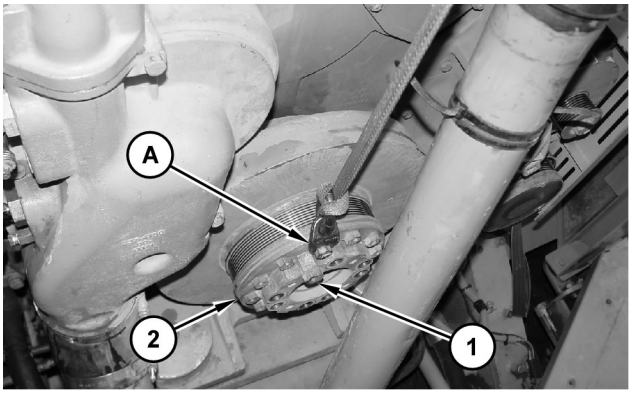


Illustration 70 g01232672

3. Use Tooling (A) and a suitable lifting device in order to remove vibration damper (2). The weight of vibration damper (2) is approximately 68 kg (150 lb). Remove the remaining bolt (1).

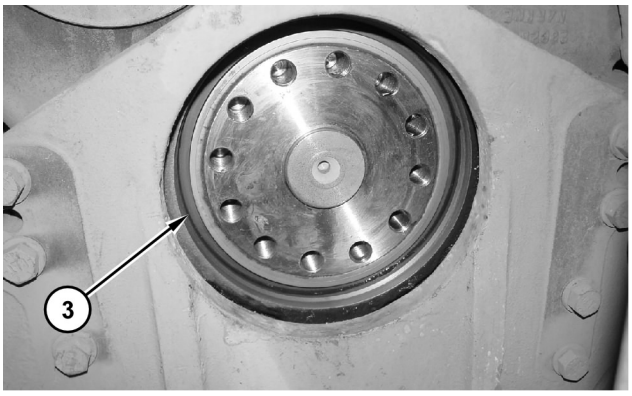


Illustration 71 g01232679

4. Use Tooling (B) or a punch and hammer in order to puncture three or more holes in crankshaft front seal (3).

5. Use Tooling (B) in order to remove crankshaft front seal (3) and the wear sleeve.

i02986918

Crankshaft Front Seal - Remove

SMCS Code: 1160-011

S/N: BTW1–99999

S/N: BWX1–Up

Removal Procedure

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7600	Slide Hammer Puller	1
B	-	Pry Bar	1
C	5P-7312	Seal Distorter	1
D	5P-7314	Distorter Ring	1

Start By:

a. Remove the crankshaft vibration damper and pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

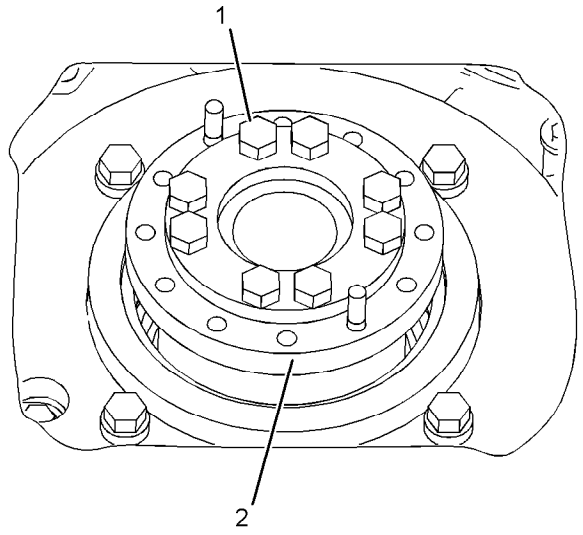


Illustration 72 g01098057

1. Remove bolts (1) and adapter (2).

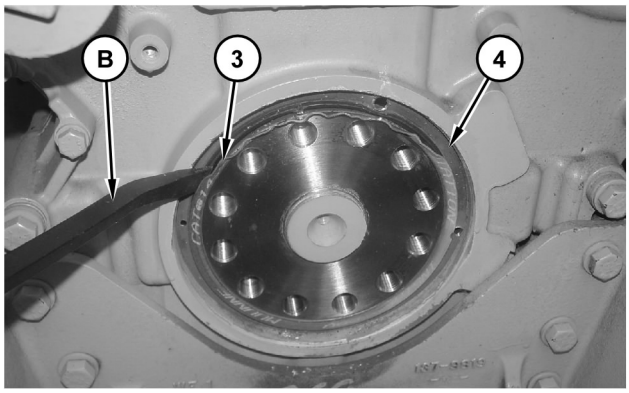


Illustration 73 g01513439

Note: Ensure that you do not damage the front housing with Tooling (B).

Note: If the crankshaft wear sleeve starts to slide off the crankshaft, go to Step 3.

2. Use Tooling (B) to pry around the lip of crankshaft wear sleeve (3).

3. Use Tooling (A) to puncture three or more holes in crankshaft front seal (4).

4. Use Tooling (A) to remove crankshaft front seal (4).

5. If necessary, use Tooling (C) and Tooling (D) to remove crankshaft wear sleeve (3).

i02471503

Crankshaft Front Seal - Install

SMCS Code: 1160-012

Installation Procedure

Table 7

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
C	5P-1733	Seal Locator	1
	5P-1737	Bolt	3
	9S-8858	Nut (Seal Installer)	1
	6V-6142	Seal Installer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

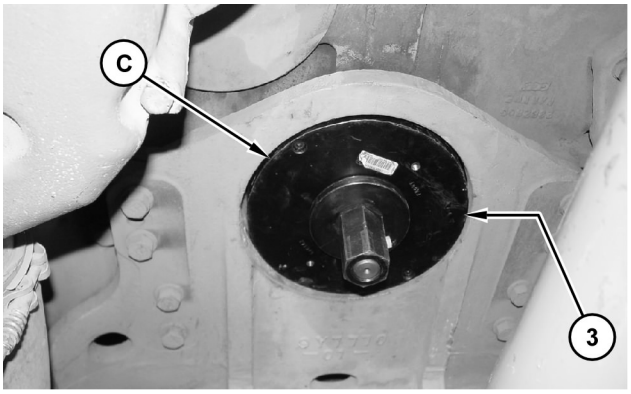


Illustration 74 g01232683

1. Use Tooling (C) in order to install crankshaft front seal (3) and the wear sleeve as a unit.

Note: Install the crankshaft front seal with the arrow that shows the direction of crankshaft rotation toward the front of the engine.

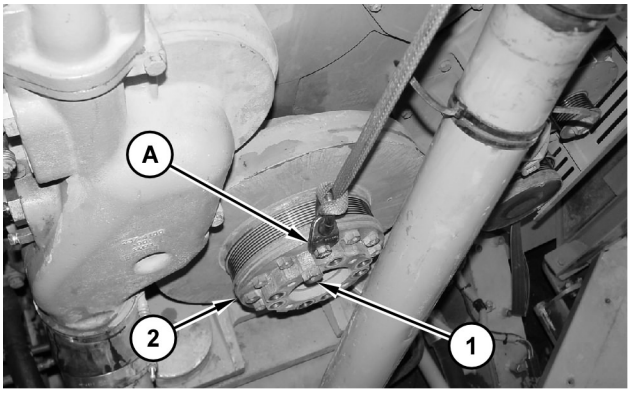


Illustration 75 g01232672

2. Use Tooling (A) and a suitable lifting device in order to install vibration damper (2). The weight of vibration damper (2) is approximately 68 kg (150 lb).

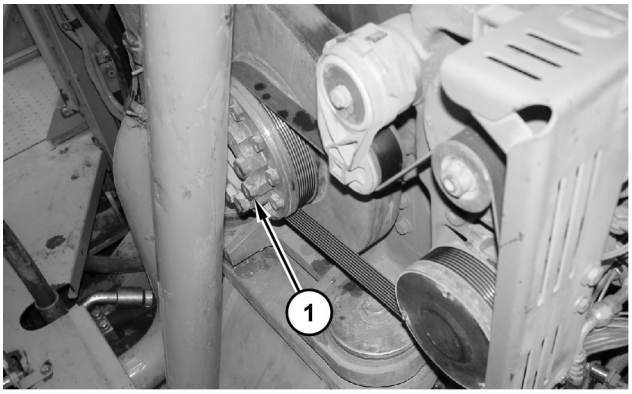


Illustration 76 g01232671

3. Install bolts (1).

4. Install the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/ Replace”.

i02986920

Crankshaft Front Seal - Install

SMCS Code: 1160-012

S/N: BTW1–99999

S/N: BWX1–Up

Installation Procedure

Table 8

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
E	5P-1733	Seal Locator	1
	5P-1737	Bolt	3
	9S-8858	Nut (Seal Installer)	1
	6V-6142	Seal Installer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the outside diameter of the crankshaft.

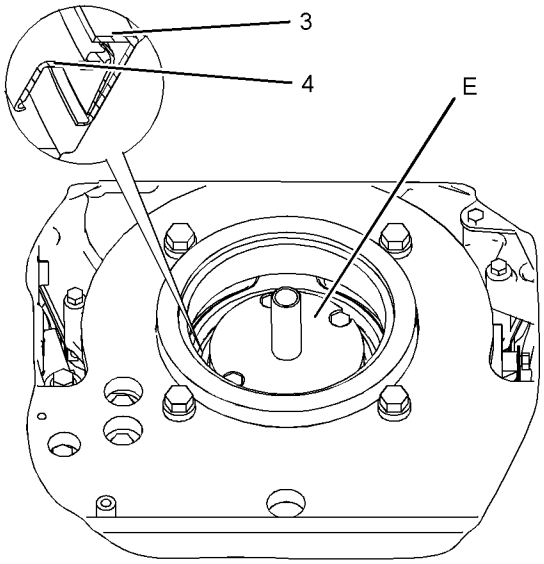


Illustration 77 g01513455

2. Use Tooling (E) to install crankshaft front seal (4) and crankshaft wear sleeve (3) as a unit.

Note: Install the crankshaft front seal with the arrow that shows the direction of crankshaft rotation toward the front of the engine.

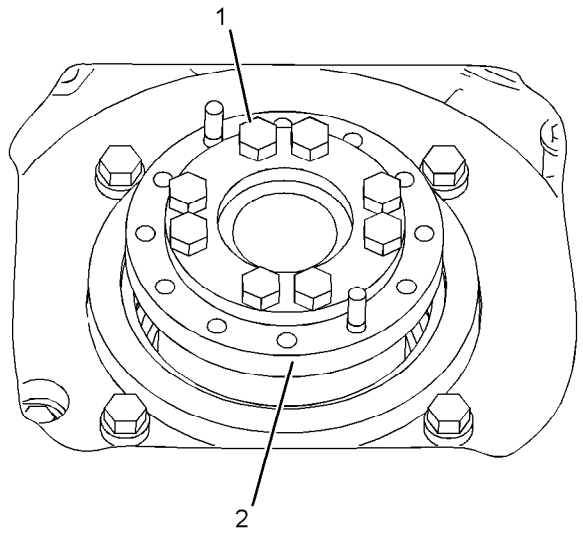


Illustration 78 g01098057

3. Install adapter (2) and bolts (1).

End By:

a. Install the crankshaft vibration damper and pulley. Refer to Disassembly and Assembly, “Vibration Damper and Pulley - Remove and Install”.

i02469842

Fuel Priming Pump and Fuel Filter Base - Remove and Install

SMCS Code: 1258-010; 1260-010; 1262-010

Removal Procedure

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

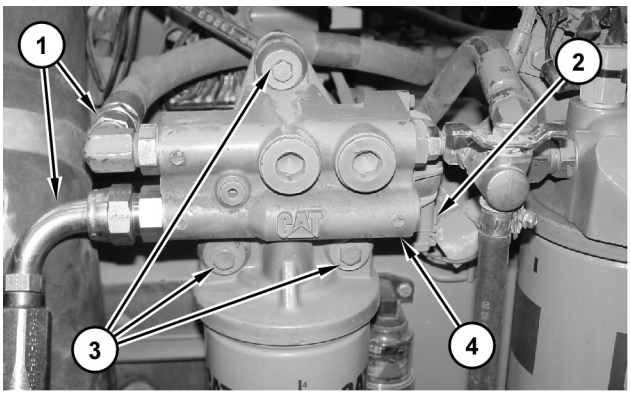


Illustration 79 g01231846

1. Disconnect hose assemblies (1).

2. Disconnect harness assembly (2).

3. Remove bolts (3).

4. Remove fuel priming pump and fuel filter base assembly (4).

5. Remove the fuel filter. Refer to Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace”.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

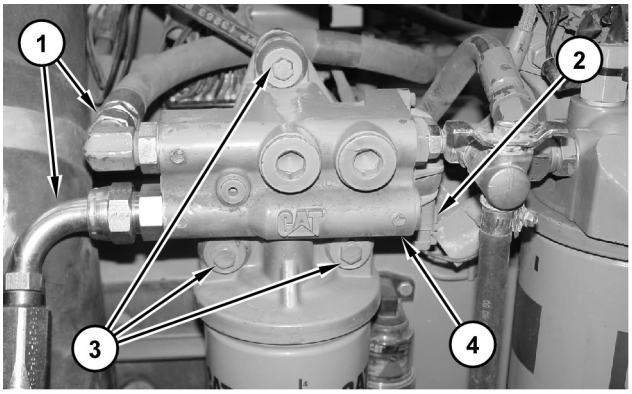


Illustration 80 g01231846

1. Position fuel priming pump and fuel filter base assembly (4).

2. Install bolts (3).

3. Connect harness assembly (2).

4. Connect hose assembly (1).

5. Install the fuel filter. Refer to Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace”.

i02504246

Fuel Filter and Fuel Filter Base (Secondary) - Remove and Install

(Engine in Machine)

SMCS Code: 1261-010-SE; 1262-010

Removal Procedure

Table 9

Required Tools			
Tool	Part Number	Part Description	Qty
A	2P-8250	Strap wrench Assembly	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

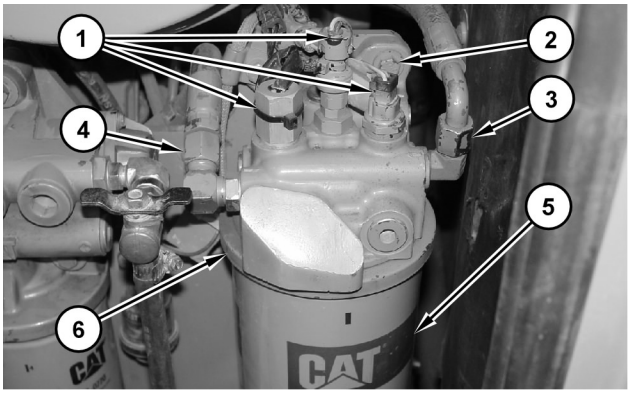


Illustration 81 g01232193

1. Disconnect harness assemblies (1).

2. Disconnect hose assembly (3). Disconnect hose assembly (4).

3. Use Tooling (A) in order to remove filter (5). Refer to the Operations and Maintenance Manual, “Fuel System Secondary Filter - Replace”.

4. Remove bolts (2) and remove fuel filter and filter base assembly (6).

Installation Procedure

Table 10

Required Tools			
Tool	Part Number	Part Description	Qty
A	2P-8250	Strap wrench Assembly	1

NOTICE
Do not fill fuel filters with fuel before installing them. Contaminated fuel will cause accelerated wear to fuel system parts.

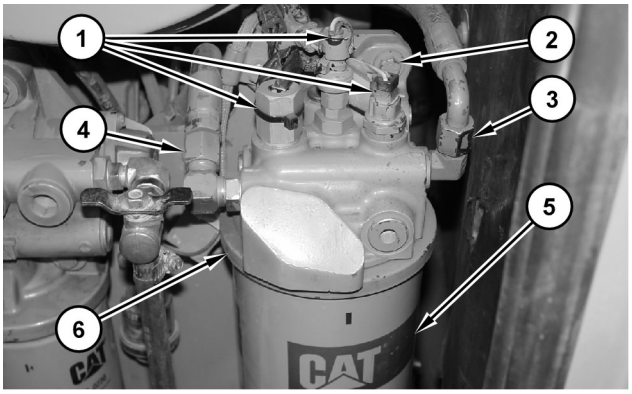


Illustration 82 g01232193

1. Position fuel filter and filter base assembly (6) and install bolts (2).

2. Connect hose assembly (4). Connect hose assembly (3).

3. Connect harness assemblies (1).

4. Use Tooling (A) in order to install filter (5). Refer to Operations and Maintenance Manual, “Fuel System Secondary Filter - Replace”.

i02504253

Fuel Transfer Pump - Remove and Install

SMCS Code: 1256-010

Removal Procedure

Table 11

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

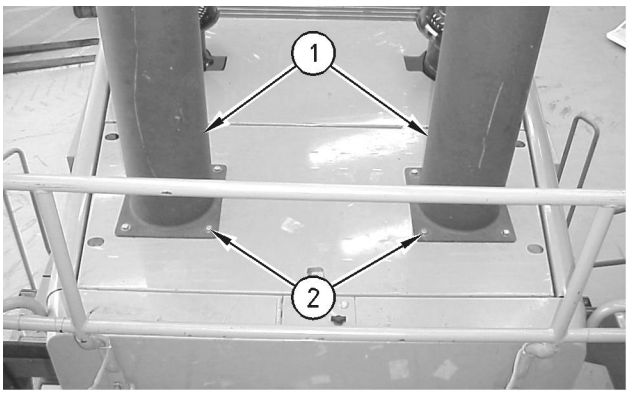


Illustration 83 g00839858

1. Remove bolts (2). Remove exhaust stacks (1).

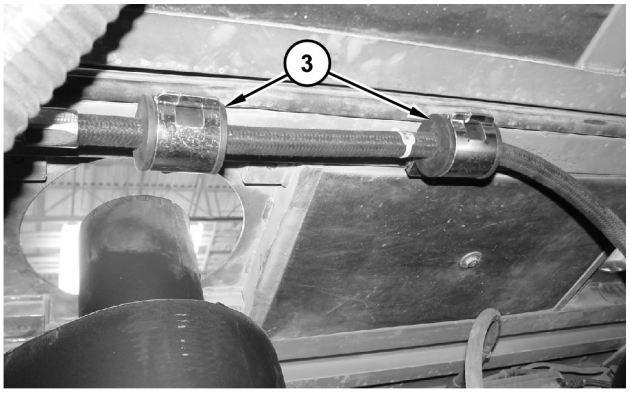


Illustration 84 g01231540

2. Remove clamps (3).

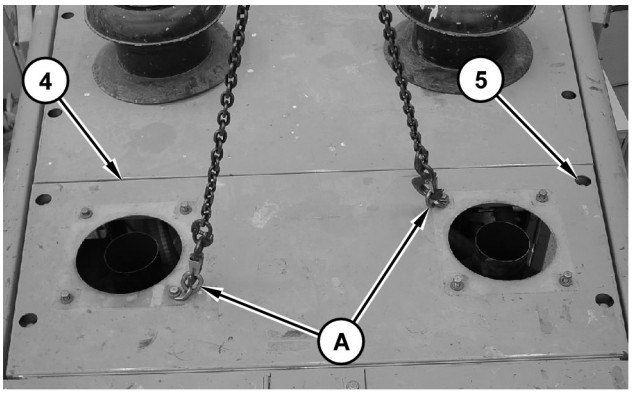


Illustration 85 g01231541

3. Install Tooling (A) onto hood panel (4). Remove bolts (5) and remove hood panel (4). The weight of hood panel (4) is approximately 54 kg (120 lb).

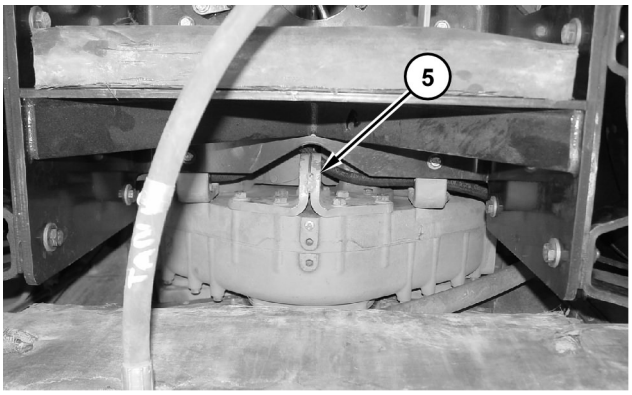


Illustration 86 g01231858

4. Remove bracket (5).

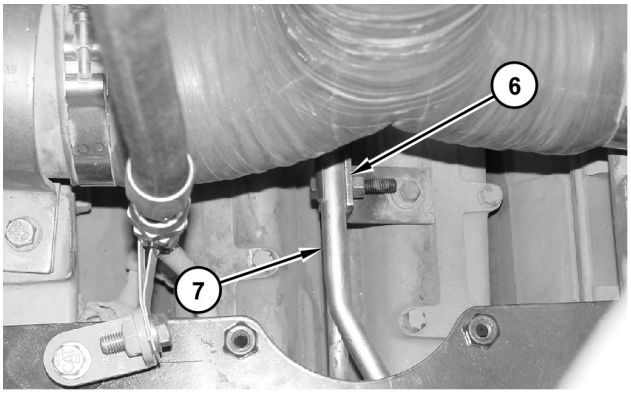


Illustration 87 g01231862

5. Remove clips (6) in order to position tube assemblies (7) out of the way.

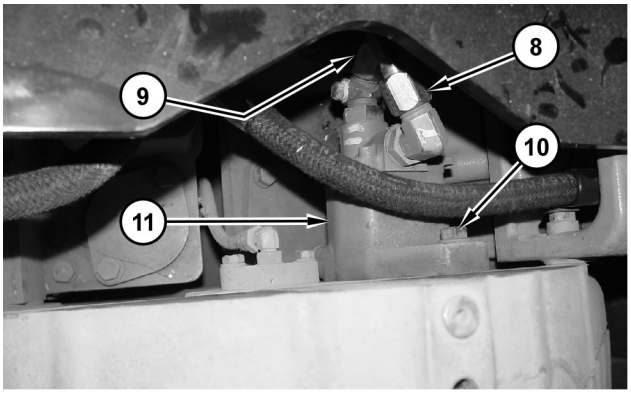


Illustration 88 g01231865

6. Disconnect tube assembly (8). Disconnect tube assembly (9). Remove bolts (10). Remove fuel transfer pump (11).

Installation Procedure

Table 12

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

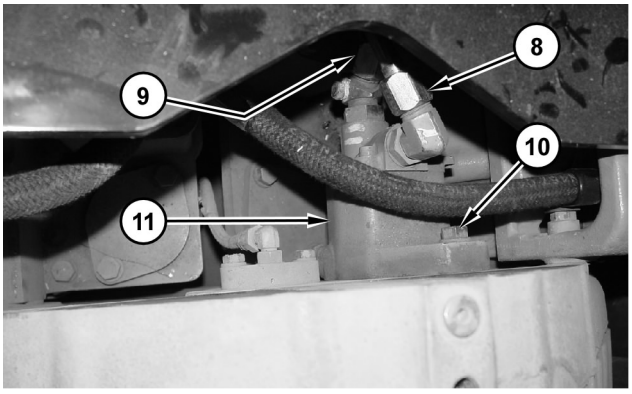


Illustration 89 g01231865

1. Position fuel transfer pump (11). Install bolts (10). Connect tube assembly (9). Connect tube assembly (8).

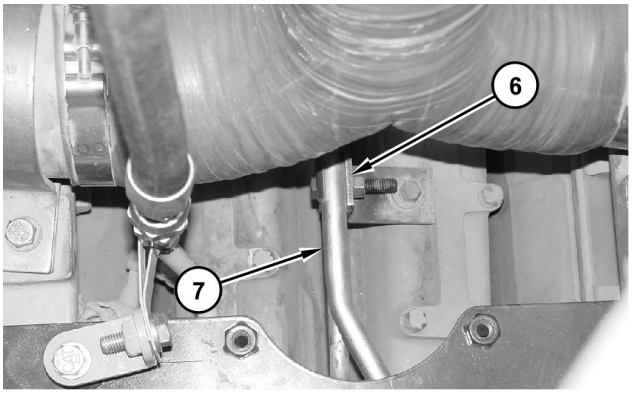


Illustration 90 g01231862

2. Position tube assemblies (7) and install clips (6).

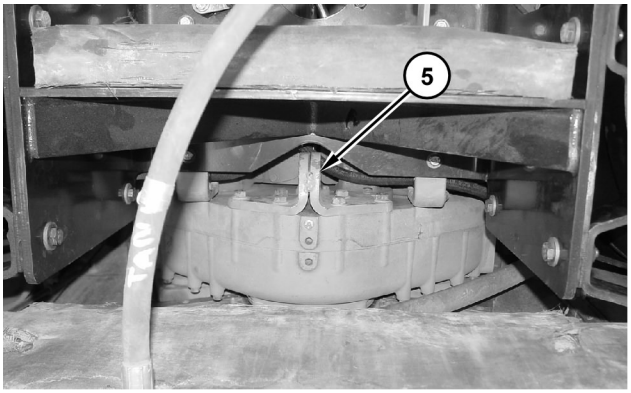


Illustration 91 g01231858

3. Install bracket (5).

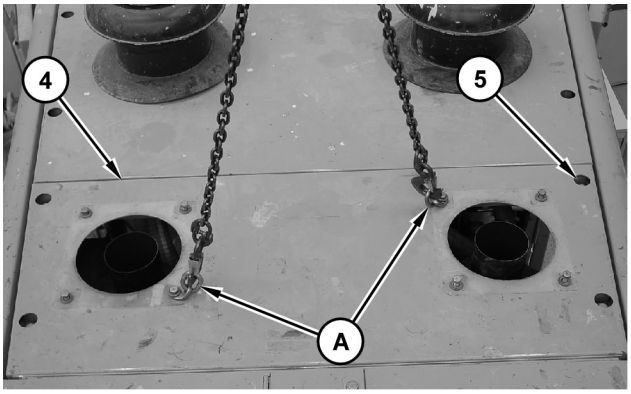


Illustration 92 g01231541

4. Use Tooling (A) and a suitable lifting device in order to position hood panel (4). Install bolts (5). The weight of hood panel (4) is approximately 54 kg (120 lb).

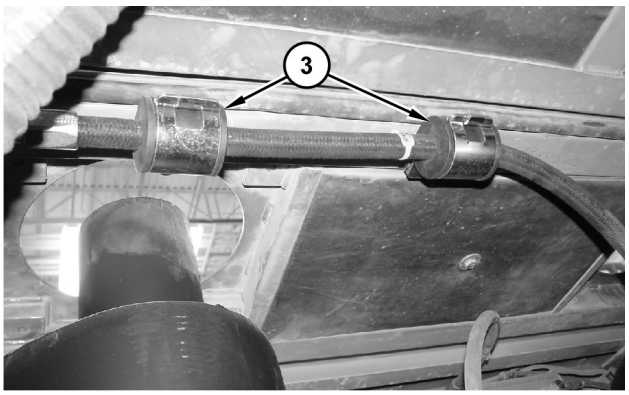


Illustration 93 g01231540

5. Install clamps (3).

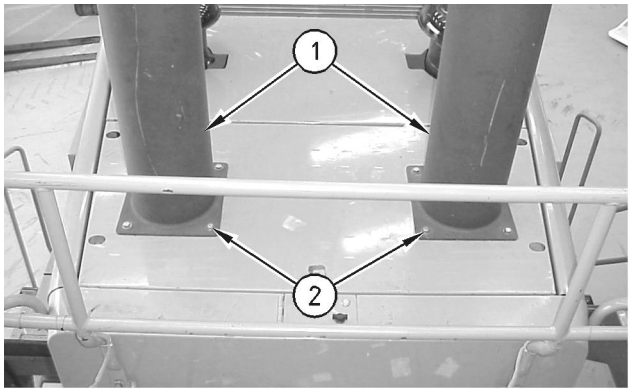


Illustration 94 g00839858

6. Position exhaust stacks (1). Install bolts (2).

7. Prime the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime”.

i02504118

Fuel Tank - Remove

SMCS Code: 1273-011

Removal Procedure

Table 13

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	1U-9200	Lever Puller Hoist	1
C	138-7574	Link Bracket	2

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

1. Drain the fuel tank into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Capacities (Refill)”.

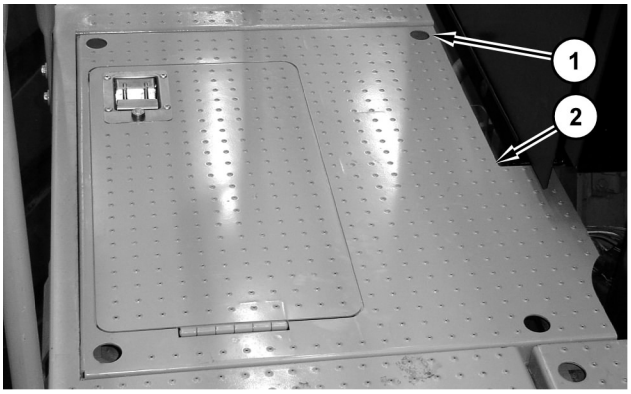


Illustration 95 g01237642

2. Remove bolts (1). Use two people in order to remove panel (2). The weight of panel (2) is approximately 27 kg (60 lb).

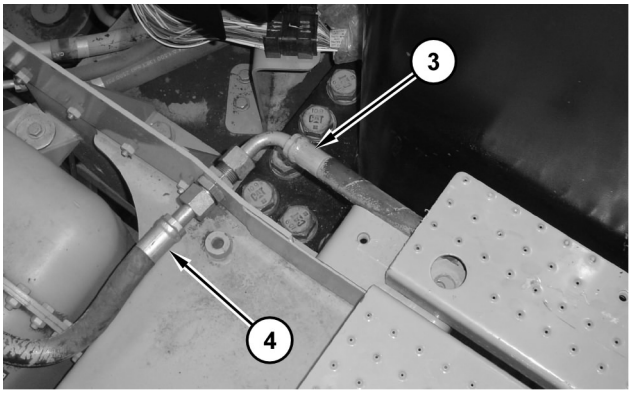


Illustration 96 g01237657

3. Disconnect hose assembly (3). Disconnect hose assembly (4) from the hydraulic oil tank.

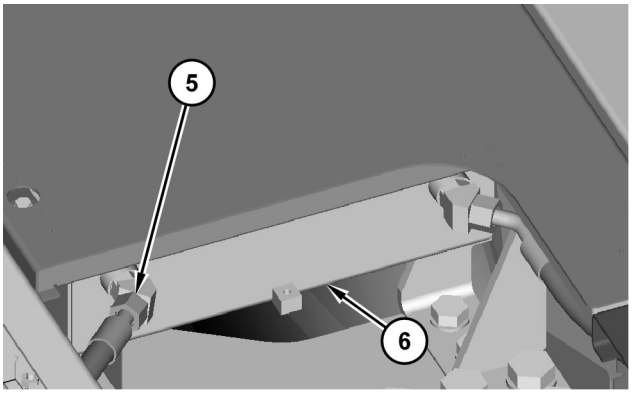


Illustration 97 g01237689

4. Disconnect hose assembly (5) from tank assembly (6).

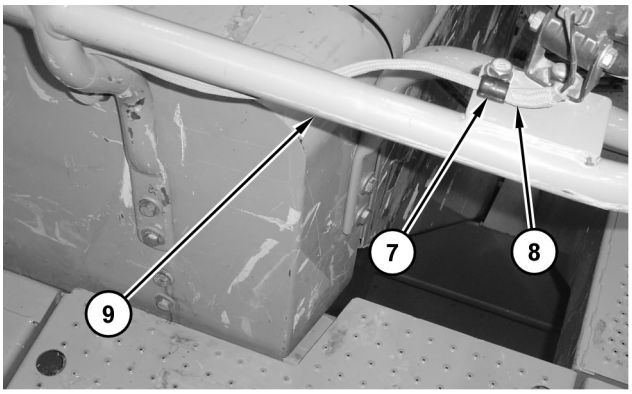


Illustration 98 g01237686

5. Remove clip (7) and disconnect harness assembly (8). Repeat the procedure for the opposite side.

6. Use two people in order to remove handrail assembly (9). The weight of handrail assembly (9) is approximately 34 kg (75 lb).

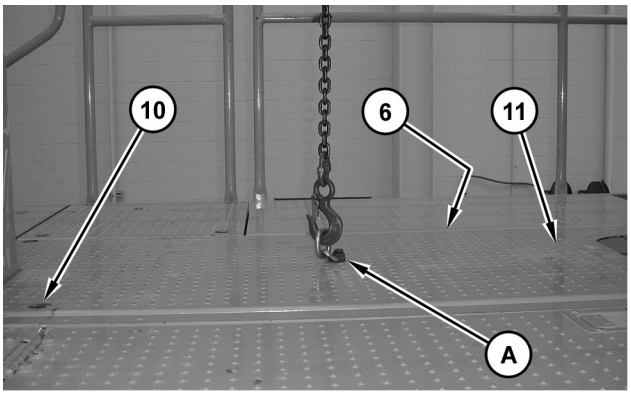


Illustration 99 g01237701

7. Remove bolts (10). Use Tooling (A) and a suitable lifting device in order to remove panel assembly (11) and tank assembly (6) as a unit. The weight of panel assembly (11) and tank assembly (6) is approximately 118 kg (260 lb).

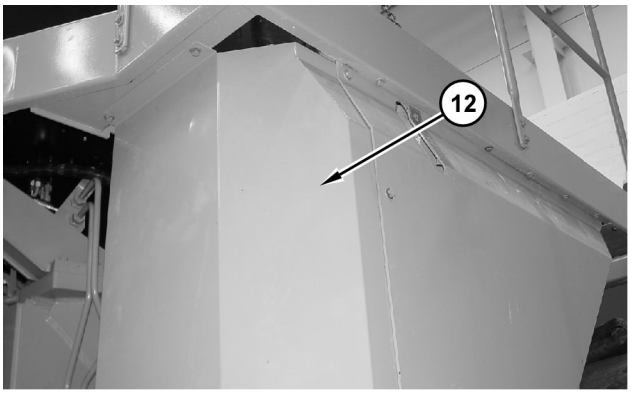


Illustration 100 g01237663

8. Remove guard assembly (12).

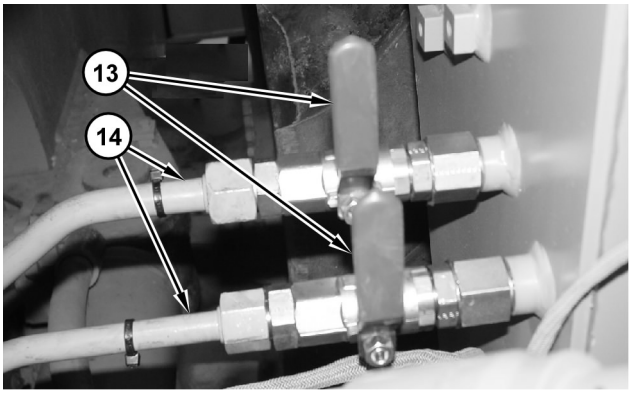


Illustration 101 g01237659

9. Turn fuel valves (13) to the OFF position. Disconnect tube assemblies (14).

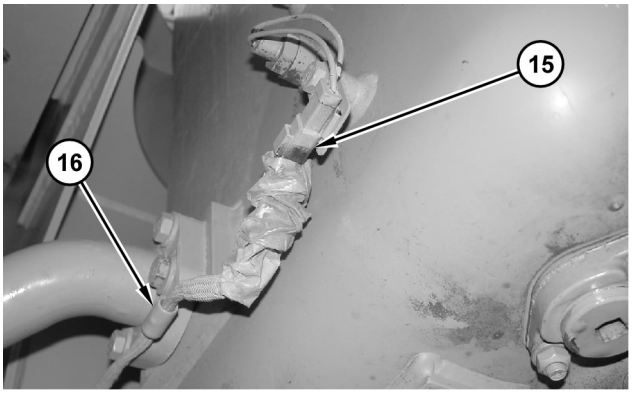


Illustration 102 g01237646

10. Disconnect harness assembly (15). Remove clip (16).

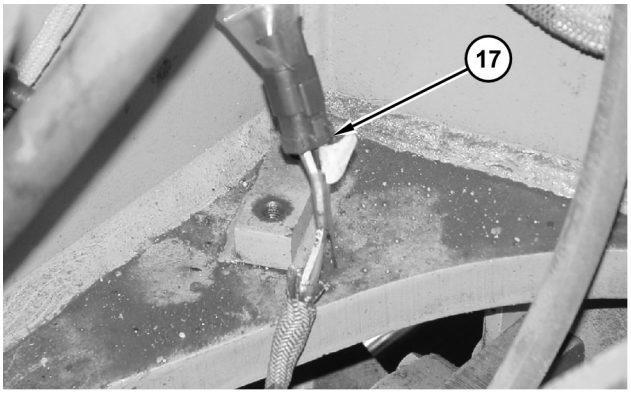


Illustration 103 g01237649

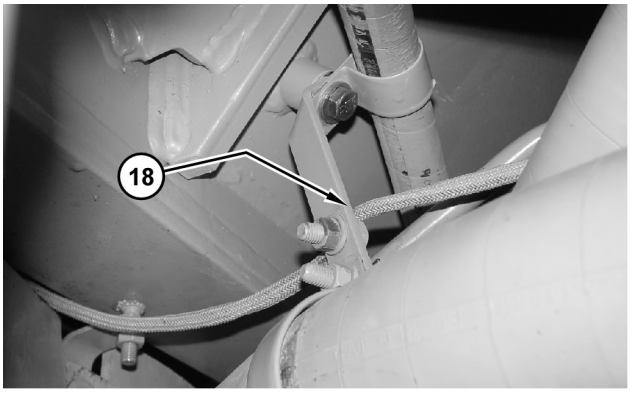


Illustration 104 g01237650

11. Disconnect harness assembly (17). Remove clip (18).

Note: If necessary, Remove additional connecting hardware.

Note: Harness assembly (17) is located under the cab on the left side of the frame assembly.

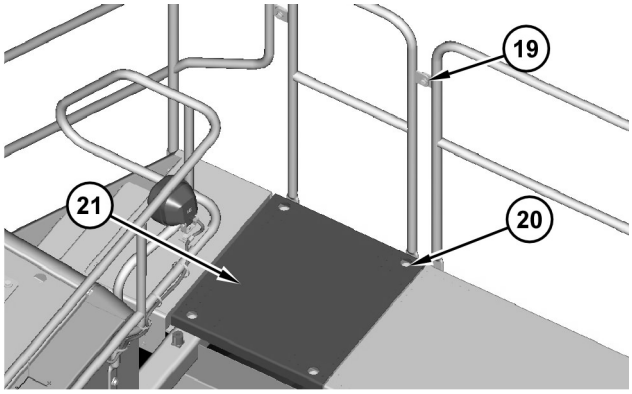


Illustration 105 g01253372

12. Remove bolts (19). Remove bolts (20). Use two people in order to remove panel assembly and handrail (21). The weight of panel assembly and handrail (21) is approximately 27 kg (60 lb).

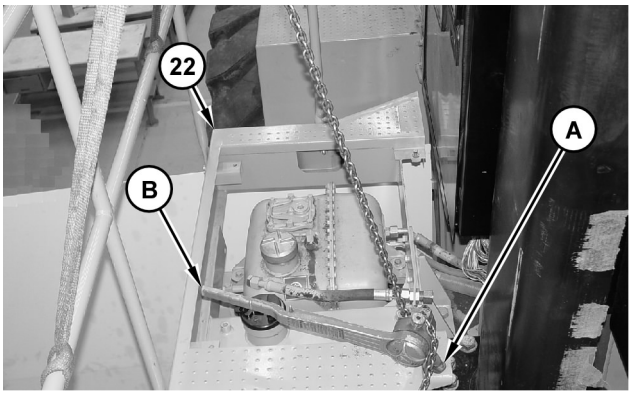


Illustration 106 g01253383

13. Attach Tooling (A), Tooling (B), and a suitable lifting device onto platform assembly (22). The weight of platform assembly (22) is approximately 100 kg (220 lb).

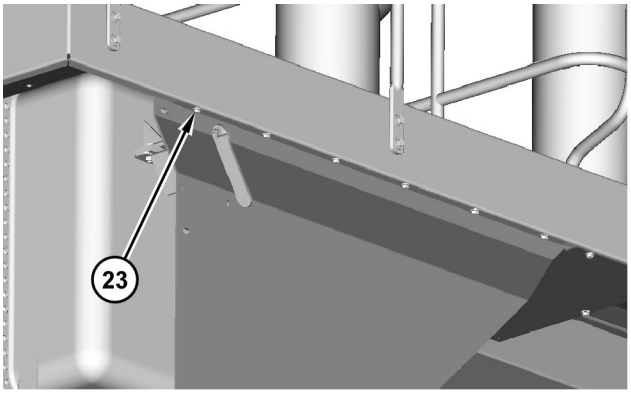


Illustration 107 g01253386

14. Remove bolts (23).

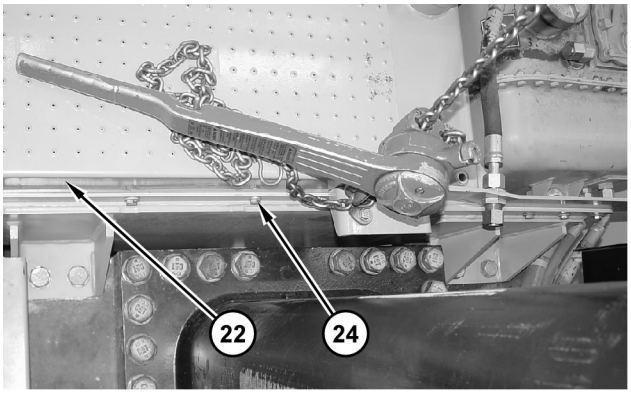


Illustration 108 g01253780

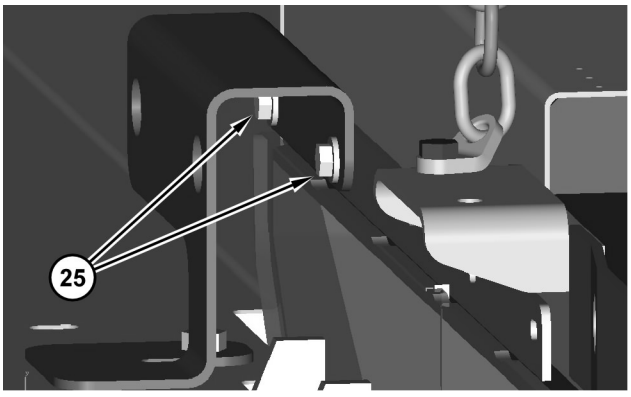


Illustration 109 g01253783

15. Remove bolts (24). Remove bolts (25). Remove platform assembly (22).

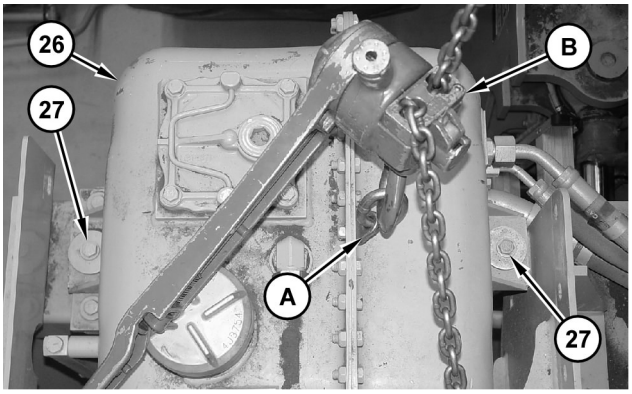


Illustration 110 g01253789

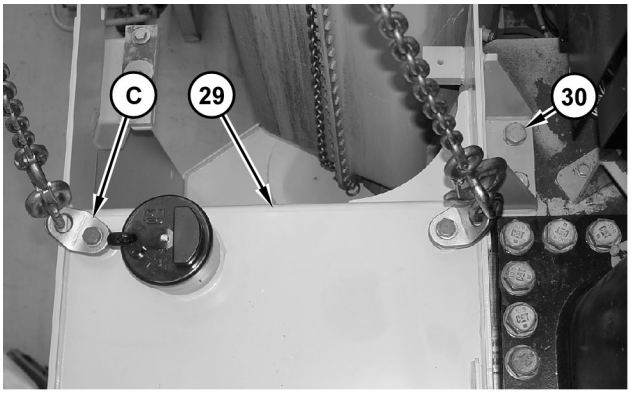


Illustration 113 g01253798

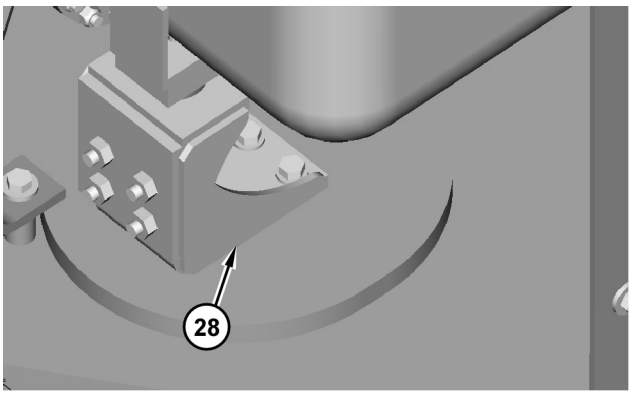


Illustration 111 g01253792

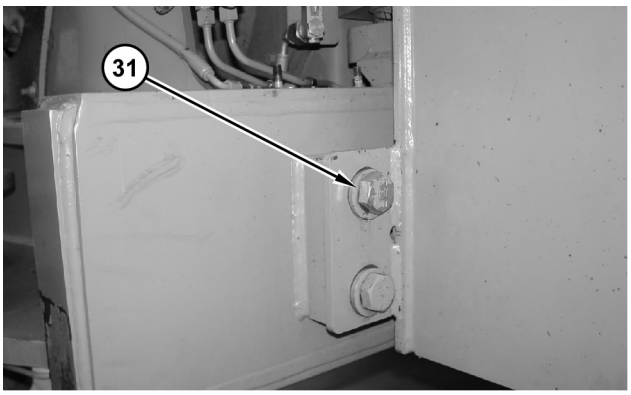


Illustration 114 g01253799

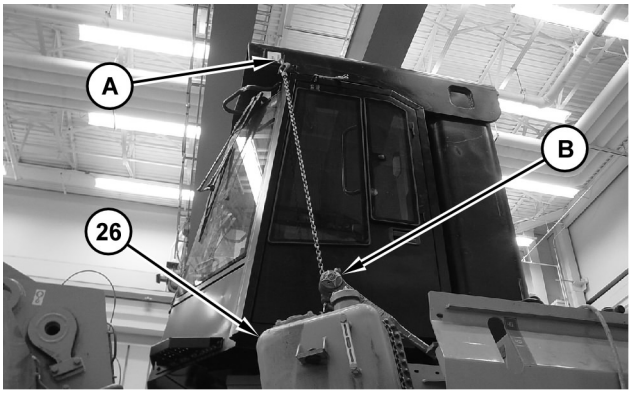


Illustration 112 g01253795

16. Attach Tooling (A), Tooling (B), and a suitable lifting device onto hydraulic oil tank (26), as shown. The weight of hydraulic oil tank (26) is approximately 208 kg (458 lb).

17. Remove bolts (27). Remove mount (28). Position hydraulic oil tank (26) out of the way.

18. Attach Tooling (C) and a suitable lifting device onto fuel tank (29). The weight of fuel tank (29) is approximately 771 kg (1700 lb).

19. Remove bolts (30).

20. Remove bolts (31).

21. Remove fuel tank (29).

i02504119

Fuel Tank - Install

SMCS Code: 1273-012

Installation Procedure

Table 14

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	1U-9200	Lever Puller Hoist	1
C	138-7574	Link Bracket	2

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

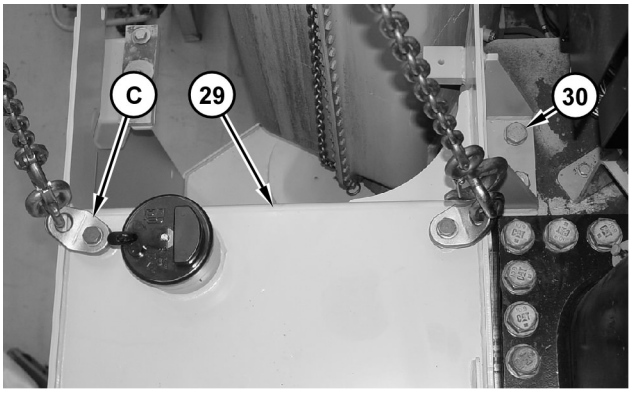


Illustration 115 g01253798

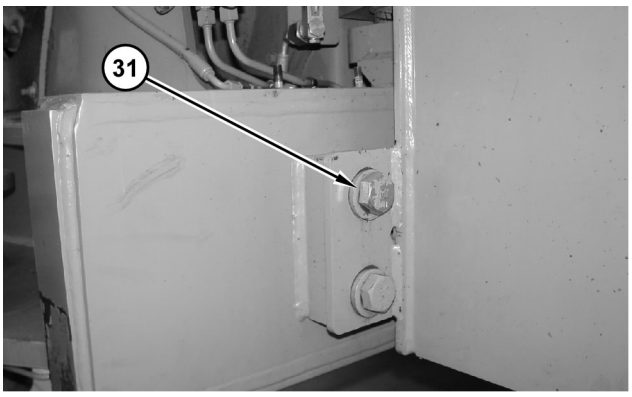


Illustration 116 g01253799

1. Use Tooling (C) and a suitable lifting device in order to Position fuel tank (29), as shown. The weight of fuel tank (29) is approximately 771 kg (1700 lb).

2. Install bolts (30).

3. Install bolts (31).

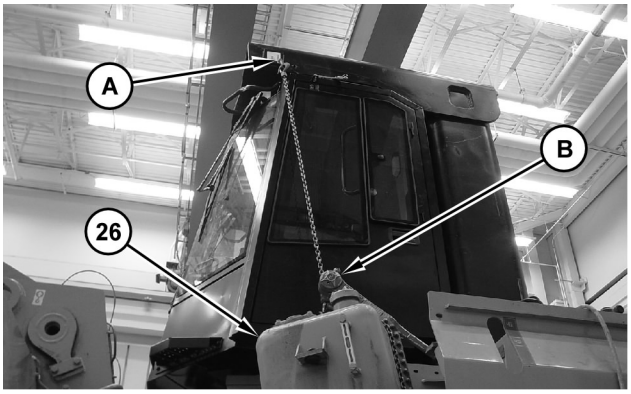


Illustration 117 g01253795

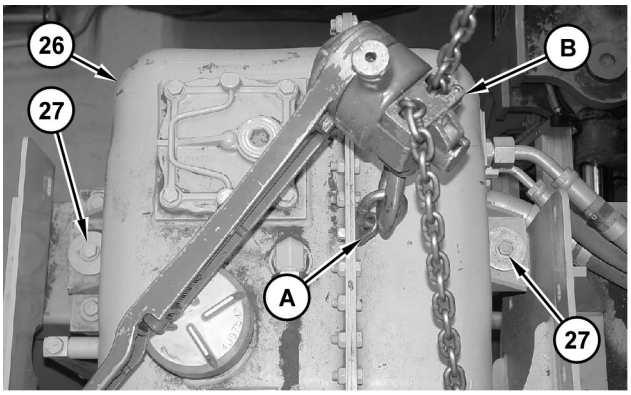


Illustration 118 g01253789

4. Use Tooling (A), Tooling (B), and a suitable lifting device in order to position hydraulic oil tank (26), as shown. The weight of hydraulic oil tank (26) is approximately 208 kg (458 lb).

5. Install bolts (27).

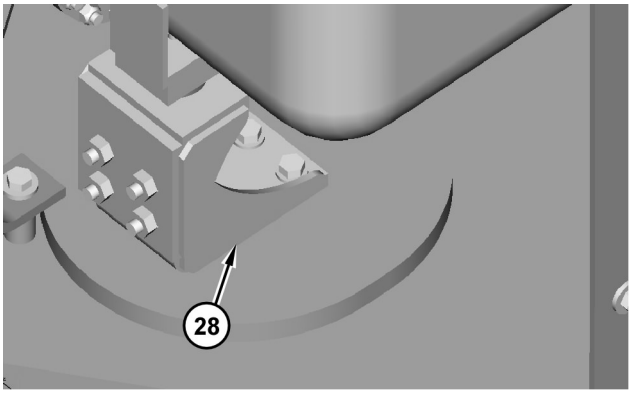


Illustration 119 g01253792

6. Install mount (28).

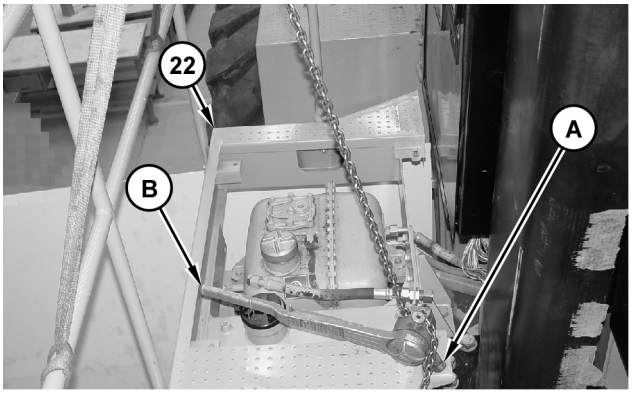


Illustration 120 g01253383

7. Use Tooling (A), Tooling (B), and a suitable lifting device in order to position platform assembly (22), as shown. The weight of platform assembly (22) is approximately 100 kg (220 lb).

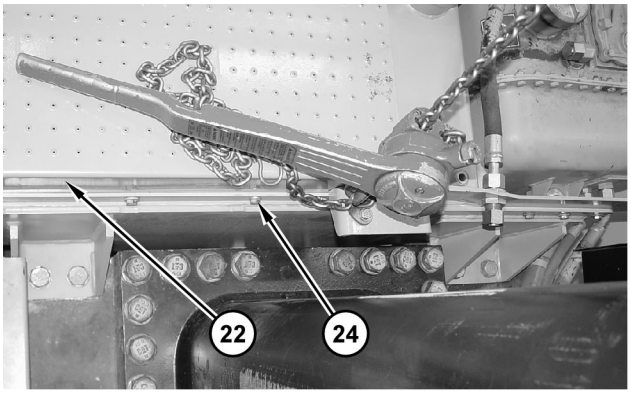


Illustration 121 g01253780

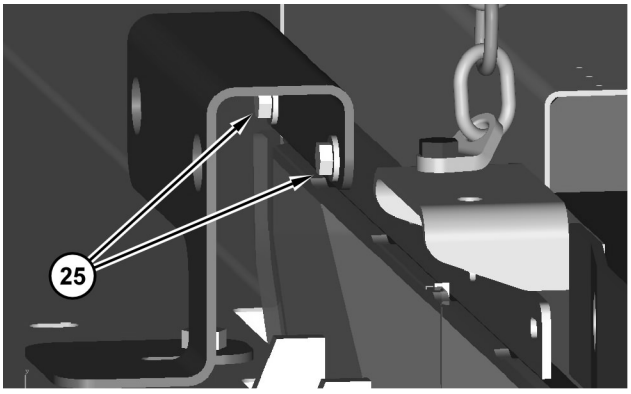


Illustration 122 g01253783

8. Install bolts (24) and install bolts (25) onto platform assembly (22).

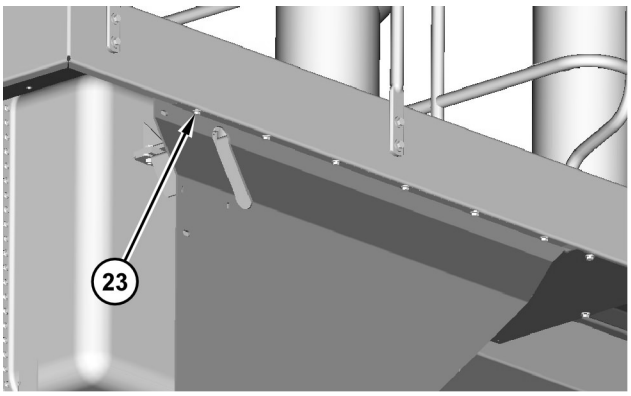


Illustration 123 g01253386

9. Install bolts (23).

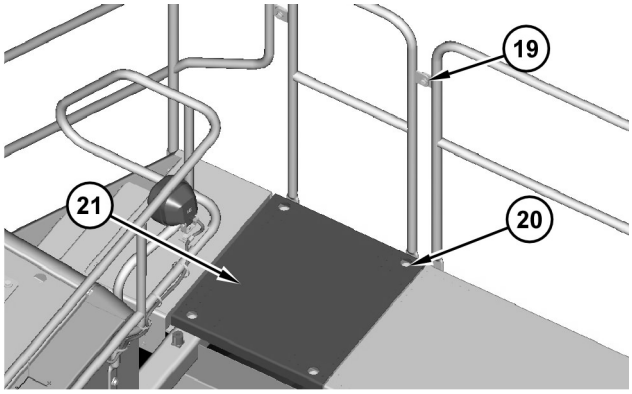


Illustration 124 g01253372

10. Use two people in order to install panel assembly and handrail (21). The weight of panel assembly and handrail (21) is approximately 27 kg (60 lb). Install bolts (20). Install bolts (19).

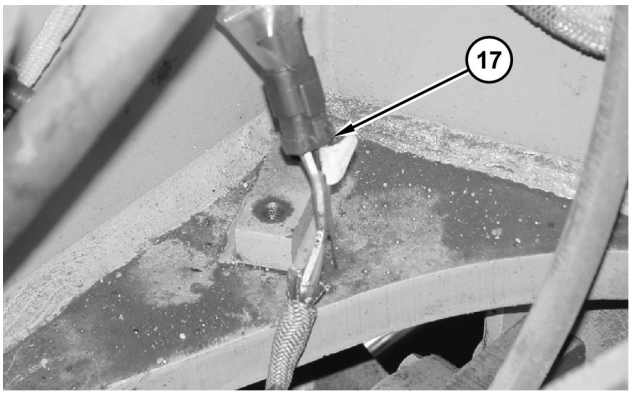


Illustration 125 g01237649

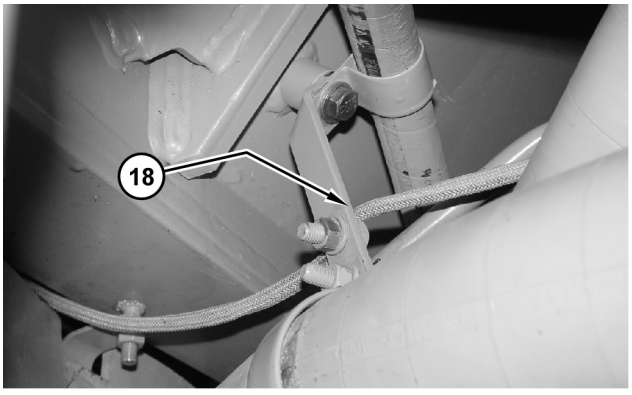


Illustration 126 g01237650

11. Connect harness assembly (17). Install clip (18).

Note: If necessary, install additional connecting hardware.

Note: Harness assembly (17) is located under the cab on the left side of the frame assembly.

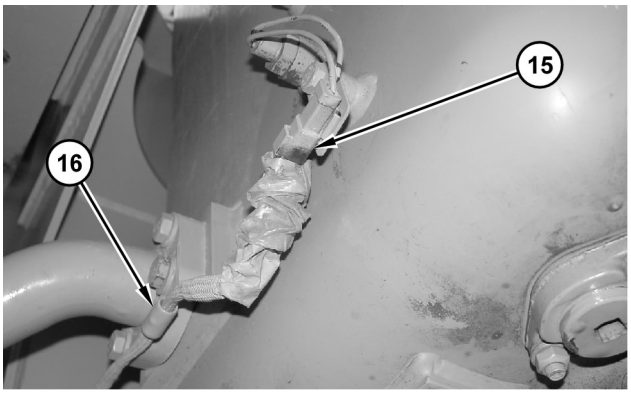


Illustration 127 g01237646

12. Connect harness assembly (15). Install clip (16).

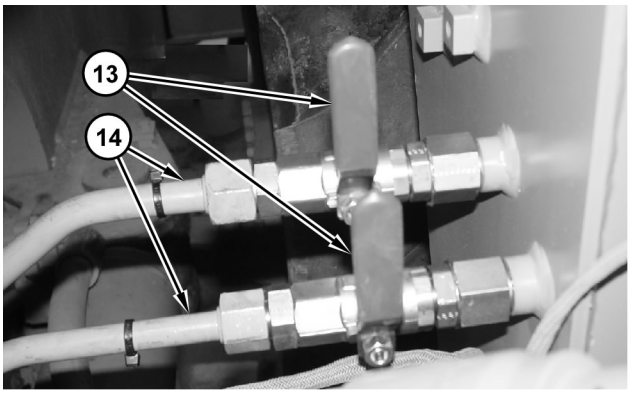


Illustration 128 g01237659

13. Connect tube assemblies (14). Turn fuel valves (13) to the ON position.

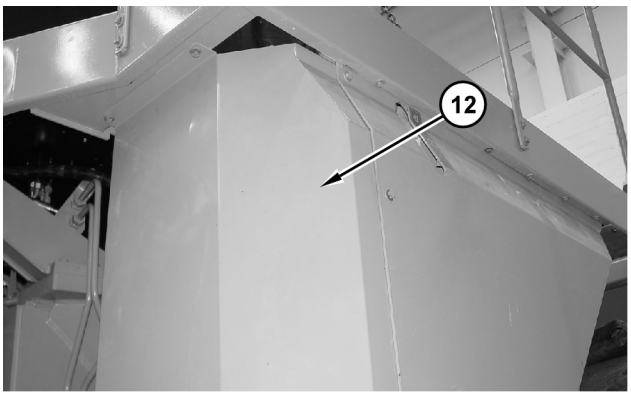


Illustration 129 g01237663

14. Install guard assembly (12).

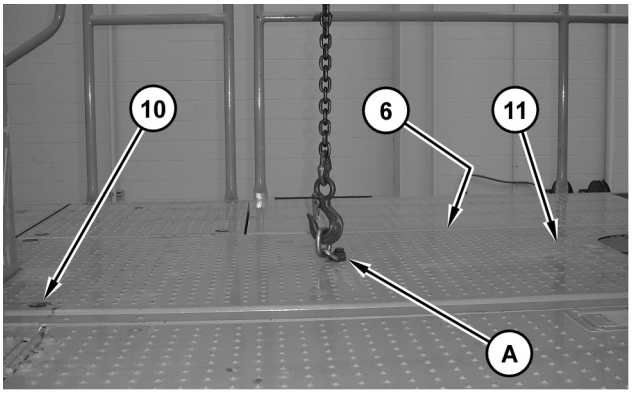


Illustration 130 g01237701

15. Use Tooling (A) and a suitable lifting device in order to position panel assembly (11) and tank assembly (6) as a unit. The weight of panel assembly (11) and tank assembly (6) is approximately 118 kg (260 lb).

16. Install bolts (8).

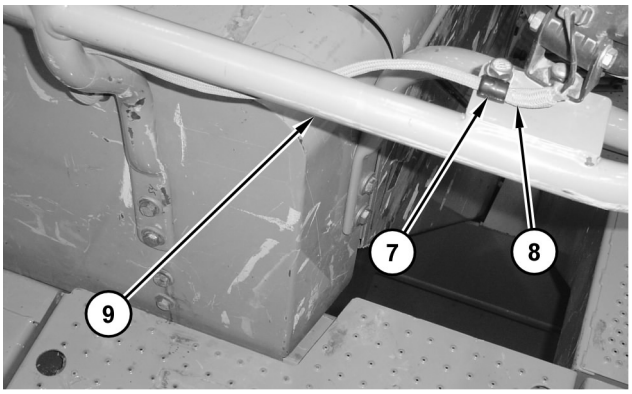


Illustration 131 g01237686

17. Use two people in order to install handrail assembly (9). The weight of handrail assembly (9) is approximately 34 kg (75 lb).

18. Connect harness assembly (8) and install clip (7). Repeat the procedure for the opposite side.

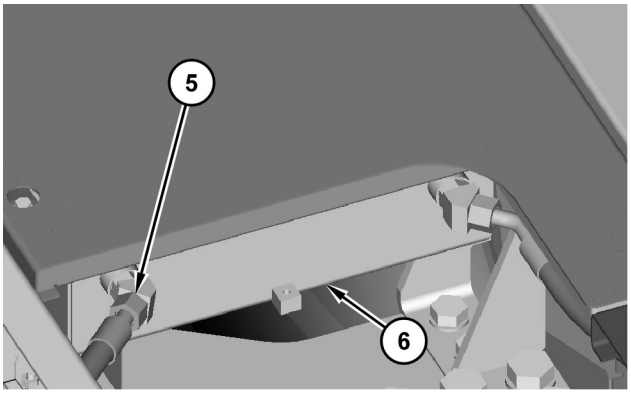


Illustration 132 g01237689

19. Connect hose assembly (5) onto tank assembly (6).

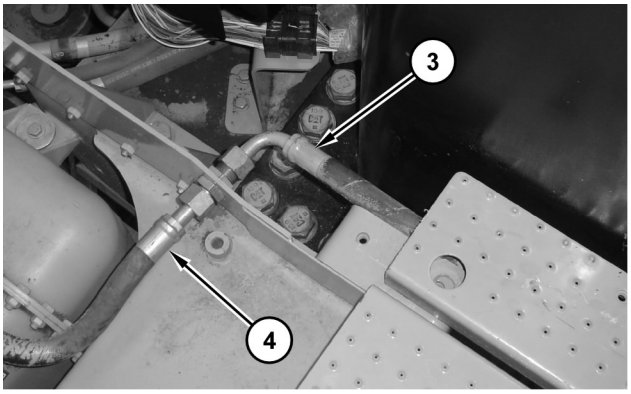


Illustration 133 g01237657

20. Connect hose assembly (4) to the hydraulic oil tank. Connect hose assembly (3).

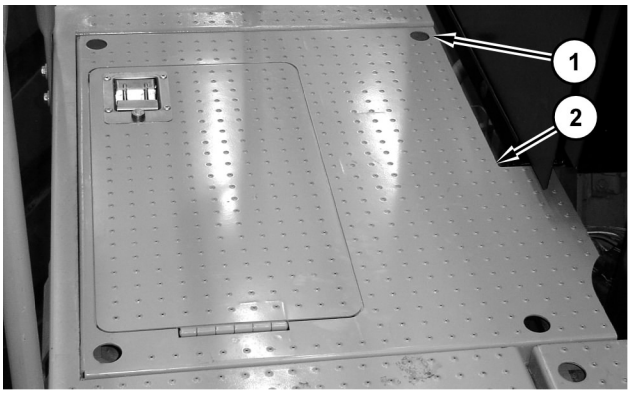


Illustration 134 g01237642

21. Use two people in order to install panel (2). The weight of panel (2) is approximately 27 kg (60 lb). Install bolts (1).

22. Fill the fuel tank. Refer to Operation and maintenance Manual, “Capacities (Refill)”.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect” for the machine that is being serviced.

i08289553

Water Temperature Regulator - Remove

SMCS Code: 1355-011

Removal Procedure

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all hose assemblies, on all tube assemblies, and on all wire harnesses for installation purposes. Plug all hose assemblies and all tube assemblies to prevent fluid loss and prevent contaminants from entering the system.

1. Release the system pressure. Refer to Operation and Maintenance Manual, “System pressure - Release” for the correct procedure.

2. Drain the cooling system coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct draining procedure.

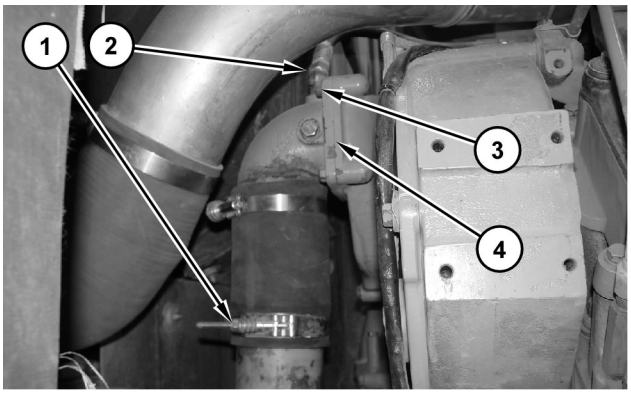


Illustration 135 g01232223

3. Loosen clamp (1) and disconnect hose assembly (2). Remove bolts (3) and elbow (4).

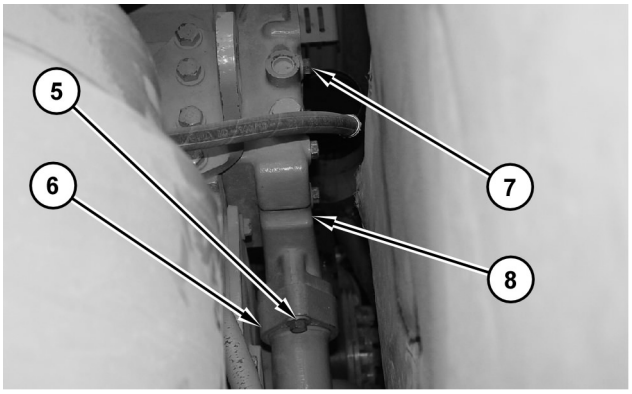


Illustration 136 g01232245

4. Remove bolts (5) to disconnect elbow (6).

5. Remove bolts (7) and water temperature regulator (8).

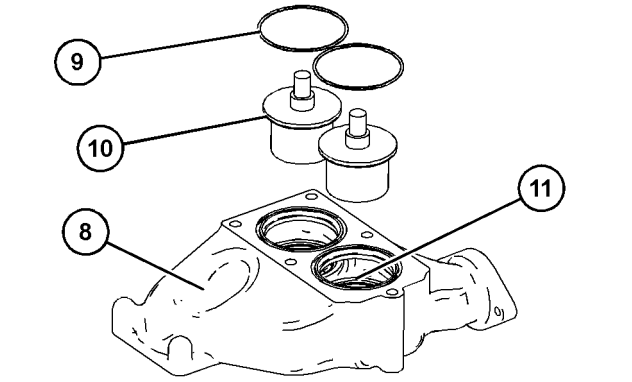


Illustration 137 g06614397

6. Remove O-ring seals (9) and water temperature regulators (10) from water temperature regulator housing (8).

7. Remove lip seals (11).

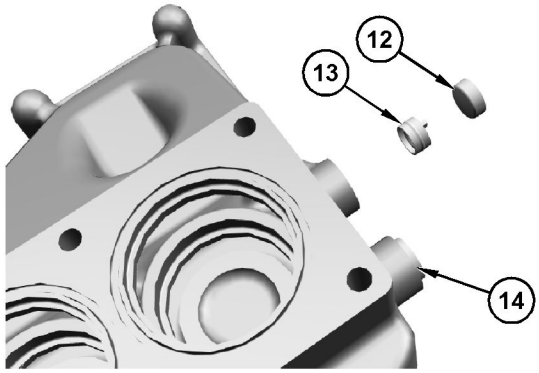


Illustration 138 g06614321

8. Remove plug (12) and valve assembly (13).

9. Remove plug (14) and the O-ring seal.

i08289562

Water Temperature Regulator - Install

SMCS Code: 1355-012

Installation Procedure

Table 15

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT-3578	Driver As	1
B	FT-3642	Driver Tool	1
C	-	Loctite 540	-
D	221-8647	Driver Gp	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

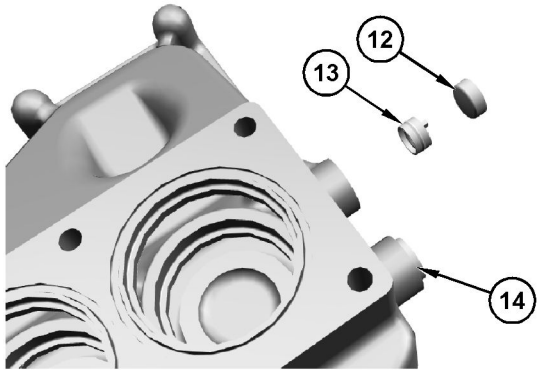


Illustration 139 g06614321

1. Install the O-ring seal and plug (14).

2. Use Tooling (A) (not shown) to install valve assembly (13). Install valve assembly (13).

3. Apply Tooling (C) to plug (12). Use Tooling (B) (not shown) to install plug (12). Install plug (12).

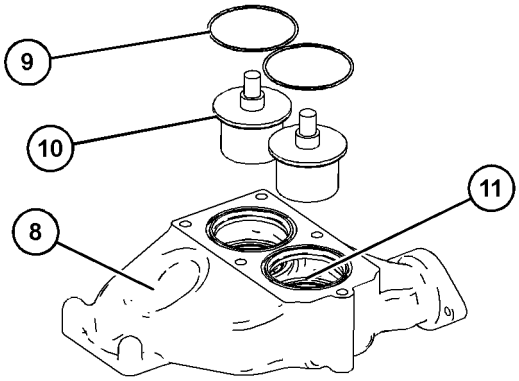


Illustration 140 g06614397

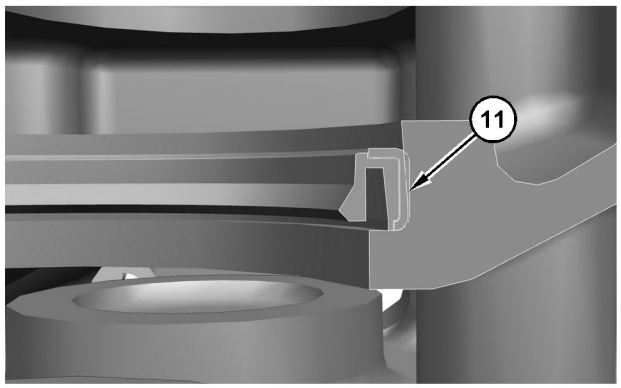


Illustration 141 g06614064

Orientation of the lip seals

4. Use Tooling (D) (not shown) to install lip seals (11). Install lip seals (11) in the orientation as shown in Illustration 141 .

5. Install water temperature regulators (10) and O-ring seals (9) into water temperature regulator housing (8).

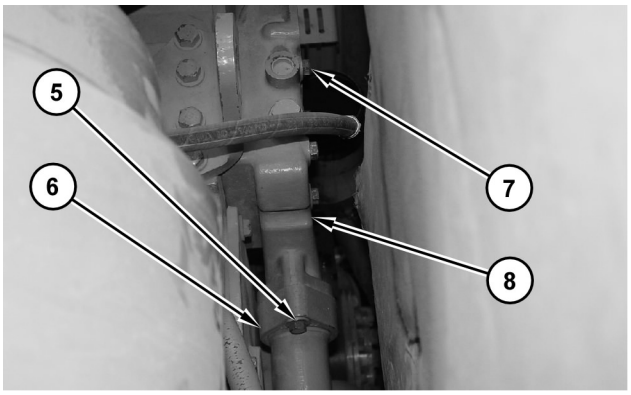


Illustration 142 g01232245

6. Position water temperature regulator housing (8) on the engine. Install bolts (7).

7. Install bolts (5) to connect elbow (6).

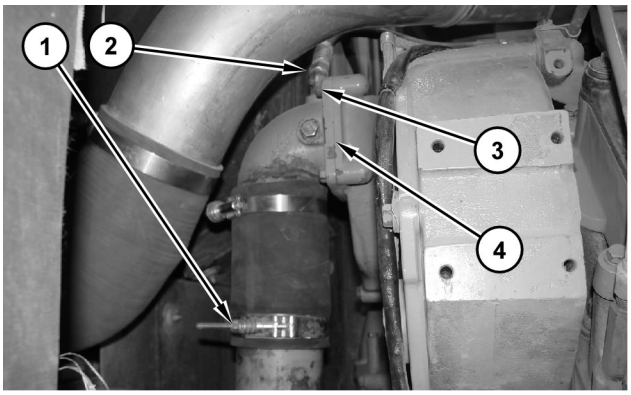


Illustration 143 g01232223

8. Position elbow (4) and install bolts (3). Connect hose assembly (2). Tighten clamp (1) to a torque of 11 N·m (97 lb in).

9. Fill the cooling system with the coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct filling procedure.

i02289620

Water Pump - Remove

SMCS Code: 1361-011

S/N: BTW1–99999

S/N: BWX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

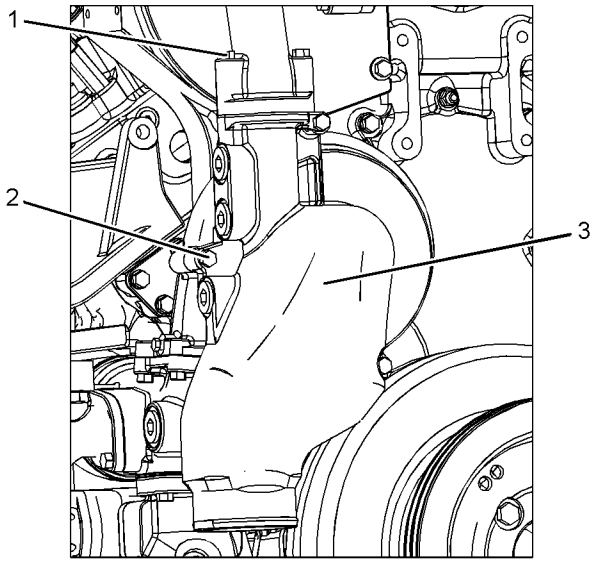


Illustration 144 g01146307

2. Remove bolts (1) and bolts (2).

3. Remove cover (3).

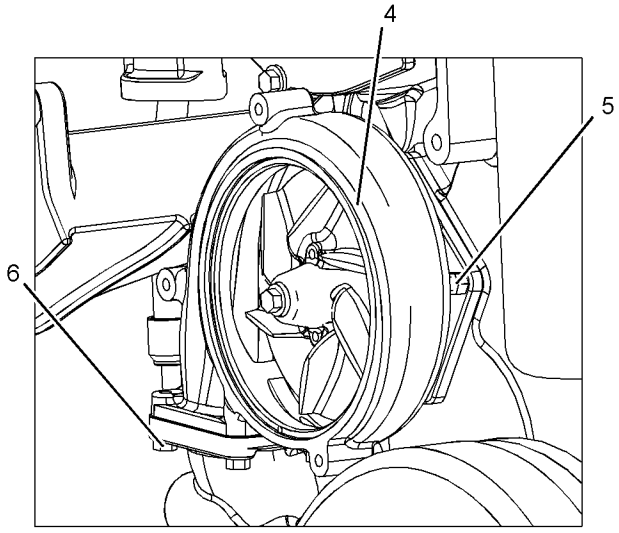


Illustration 145 g01146308

4. Remove bolts (6) and nuts (5).

5. Remove water pump (4).

i02471420

Water Pump - Remove

SMCS Code: 1361-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

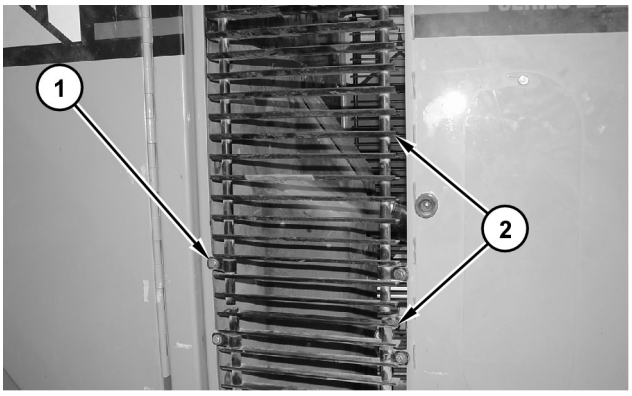


Illustration 146 g01232814

2. Remove bolts (1) and open grill assemblies (2).

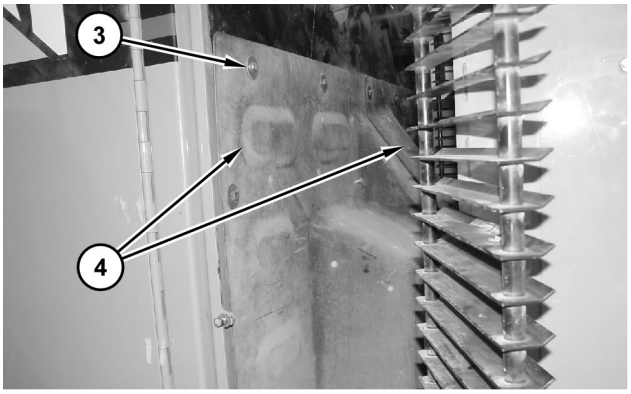


Illustration 147 g01232815

3. Remove bolts (3) and remove baffles (4).

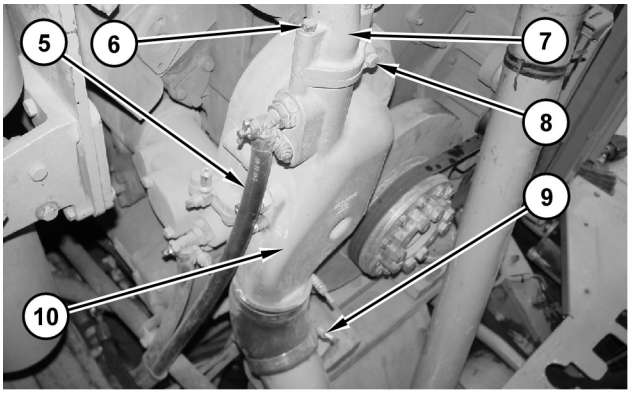


Illustration 148 g01232408

4. Disconnect hose (5).

5. Remove bolts (6) in order to disconnect elbow (7).

6. Loosen clamp (9).

7. Remove three bolts (8) in order to remove housing (10).

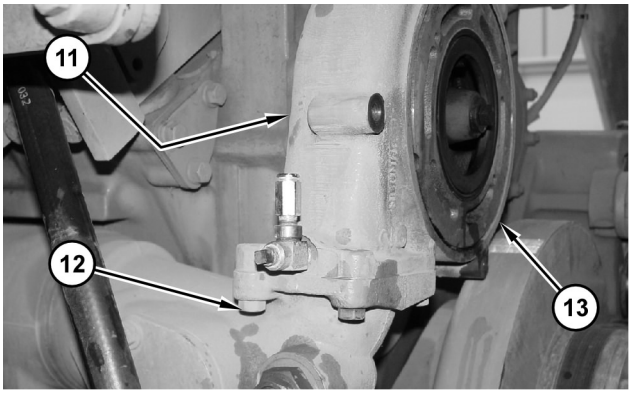


Illustration 149 g01232424

8. Remove bolts (11).

9. Remove bolts (12) in order to remove water pump (13).

i02290018

Water Pump - Install

SMCS Code: 1361-012

S/N: BTW1–99999

S/N: BWX1–Up

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

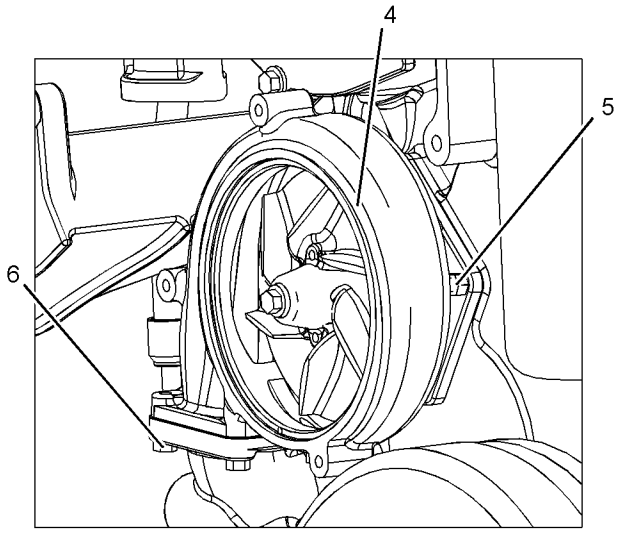


Illustration 150 g01146308

1. Position water pump (4) in the front housing.

2. Install nuts (5) and bolts (6).

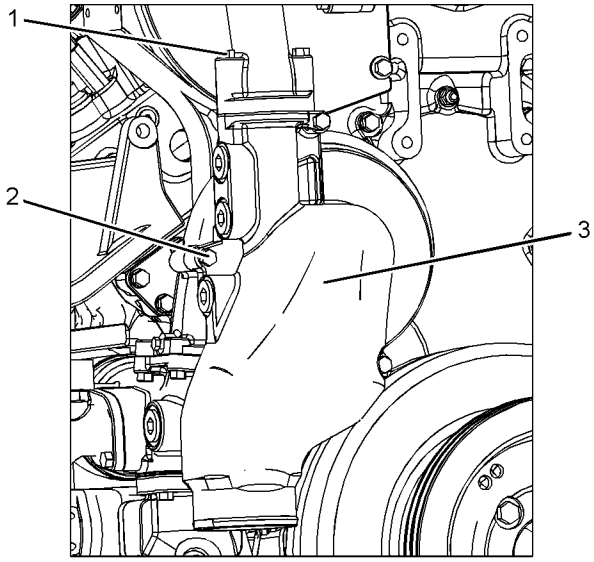


Illustration 151 g01146307

3. Position cover (3) on the water pump.

4. Install bolts (2) and bolts (1).

5. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i02471424

Water Pump - Install

SMCS Code: 1361-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

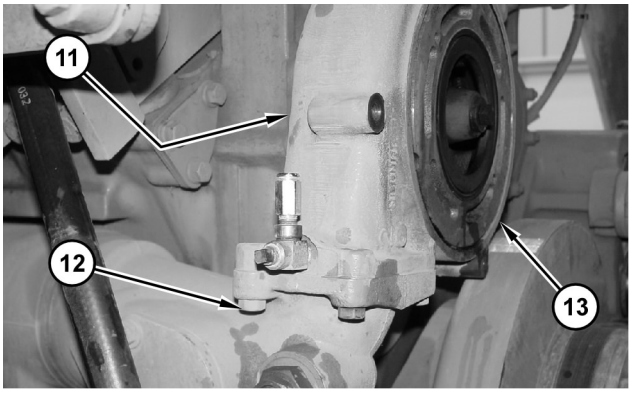


Illustration 152 g01232424

1. Position water pump (13) and install bolts (12).

2. Install bolts (11).

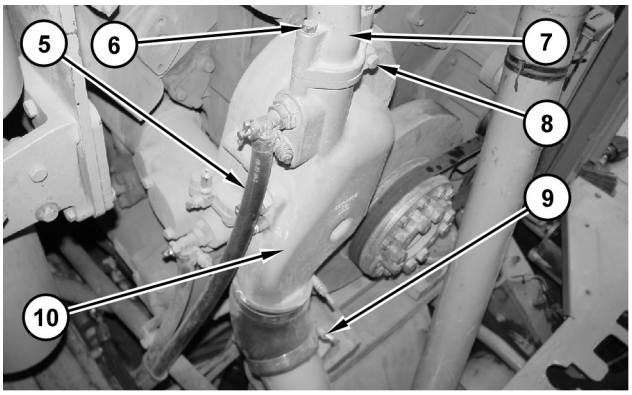


Illustration 153 g01232408

3. Position housing (10) and install bolts (8).

4. Tighten clamp (9) to a torque of 11 N·m (97 lb in).

5. Position elbow (7) and install bolts (6).

6. Connect hose (5). Tighten the clamp to a torque of 11 N·m (97 lb in).

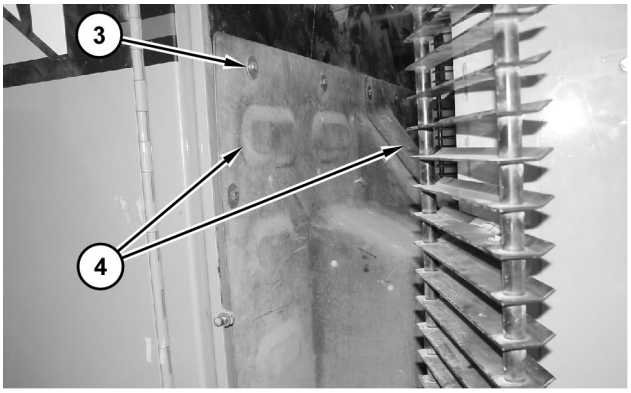


Illustration 154 g01232815

7. Position baffles (4) and install bolts (3).

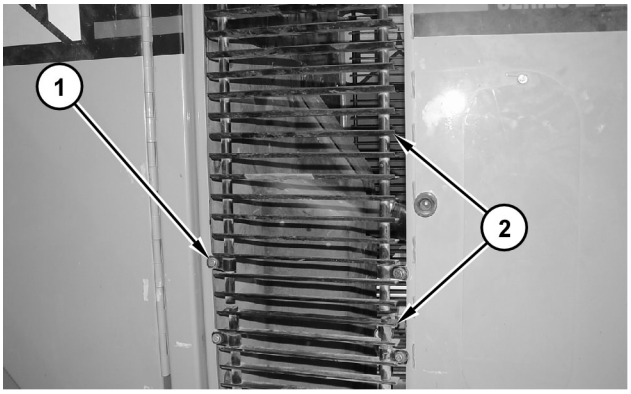


Illustration 155 g01232814

8. Close grill assemblies (2) and install bolts (1).

9. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i02469601

Fuel Cooler - Remove and Install

SMCS Code: 1712-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

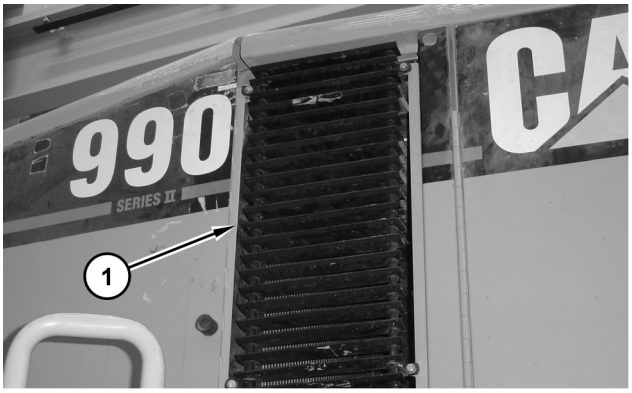


Illustration 156 g01231658

1. Remove grill assembly (1). Repeat for the opposite side.

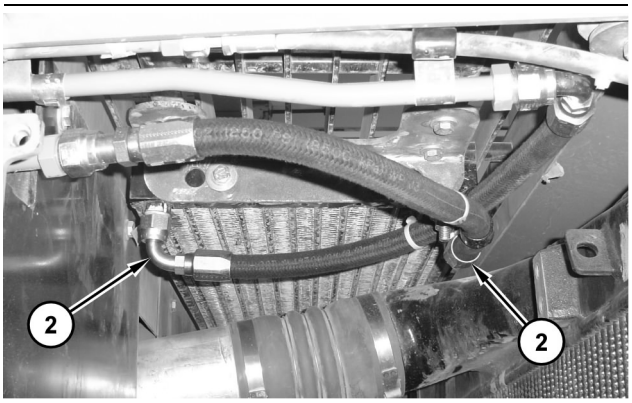


Illustration 157 g01231661

2. Disconnect hose assemblies (2).

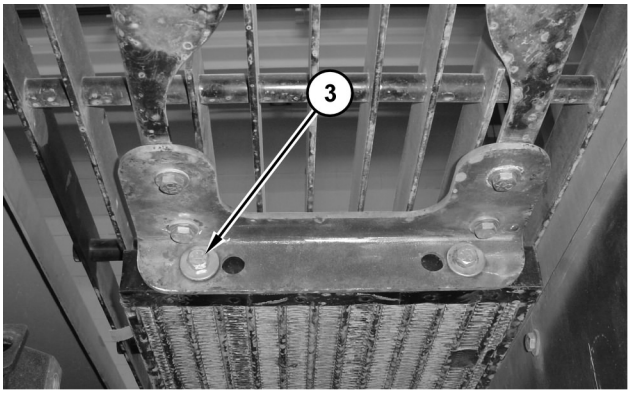


Illustration 158 g01231662

3. Remove bolts (3).

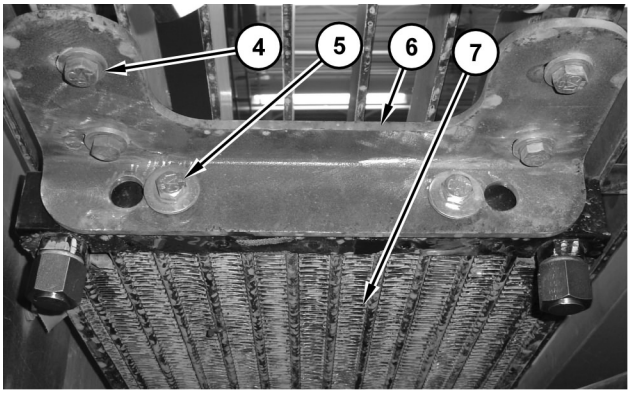


Illustration 159 g01231663

4. Remove bolts (4). Remove bolts (5). Remove bracket (6). Remove fuel cooler (7).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

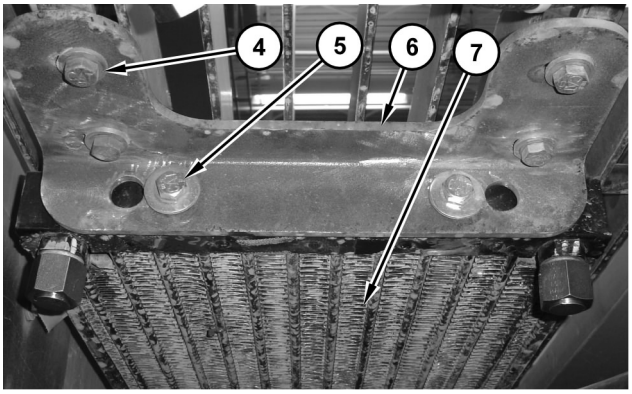


Illustration 160 g01231663

1. Position fuel cooler (7). Install bracket (6) and install bolts (5). Install bolts (4).

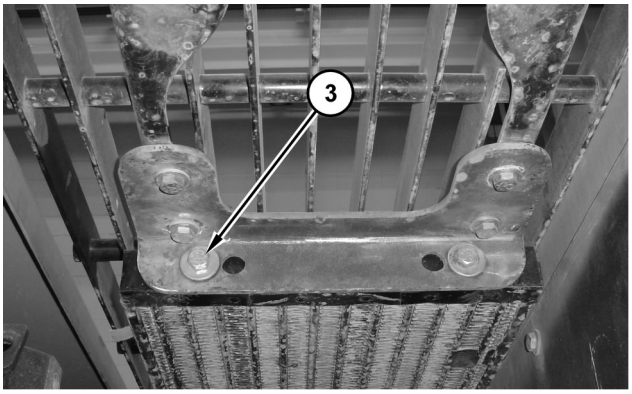


Illustration 161 g01231662

2. Install bolts (3).

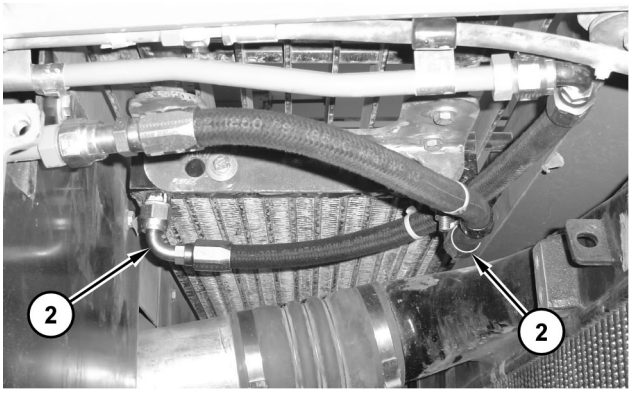


Illustration 162 g01231661

3. Connect hose assemblies (2).

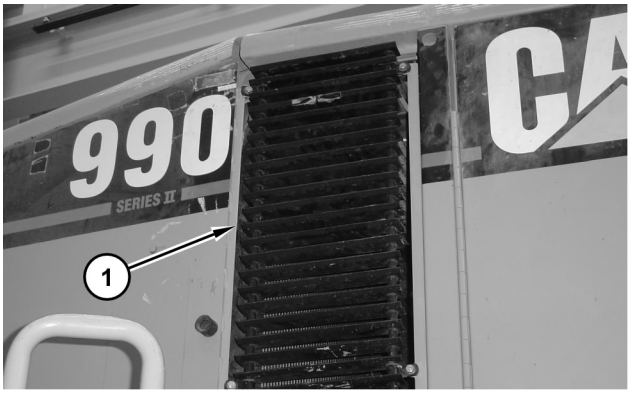


Illustration 163 g01231658

4. Install grill assembly (1). Repeat for the opposite side.

i02472718

Oil Cooler (Transmission) - Remove
(Engine in Machine)

SMCS Code: 1375-011

Removal Procedure

Start By:

a. Remove the hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Remove”.

b. Remove the crankcase guard. Refer to Disassembly and Assembly, “Crankcase Guard - Remove and Install”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

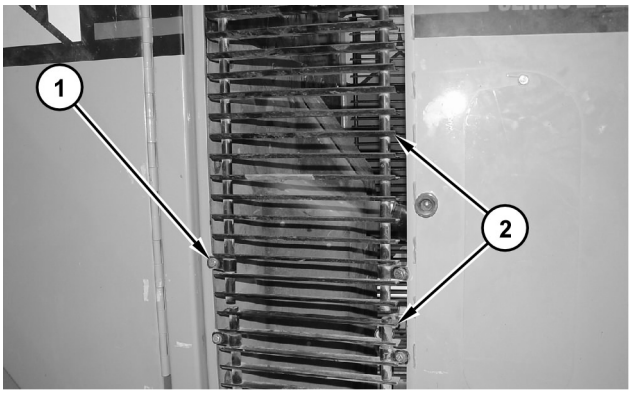


Illustration 164 g01232814

2. Remove bolts (1) and open grill assemblies (2).

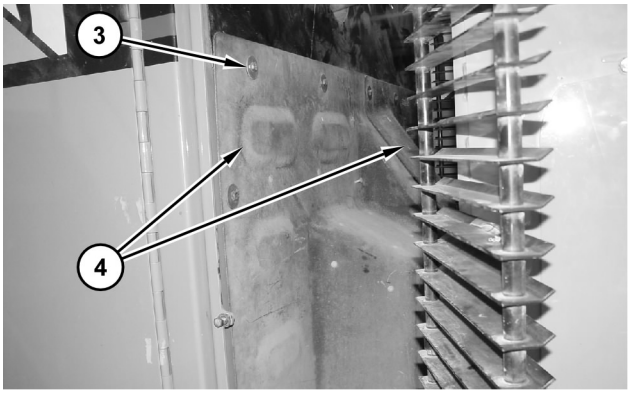


Illustration 165 g01232815

3. Remove bolts (3) and remove baffles (4).

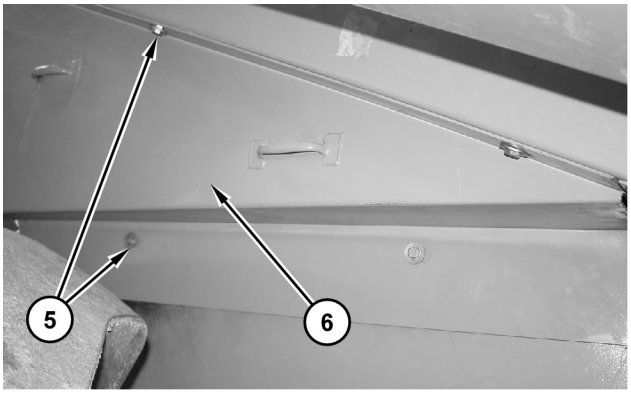


Illustration 166 g01232862

4. Remove bolts (5). Remove panel assembly (6).

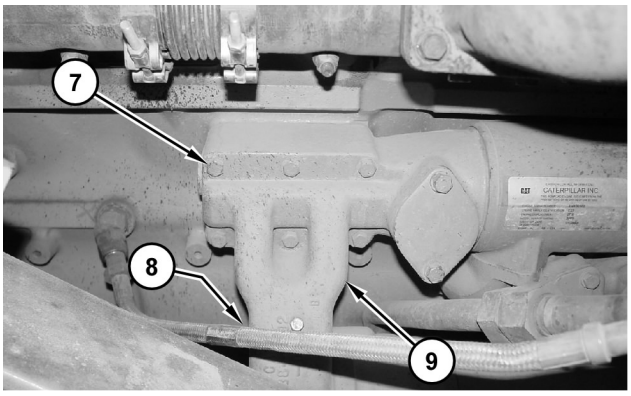


Illustration 167 g01232940

5. Remove bolts (7). Remove bolts (8). Remove bonnet (9).

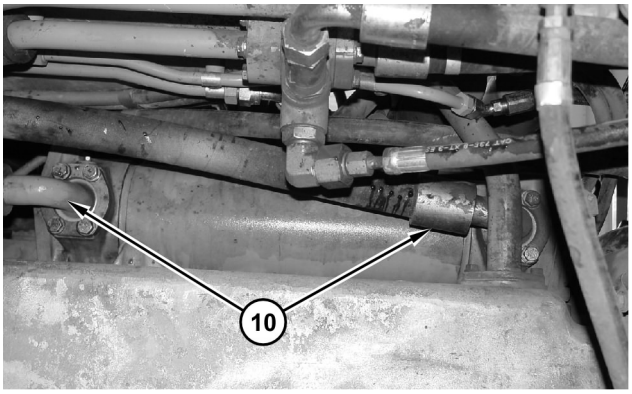


Illustration 168 g01233457

6. Disconnect hose assemblies (10).

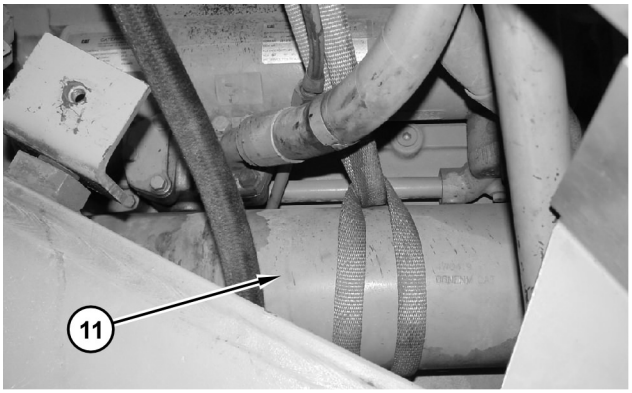


Illustration 169 g01233458

7. Attach a suitable lifting device onto transmission oil cooler (11). The weight of transmission oil cooler (11) is approximately 45 kg (100 lb).

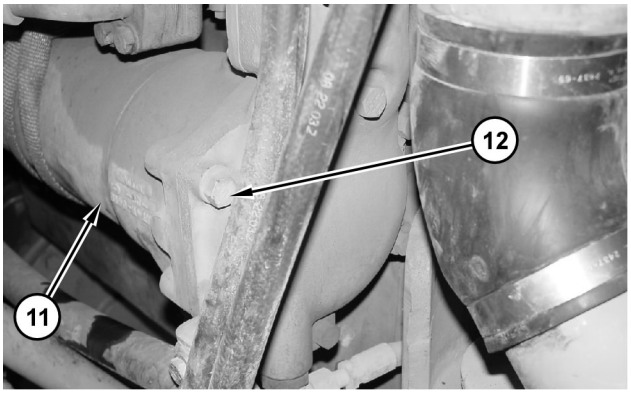


Illustration 170 g01233460

8. Remove bolts (12) and remove transmission oil cooler (11).

i02504271

Oil Cooler (Transmission) - Install
(Engine in Machine)

SMCS Code: 1375-012

Installation Procedure

Table 16

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	**1U-6396**	**O-Ring Assembly Compound**	**1**
B	5H-2471	Adhesive	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Check the condition of the gaskets and the O-ring seals. If the gaskets or the O-ring seals are worn or damaged, use new parts for replacement.

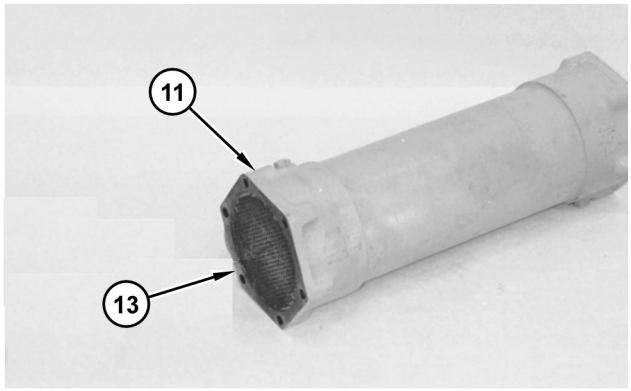


Illustration 171 g01233480

1. Carefully clean the tube bundles that are in transmission oil cooler (11). Use a rod with a 3.20 mm (0.125 inch) diameter.

2. Use Tooling (B) in order to install gasket (13) onto transmission oil cooler (11).

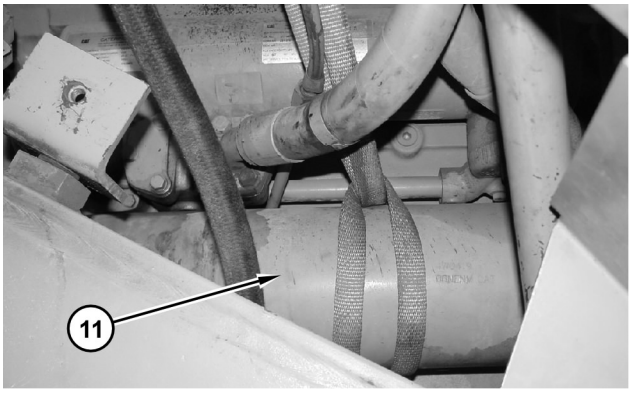


Illustration 172 g01233458

3. Attach a suitable lifting device onto transmission oil cooler (11). The weight of transmission oil cooler (11) is approximately 45 kg (100 lb).

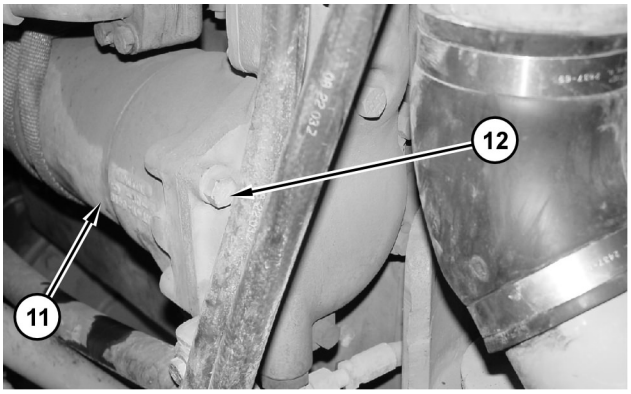


Illustration 173 g01233460

4. Position transmission oil cooler (11) and install bolts (12).

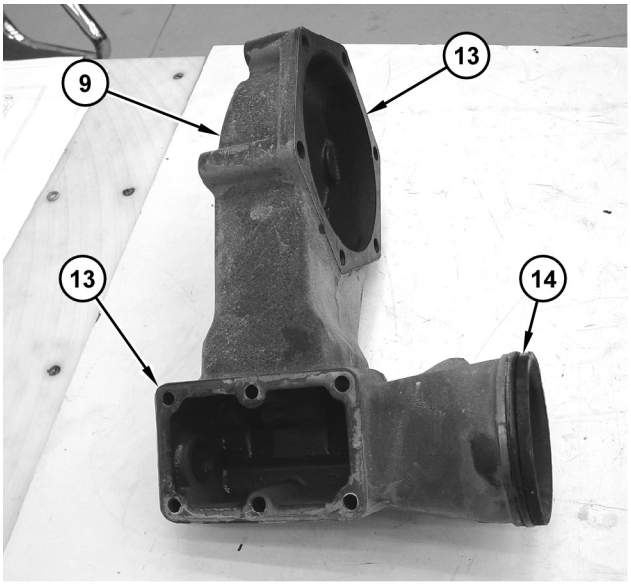


Illustration 174 g01234865

5. Apply Tooling (B) to the contact surface of bonnet (9) and install gaskets (13). Apply Tooling (A) onto O-ring seal (14) and install O-ring seal (14) onto bonnet (9).

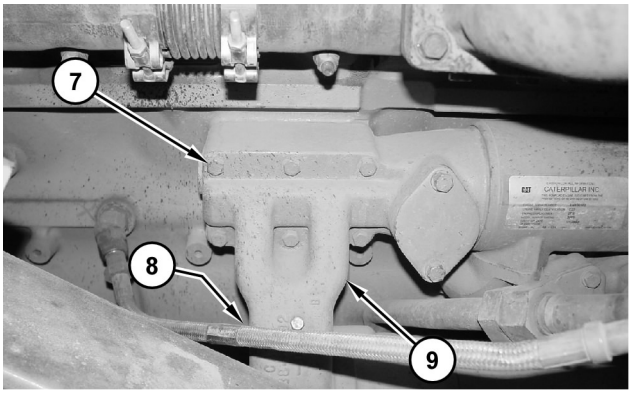


Illustration 175 g01232940

6. Position bonnet (9). Install bolts (8) and install bolts (7).

Note: Lightly tighten bolts (8) and bolts (7) before applying torque.

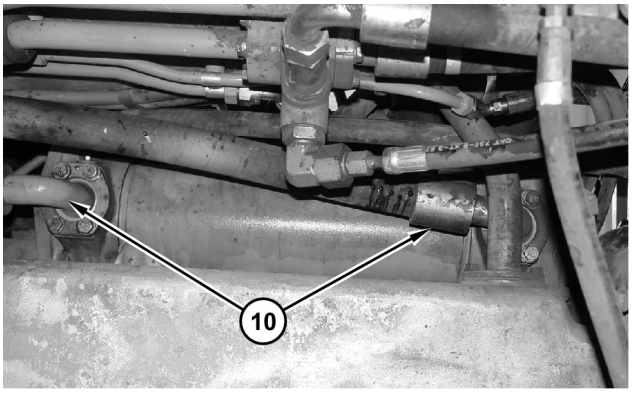


Illustration 176 g01233457

7. Connect hose assemblies (10).

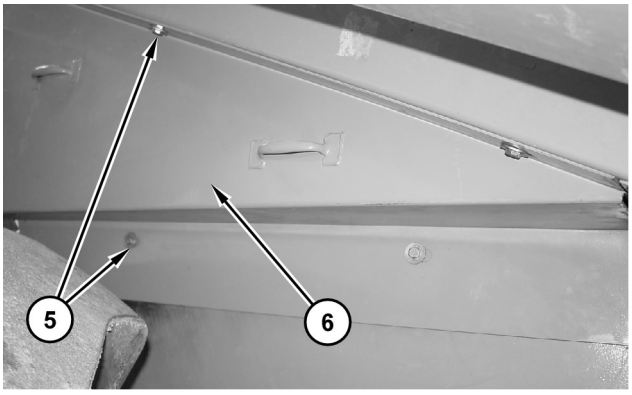


Illustration 177 g01232862

8. Install panel assembly (6) and install bolts (5).

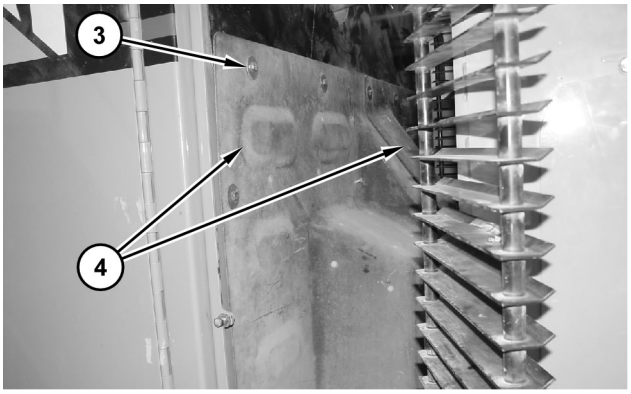


Illustration 178 g01232815

9. Position baffles (4) and install bolts (3).

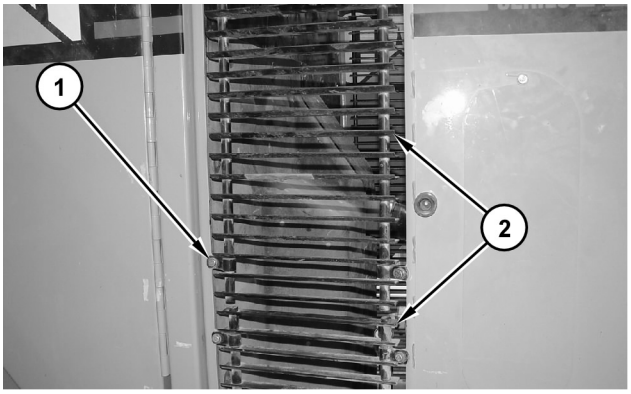


Illustration 179 g01232814

10. Close grill assemblies (2). Install bolts (1).

11. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

End By:

a. Install the hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Install”.

b. Install the crankcase guard. Refer to Disassembly and Assembly, “Crankcase Guard - Remove and Install”.

i02471975

Oil Cooler (Engine) - Remove (Engine in Machine)

SMCS Code: 1378-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

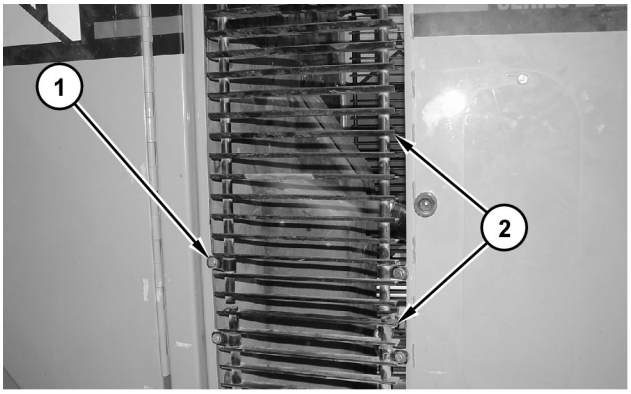


Illustration 180 g01232814

2. Remove bolts (1) and open grill assemblies (2).

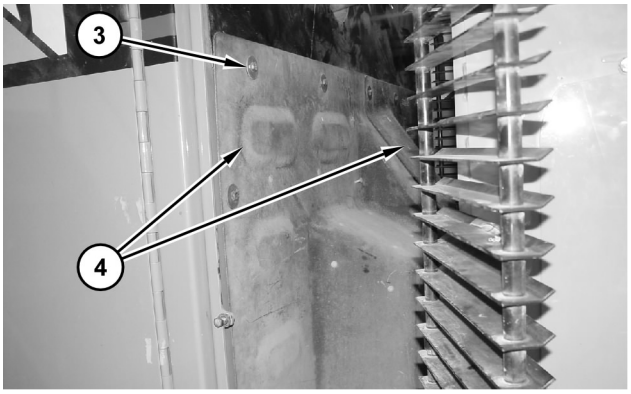


Illustration 181 g01232815

3. Remove bolts (3) and remove baffles (4).

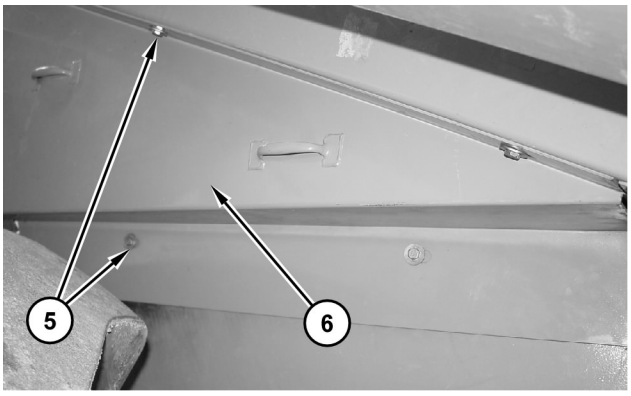


Illustration 182 g01232862

4. Remove bolts (5). Remove panel assembly (6).

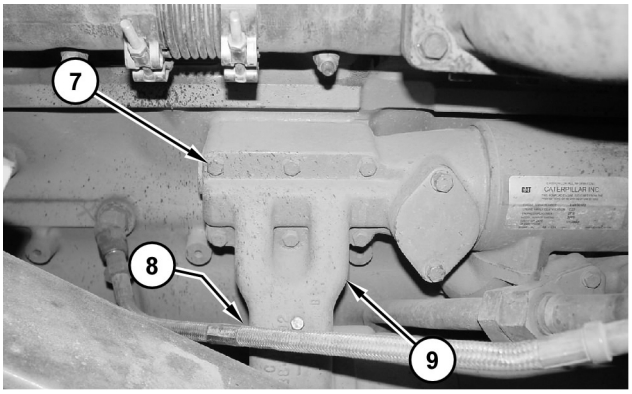


Illustration 183 g01232940

5. Remove bolts (7) and remove bolts (8) from bonnet (9).

6. Remove bonnet (9).

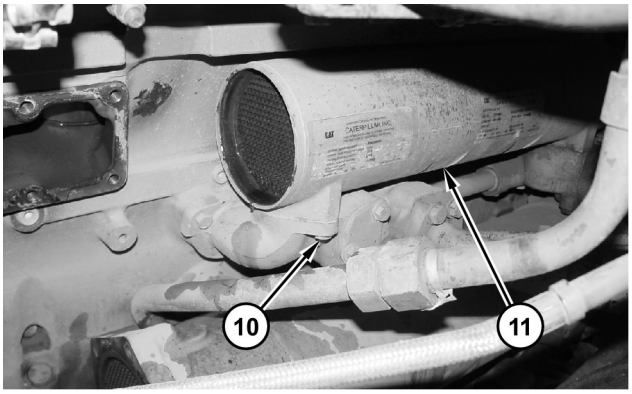


Illustration 184 g01232937

7. Remove bolts (10) from both ends of engine oil cooler (11). Remove engine oil cooler (11).

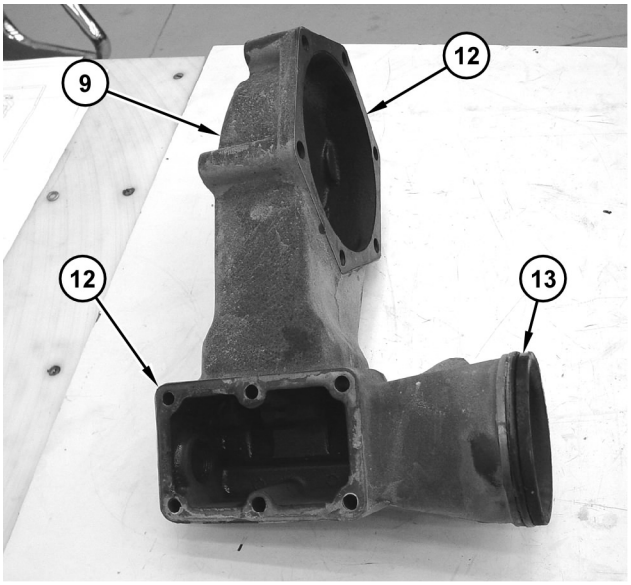


Illustration 185 g01232927

8. Remove gaskets (12) and remove O-ring seal (13) from bonnet (9).

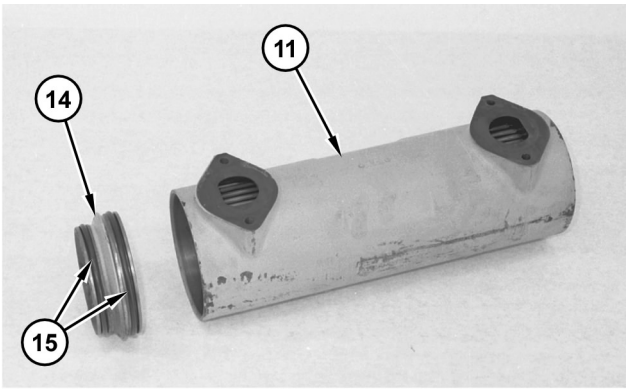


Illustration 186 g01232926

9. Remove adapter (14) from engine oil cooler (11). Remove O-ring seals (15) from adapter (14).

i02504279

Oil Cooler (Engine) - Install (Engine in Machine)

SMCS Code: 1378-012

Installation Procedure

Table 17

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	**1U-6396**	**O-Ring Assembly Compound**	**1**
B	5H-2471	Adhesive	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Check the condition of the O-ring seals. If the O-ring seals are worn or damaged, use new parts for replacement. Always replace used gaskets with new gaskets.

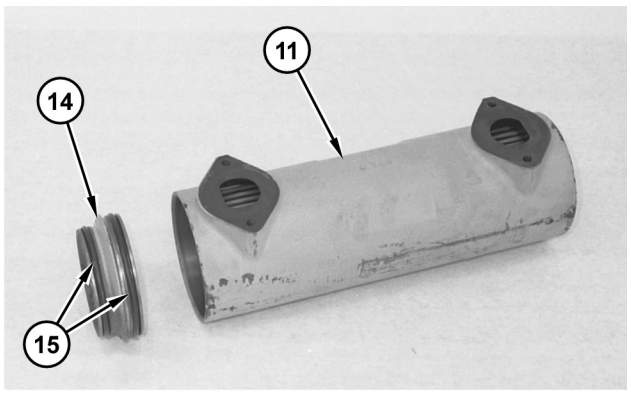


Illustration 187 g01232926

1. Apply Tooling (A) to the bore of engine oil cooler (11) and O-ring seals (15).

2. Install O-ring seals (15) on adapter (14).

3. Install adapter (14) into engine oil cooler (11).

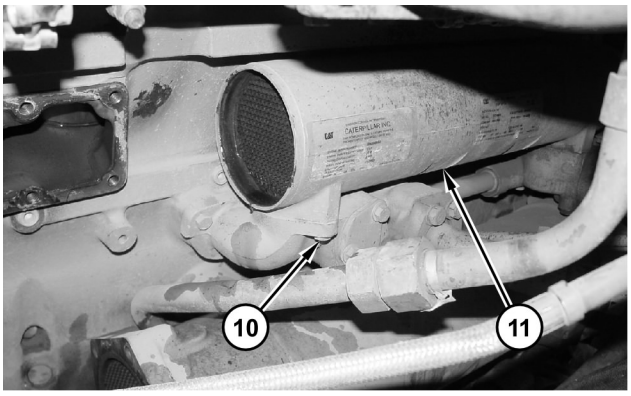


Illustration 188 g01232937

4. Position engine oil cooler (11) and install bolts (10).

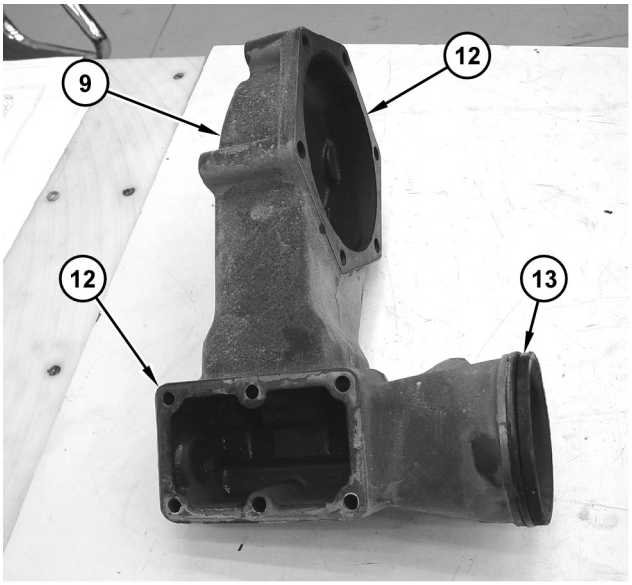


Illustration 189 g01232927

5. Apply Tooling (B) to the contact surface of bonnet (9) and install gaskets (12). Apply Tooling (A) onto O-ring seal (13) and install O-ring seal (13) onto bonnet (9).

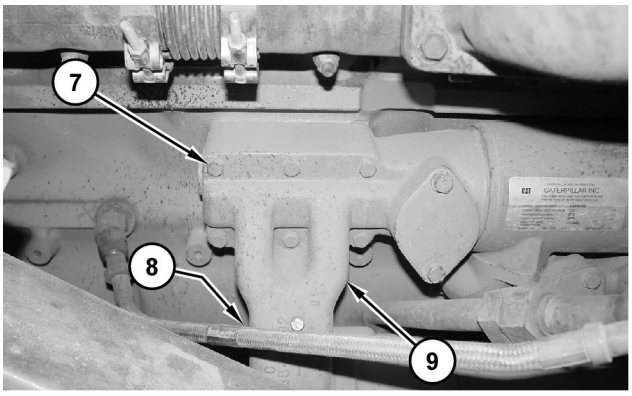


Illustration 190 g01232940

6. Position bonnet (9). Install bolts (8) and install bolts (7).

Note: Lightly tighten bolts (8) and bolts (7) before applying torque.

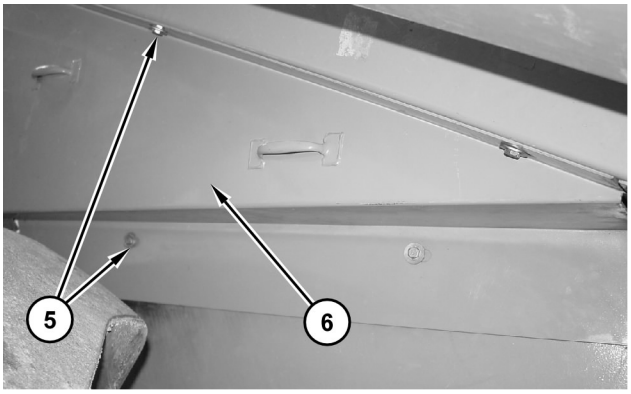


Illustration 191 g01232862

7. Position panel assembly (6) and install bolts (5).

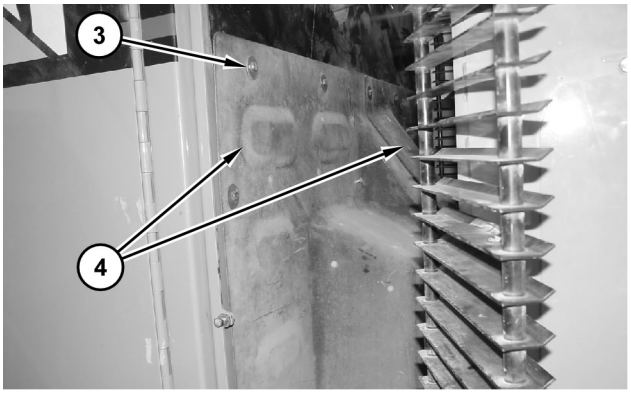


Illustration 192 g01232815

8. Position baffles (4) and install bolts (3).

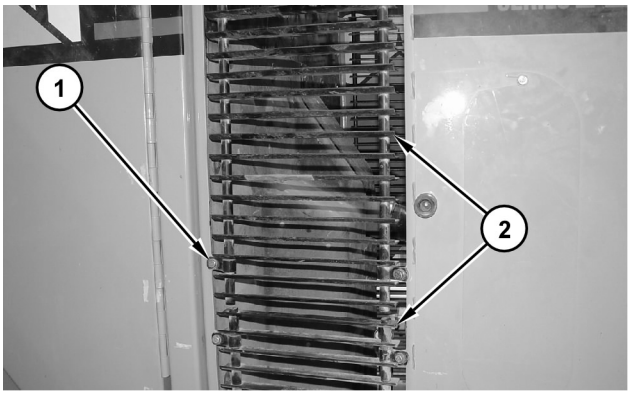


Illustration 193 g01232814

9. Close grill assemblies (2). Install bolts (1).

10. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i02479130

Radiator Top Tank - Remove

SMCS Code: 1377-011-TP

Removal Procedure

Start By:

a. Remove the front hood panel. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the cooling system to a level below the tank into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Capacities (Refill)”.

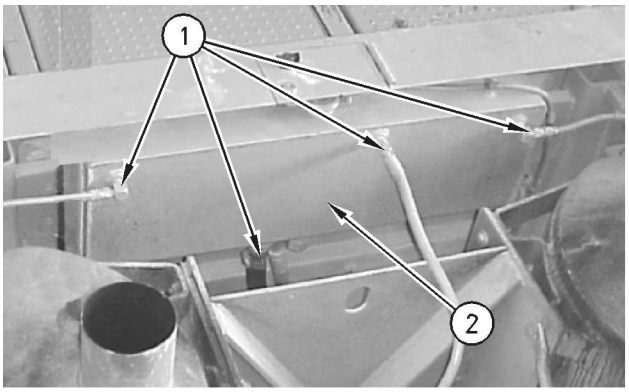


Illustration 194 g00844426

2. Remove hose assemblies (1) from top radiator tank (2).

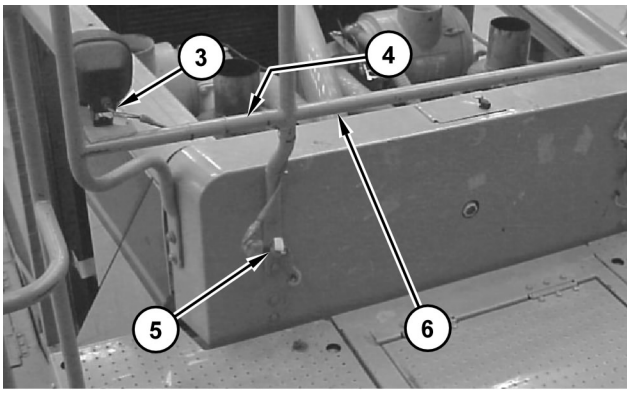


Illustration 195 g01241156

3. Disconnect harness assembly (3) and remove clip (4). Repeat the procedure for the opposite side.

4. Remove bolts (5).

5. Use a suitable lifting device in order to remove handhold assembly (6). The weight of handhold assembly (6) is approximately 34 kg (75 lb).

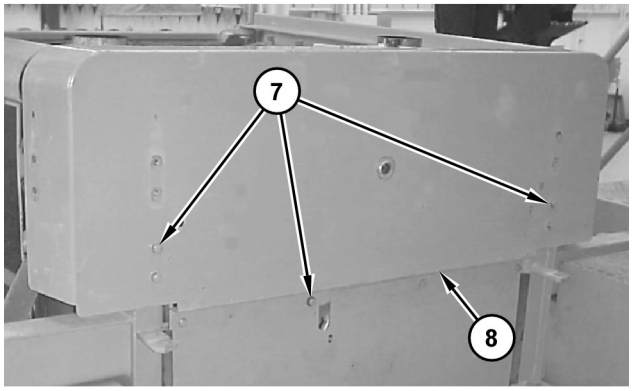


Illustration 196 g01241164

Note: Floor panels have been removed for photographic purposes.

6. Remove bolts (7).

7. Use two people in order to remove panel assembly (8). The weight of panel assembly (8) is approximately 27 kg (60 lb).

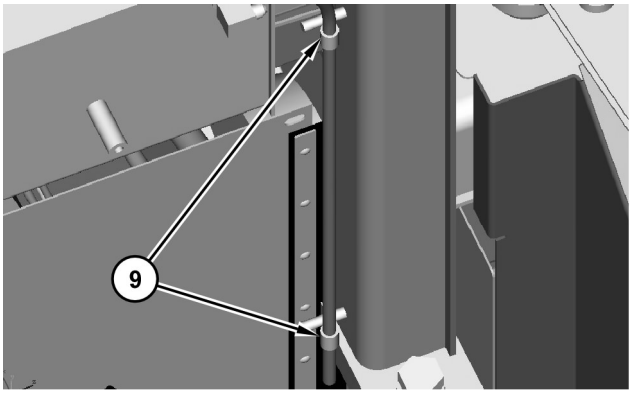


Illustration 197 g01241168

8. Remove clips (9).

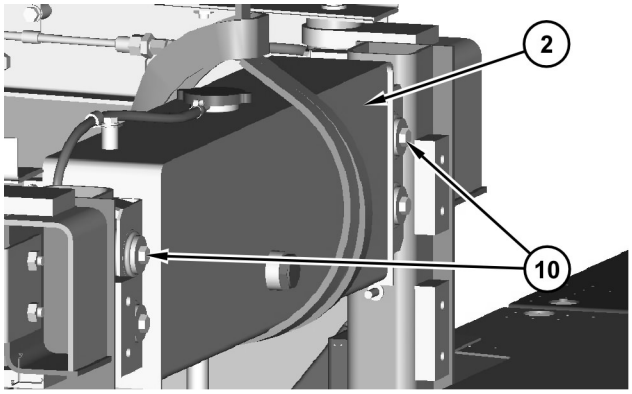


Illustration 198 g01241171

9. Attach a suitable lifting device onto top radiator tank (2). The weight of top radiator tank (2) is 41 kg (90 lb).

10. Remove bolts (10).

11. Remove top radiator tank (2).

i02479132

Radiator Top Tank - Install

SMCS Code: 1377-012-TP

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

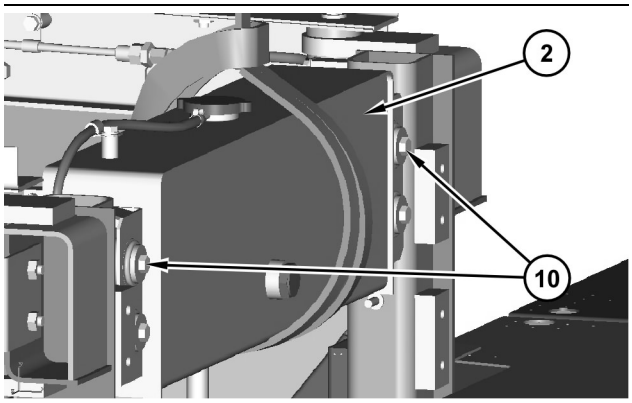


Illustration 199 g01241171

1. Use a suitable lifting device in order to position top radiator tank (2). The weight of top radiator tank is approximately 41 kg (90 lb).

2. Install bolts (10).

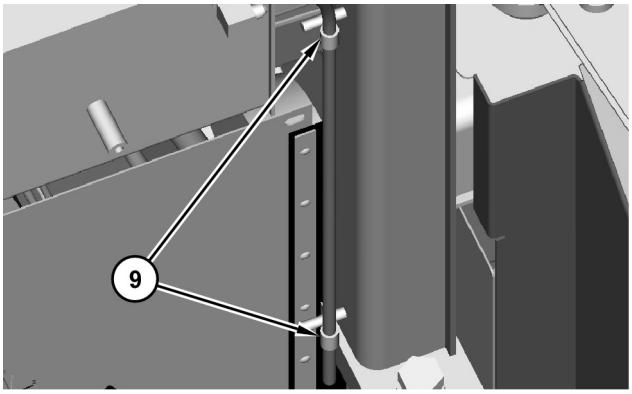


Illustration 200 g01241168

3. Install clips (9).

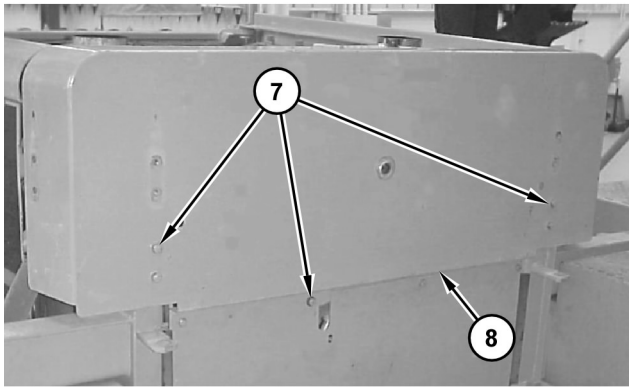


Illustration 201 g01241164

Note: Floor panels have been removed for photographic purposes.

4. Use two people in order to install panel assembly (8). The weight of panel assembly (8) is approximately 27 kg (60 lb).

5. Install bolts (7).

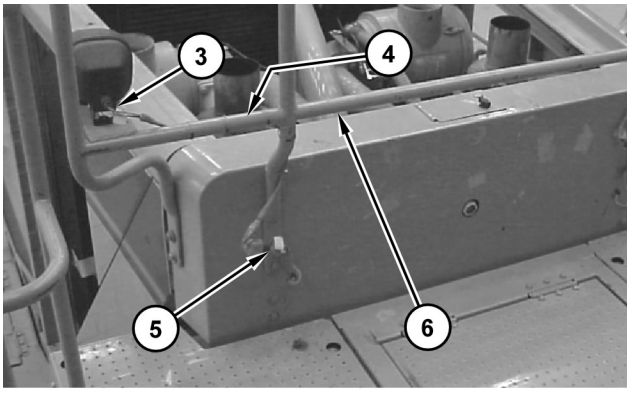


Illustration 202 g01241156

6. Use a suitable lifting device in order to install handhold assembly (6). The weight of handhold assembly (6) is approximately 34 kg (75 lb).

7. Install bolts (5).

8. Connect harness assembly (3) and install clip (4). Repeat the procedure for the opposite side.

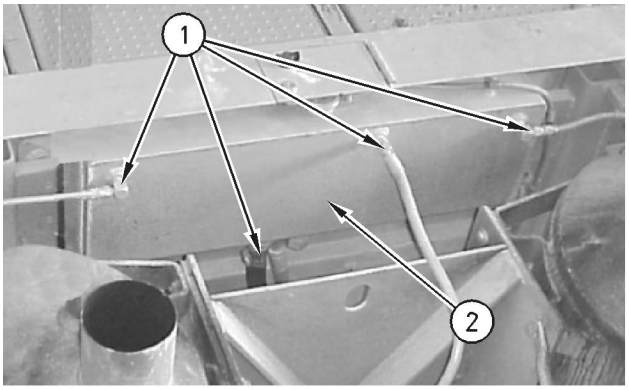


Illustration 203 g00844426

9. Connect hose assemblies (1) onto top radiator tank (2).

10. Fill the cooling system. Refer to Operation and Maintenance Manual, “Capacities (Refill)”.

End By:

a. Install the front hood panel. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Install”.

i02476021

Fan and Piston Motor (Hydraulic Fan) - Remove

SMCS Code: 1356-011-MW; 1386-011-QP

Removal Procedure

Table 18

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	4
B	140-7742	Sleeve	2

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

At operating temperature the implement hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible injury, release the pressure in the implement hydraulic system before hydraulic lines or components are disconnected or removed.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

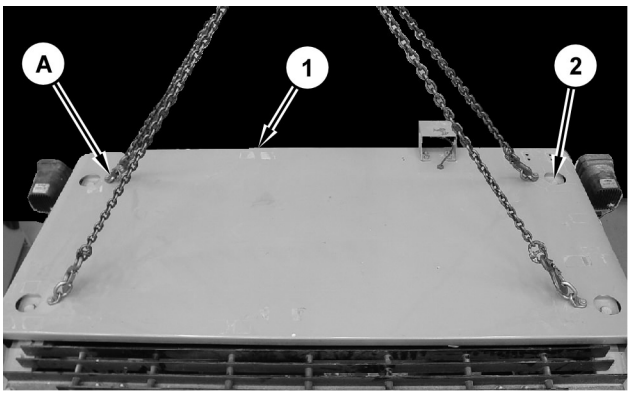


Illustration 204 g01236127

1. Attach Tooling (A) and a suitable lifting device onto panel assembly (1). The weight of panel assembly is approximately 66 kg (145 lb).

2. Remove bolts (2) and raise panel assembly (1) slightly.

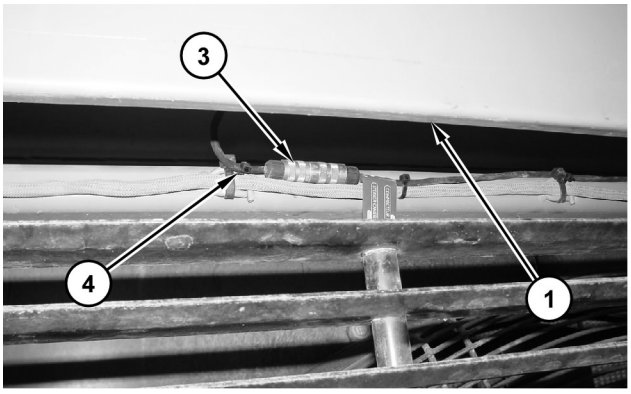


Illustration 205 g01239507

3. Disconnect harness assembly (3). Remove cable strap (4).

4. Remove panel assembly (1).

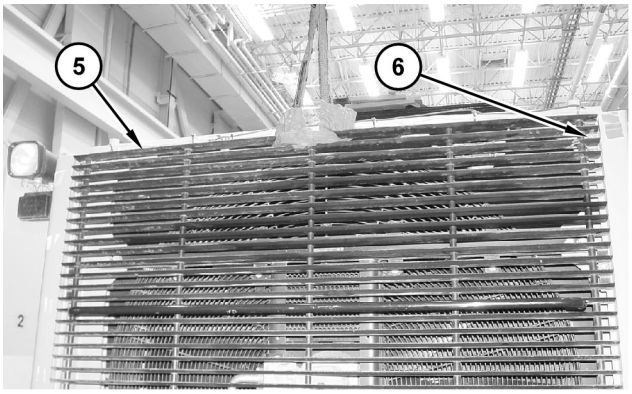


Illustration 206 g01236006

5. Attach a suitable lifting device and Tooling (B) onto grill assembly (5). The weight of grill assembly (5) is approximately 61 kg (135 lb).

6. Remove bolts (6). Remove grill assembly (5).

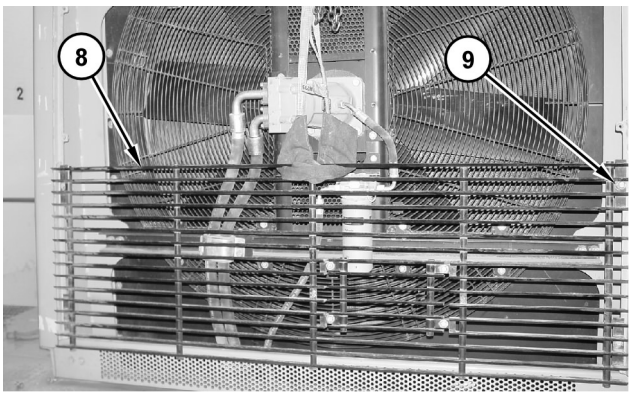


Illustration 207 g01236015

7. Attach a suitable lifting device and Tooling (B) onto grill assembly (8). The weight of grill assembly (8) is approximately 36 kg (80 lb).

8. Remove bolts (9). Remove grill assembly (8).

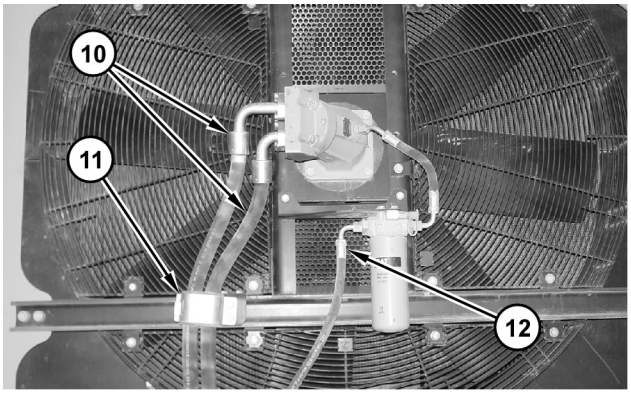


Illustration 208 g01236018

9. Disconnect hose assemblies (10). Remove clip (11). Disconnect hose assembly (12).

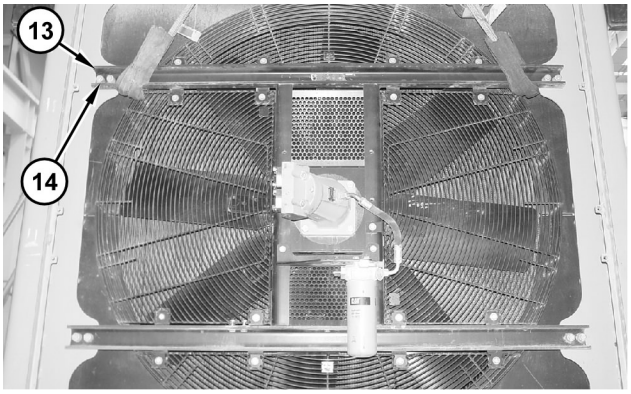


Illustration 209 g01236025

10. Attach a suitable lifting device and Tooling (B) onto fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 261 kg (575 lb).

11. Remove bolts (14). Remove fan and piston motor assembly (13).

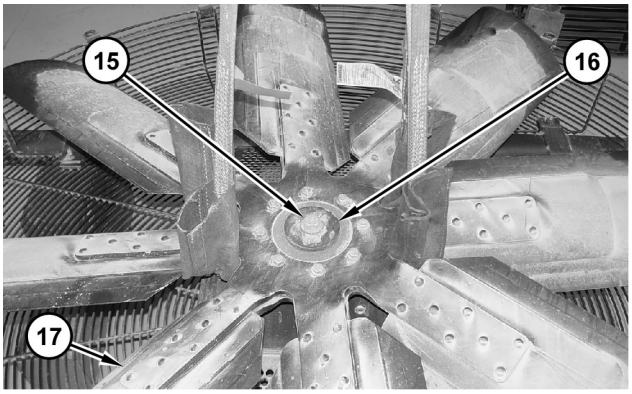


Illustration 210 g01236066

12. Position fan and piston motor assembly (13) onto suitable blocking.

13. Remove bolt (15) and washer (16). Remove fan assembly (17). The weight of fan assembly (17) is approximately 86 kg (190 lb).

14. Use a suitable lifting device in order to turn over fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 175 kg (385 lb).

Note: The fan has been removed.

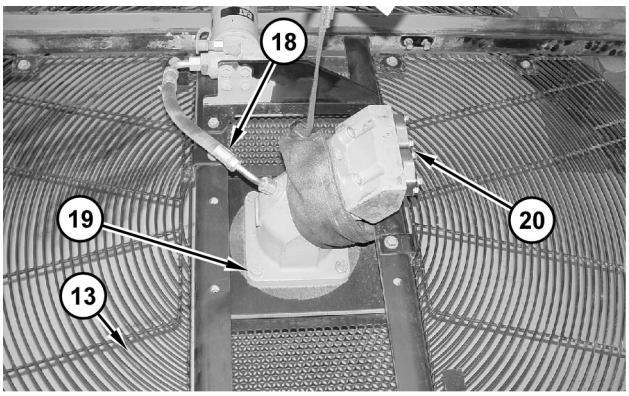


Illustration 211 g01236064

15. Attach a suitable lifting device and Tooling (B) onto piston motor (20). Disconnect hose assembly (18). Remove bolts (19). Remove piston motor (20). The weight of piston motor (20) is approximately 34 kg (75 lb).

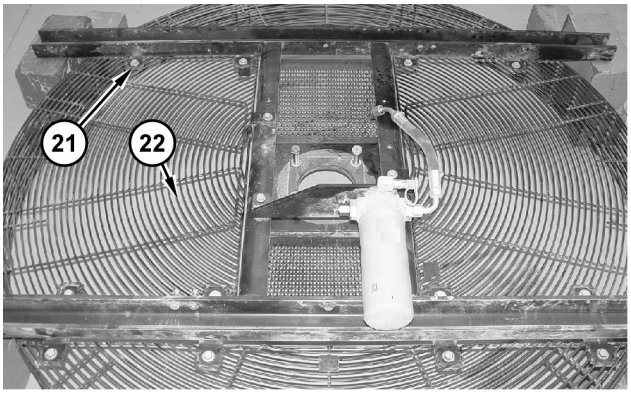


Illustration 212 g01236085

16. If necessary, Remove bolts (21) in order to remove guard assemblies (22).

i02476023

Fan and Piston Motor (Hydraulic Fan) - Install

SMCS Code: 1356-012-MW; 1386-012-QP

Installation Procedure

Table 19

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	140-7742	Sleeve	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

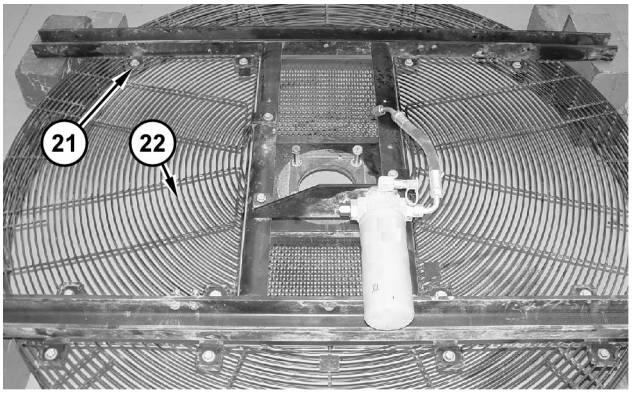


Illustration 213 g01236085

1. If the guards were removed, position guard assemblies (22) and install bolts (21).

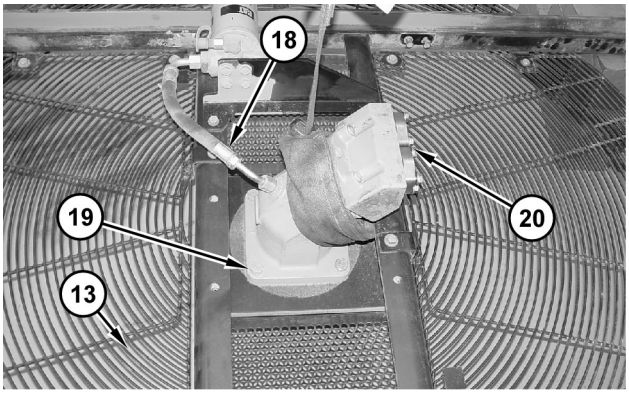


Illustration 214 g01236064

2. Attach a suitable lifting device and Tooling (B) onto piston motor (20). Install piston motor (20). The weight of piston motor (20) is approximately 34 kg (75 lb). Install bolts (19). Connect hose assembly (18).

3. Use a suitable lifting device in order to turn over fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 175 kg (385 lb).

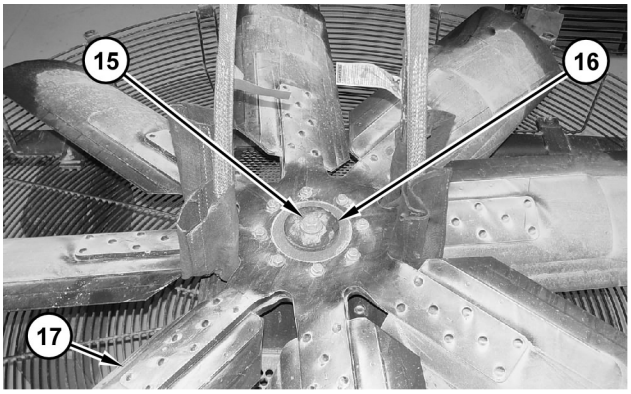


Illustration 215 g01236066

4. Install fan assembly (17). The weight of fan assembly (17) is approximately 86 kg (190 lb). Install washer (16) and install bolt (15).

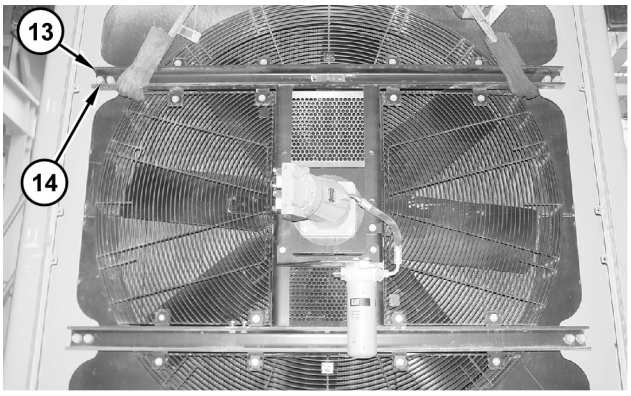


Illustration 216 g01236025

5. Attach a suitable lifting device and Tooling (B) onto fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 261 kg (575 lb).

6. Position fan and piston motor assembly (13). Install bolts (14).

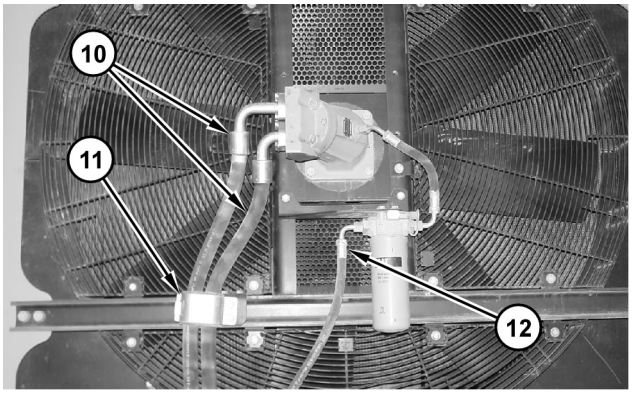


Illustration 217 g01236018

7. Connect hose assembly (12). Install clip (11). Connect hose assemblies (10).

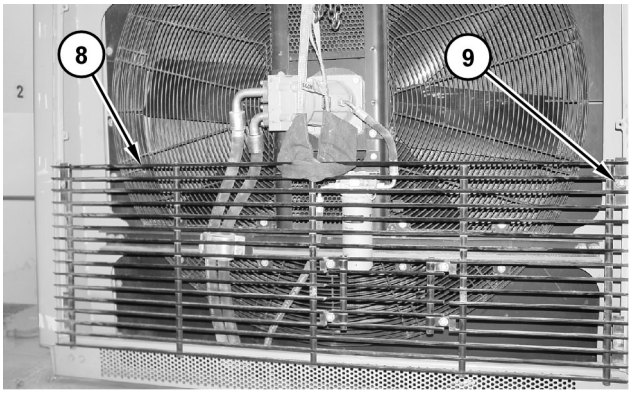


Illustration 218 g01236015

8. Attach a suitable lifting device and Tooling (B) onto grill assembly (8). The weight of grill assembly (8) is approximately 36 kg (80 lb).

9. Position grill assembly (8). Install bolts (9).

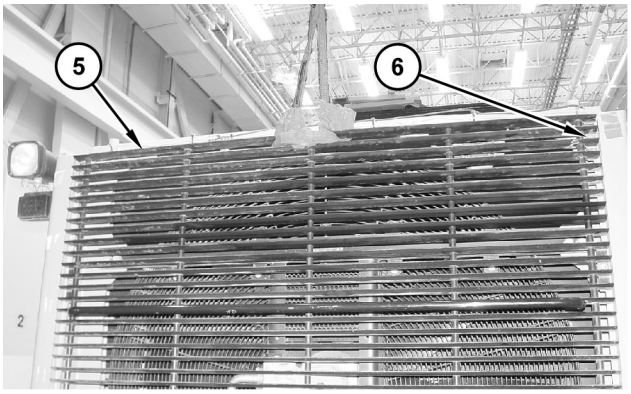


Illustration 219 g01236006

10. Attach a suitable lifting device and Tooling (B) onto grill assembly (5). The weight of grill assembly (5) is approximately 61 kg (135 lb).

11. Position grill assembly (5). Install bolts (6).

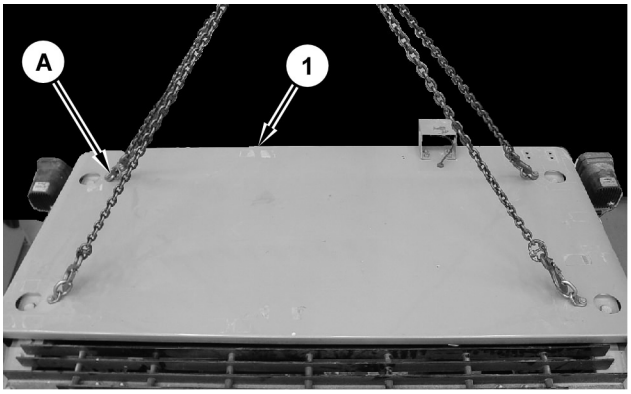


Illustration 220 g01236123

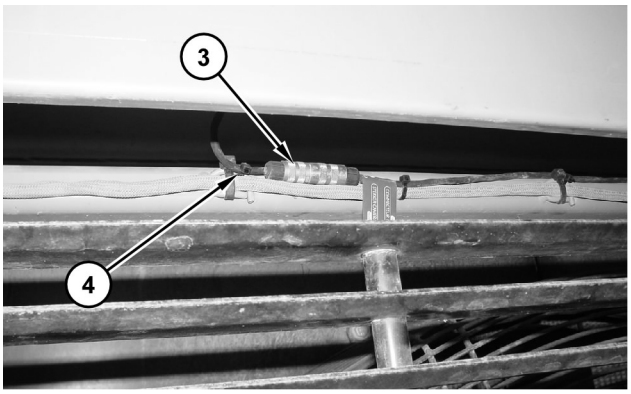


Illustration 221 g01235398

12. Attach Tooling (A) and a suitable lifting device onto panel assembly (1). The weight of panel assembly (1) is approximately 66 kg (145 lb).

13. Position panel assembly (1) in order to connect harness assembly (3). Install cable strap (4).

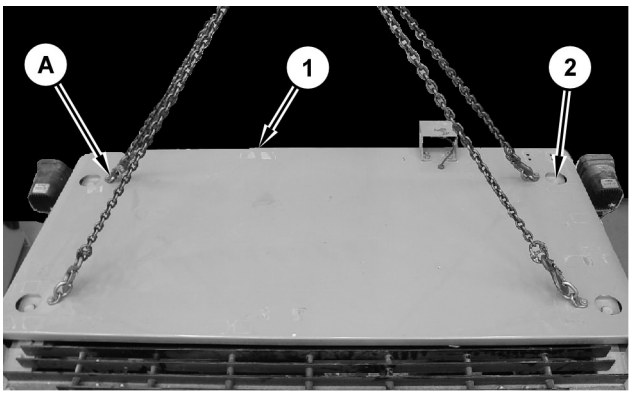


Illustration 222 g01236138

14. Lower panel assembly (1) and install bolts (2).

15. Remove Tooling (A).

i02476019

Radiator Shroud - Remove

SMCS Code: 7272-011

Removal Procedure

Start By:

a. Remove the hydraulic fan. Refer to Disassembly and Assembly, "Fan and Piston Motor (Hydraulic Fan) - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

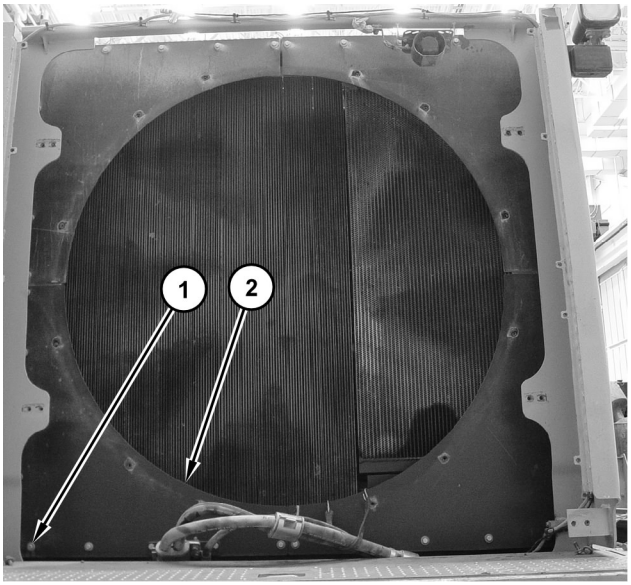


Illustration 223 g01235909

1. Remove bolts (1).

2. Remove fan shroud (2).

3. Repeat Step 1 and Step 2 for the three remaining fan shrouds.

i02476020

Radiator Shroud - Install

SMCS Code: 7272-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

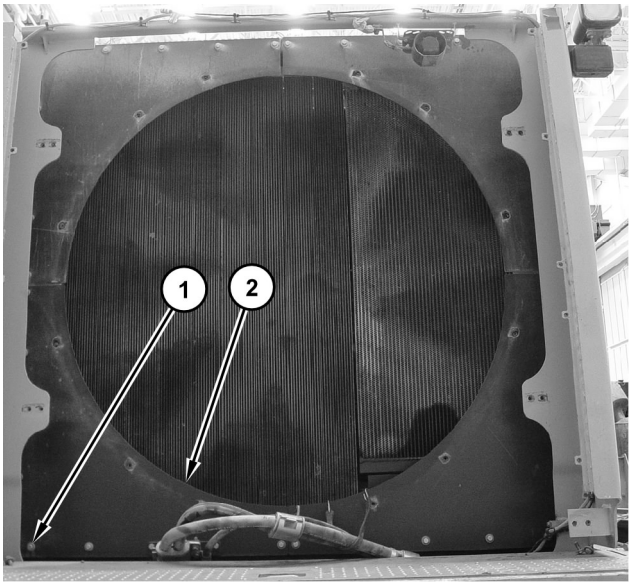


Illustration 224 g01235909

1. Position fan shroud (2).

2. Install bolts (1).

3. Repeat Step 1 and Step 2 for the three remaining fan shrouds.

End By:

a. Install the hydraulic fan. Refer to Disassembly and Assembly, "Fan and Piston Motor (Hydraulic Fan) - Install".

i02475648

Radiator Core - Remove

SMCS Code: 1353-011-KO

Removal Procedure

Table 20

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	178-3704	Lifting Bracket	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

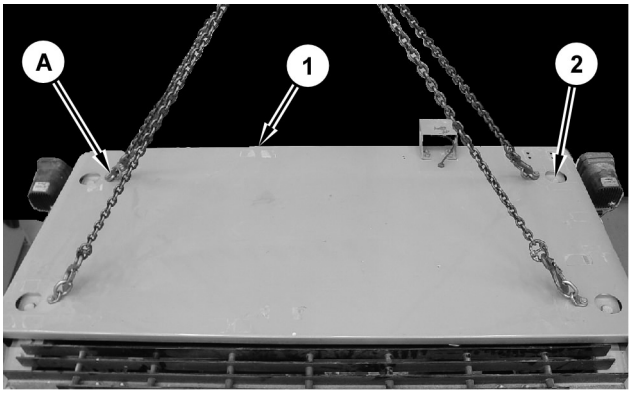


Illustration 225 g01236127

1. Attach Tooling (A) and a suitable lifting device onto panel assembly (1). The weight of panel assembly is approximately 66 kg (145 lb).

2. Remove bolts (2) and raise panel assembly (1) slightly.

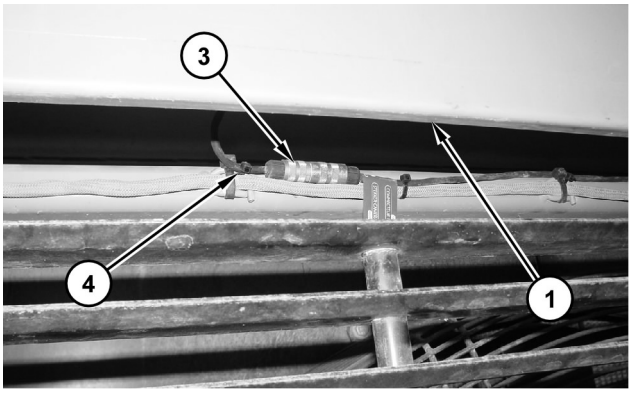


Illustration 226 g01239507

3. Disconnect harness assembly (3). Remove cable strap (4).

4. Remove panel assembly (1).

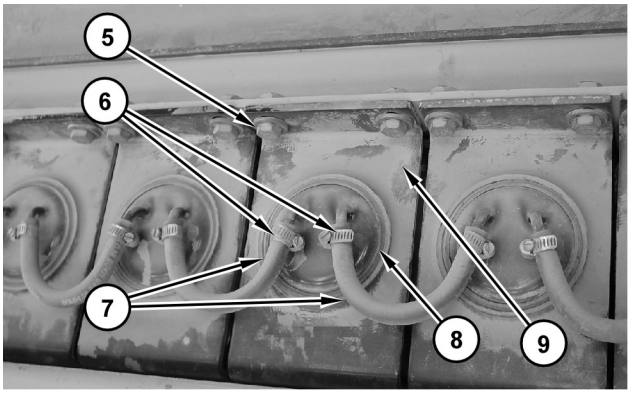


Illustration 227 g01235606

5. Loosen clamps (6).

6. Disconnect hoses (7).

7. Remove bolts (5). Remove retainer (9) and spacer (8).

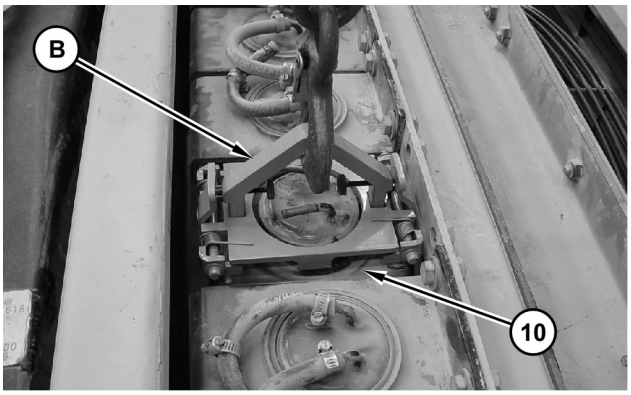


Illustration 228 g01235621

8. Install Tooling (B) and a suitable lifting device onto the top of radiator core (10).

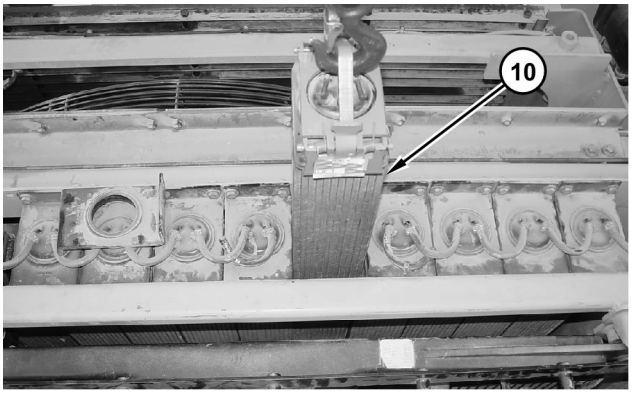


Illustration 229 g01235627

9. Remove radiator core (10). The weight of radiator core (10) is approximately 20 kg (45 lb).



Illustration 230 g01235630

10. Remove seal (11) from the lower radiator tank.

i02475651

Radiator Core - Install

SMCS Code: 1353-012-KO

Installation Procedure

Table 21

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	178-3704	Lifting Bracket	1
C	207-1601	Rubber Lubricant	1
	207-1600	Rubber Lubricant	1

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 231 g01235633

1. Clean the lower radiator tank with soapy water and apply Tooling (C).



Illustration 232 g01235634

2. Install a new seal (11) on the lower radiator tank .



Illustration 233 g01235637

3. Apply Tooling (C) to the bottom of radiator core (10).

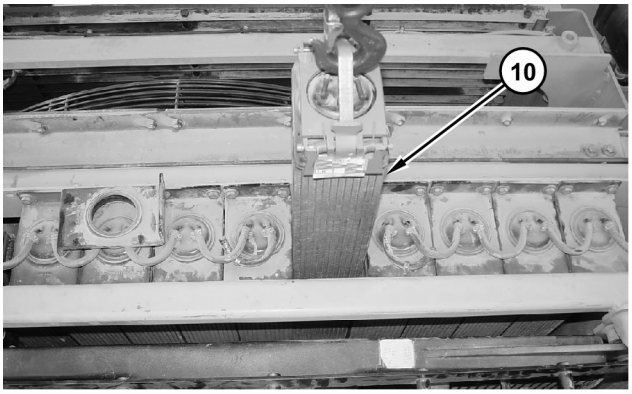


Illustration 234 g01235627

4. Use Tooling (B) and a suitable lifting device in order to install radiator core (10). The weight of radiator core (10) is approximately 20 kg (45 lb).

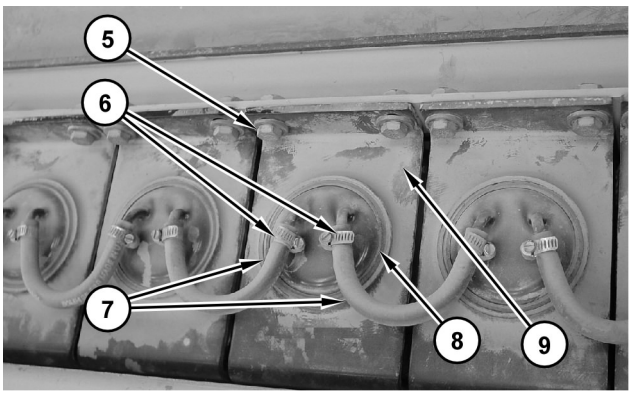


Illustration 235 g01235606

5. Install spacer (8) and retainer (9). Install bolts (5).

6. Connect hoses (7). Tighten clamps (6).

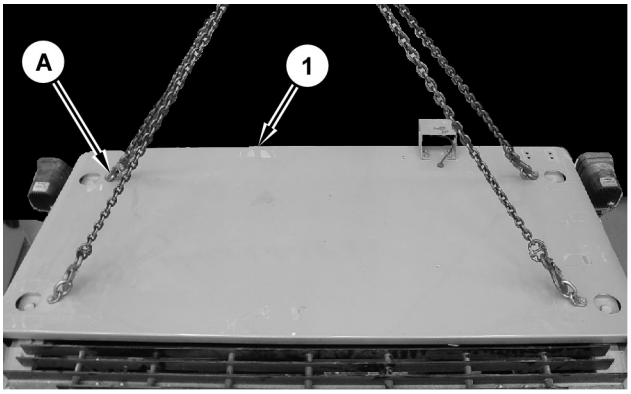


Illustration 236 g01236123

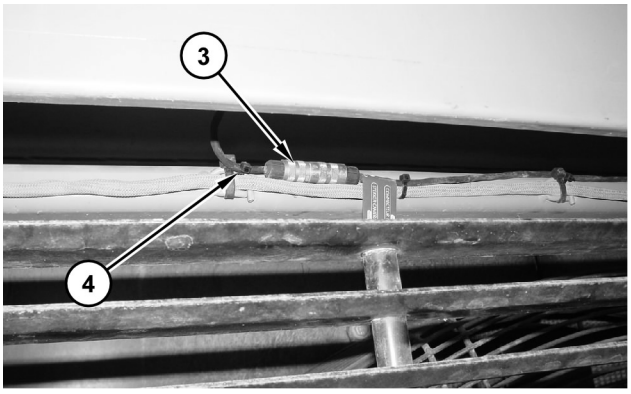


Illustration 237 g01235398

7. Attach Tooling (A) and a suitable lifting device onto panel assembly (1). The weight of panel assembly (1) is approximately 66 kg (145 lb).

8. Position panel assembly (1) in order to connect harness assembly (3). Install cable strap (4).

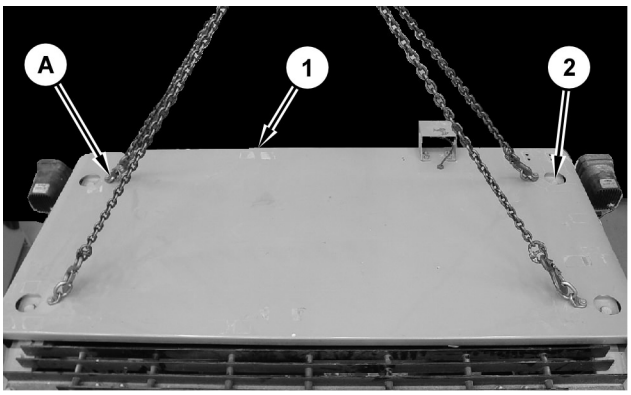


Illustration 238 g01236138

9. Lower panel assembly (1) and install bolts (2).

10. Remove Tooling (A).

i02481796

Refrigerant Condenser - Remove and Install

SMCS Code: 1805-010

Removal Procedure

Start By:

a. Remove the side grates. Refer to Disassembly and Assembly, "Hood Side Panels and Side Doors - Remove".

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Recover the air conditioner refrigerant from the air conditioner system. Refer to Service Manual, SENR5664, "Air Conditioning and Heating Systems with R-134a Refrigerant" for the correct procedure. Refer to Special Publication, NEDG5065, "Air Conditioning Tools" for the correct tools.

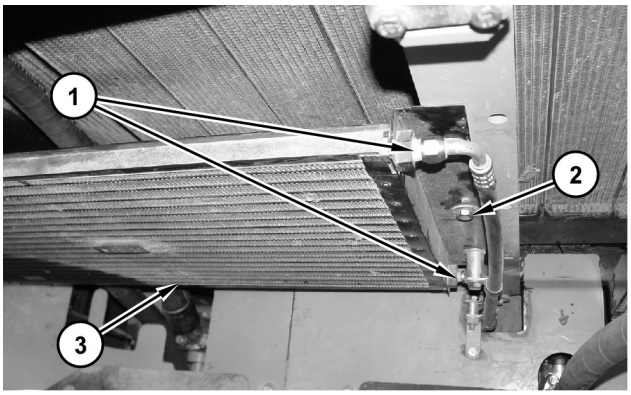


Illustration 239 g01241207

2. Disconnect hose assemblies (1) from condenser (3).

3. Remove bolts (2).

4. Remove condenser (3).

Installation Procedure

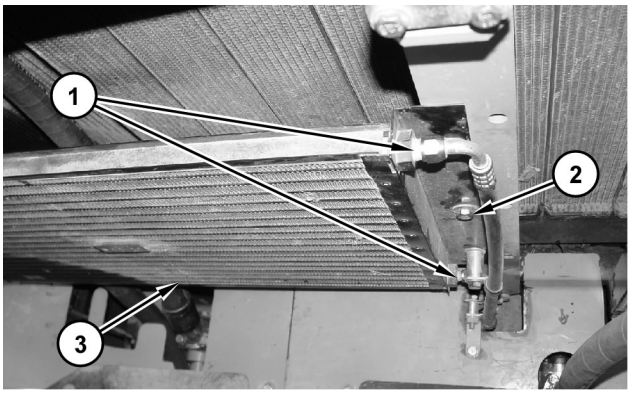


Illustration 240 g01241207

1. Install condenser (3).

2. Install bolts (2).

Note: Replace the O-ring seals that are used on the hose assemblies with new parts for the assembly.

3. Connect hose assemblies (1) to refrigerant condenser (3).

4. Evacuate the air conditioner system. Charge the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.

End By:

a. Install the side grates. Refer to Disassembly and Assembly, “Hood Side Panels and Side Doors - Install”.

i02474733

Aftercooler - Remove

SMCS Code: 1063-011

Removal Procedure

Table 22

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-9200	Lever Puller Hoist	1
B	189-0408	Shackle As	2

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

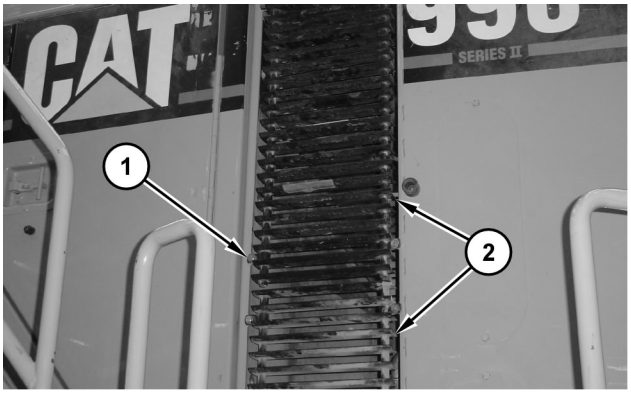


Illustration 241 g01234990

1. Remove bolts (1). Open grill assemblies (2).

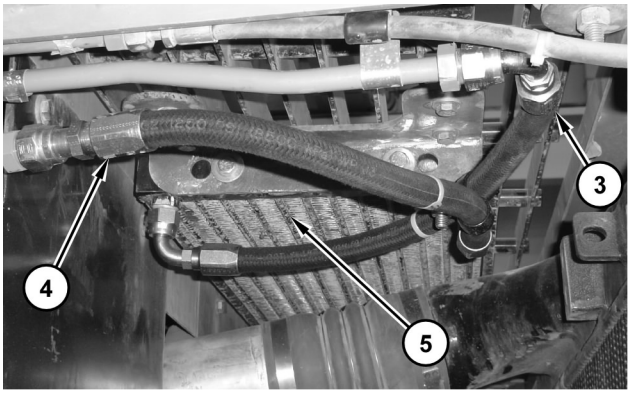


Illustration 242 g01234993

2. Disconnect hose assembly (3) and disconnect hose assembly (4) from fuel cooler (5).

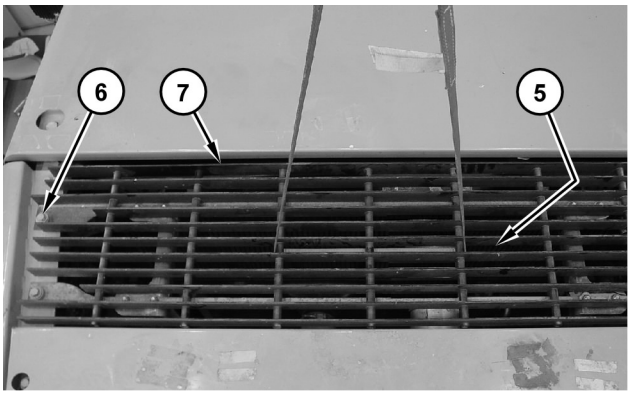


Illustration 243 g01234996

3. Remove bolts (6). Use a suitable lifting device in order to remove grate assembly (7) and fuel cooler assembly (5). The weight of grate assembly (6) and fuel cooler (5) is approximately 61 kg (135 lb).

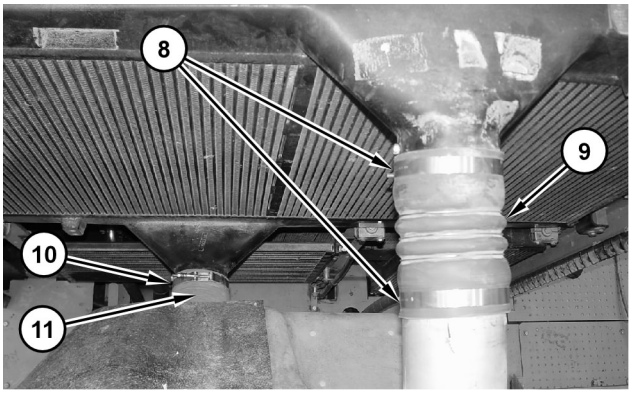


Illustration 244 g01235000

4. Loosen clamps (8) and remove hose (9). Loosen clamp (10) and disconnect hose (11).

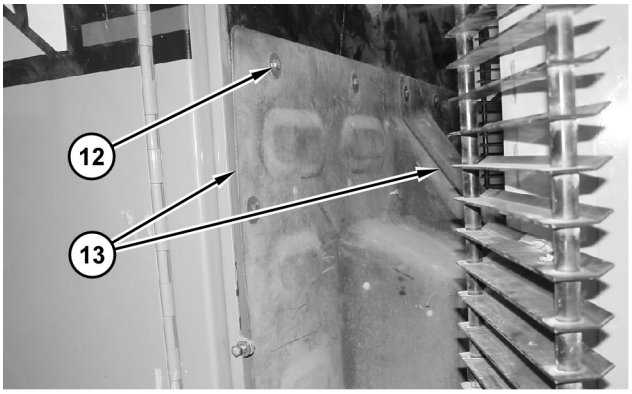


Illustration 245 g01235126

5. Remove bolts (12). Remove baffles (13).

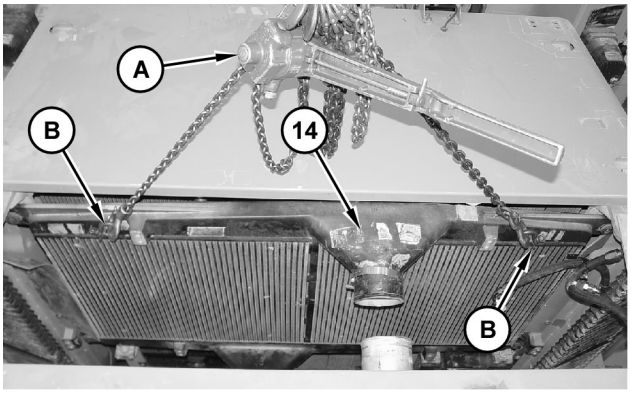


Illustration 246 g01235006

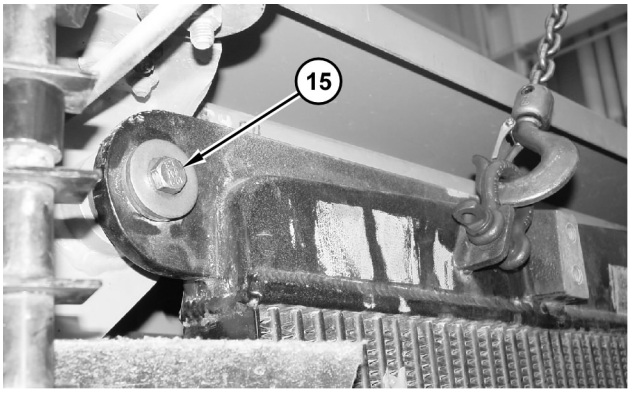


Illustration 247 g01235121

6. Attach Tooling (B), Tooling (A), and a suitable lifting device onto aftercooler (14). The weight of aftercooler (14) is approximately 61 kg (135 lb). Remove bolts (15).



Illustration 248 g01235125

7. Remove aftercooler (14).

i02474734

Aftercooler - Install

SMCS Code: 1063-012

Installation Procedure

Table 23

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-9200	Lever Puller Hoist	1
B	189-0408	Shackle As	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 249 g01235125

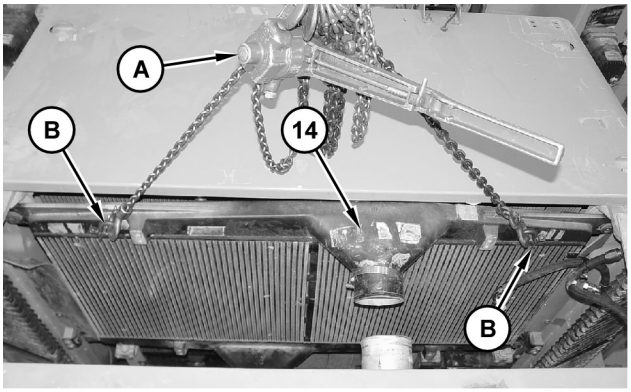


Illustration 250 g01235006

1. Use Tooling (B), Tooling (A), and a suitable lifting device in order to position aftercooler (14). The weight of aftercooler (14) is approximately 61 kg (135 lb). Install bolts (15).

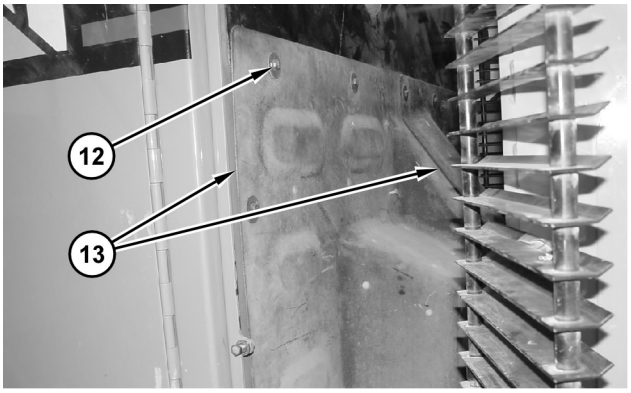


Illustration 251 g01235126

2. Install baffles (13). Install bolts (12).

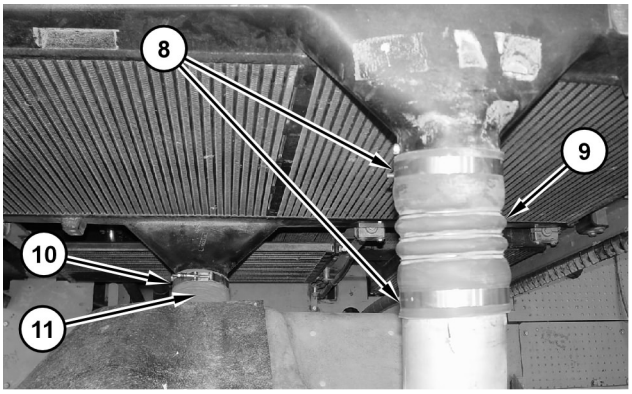


Illustration 252 g01235000

3. Connect hose (11). Tighten clamp (10) to a torque of 11 N·m (97 lb in). Install hose (9) and tighten clamps (8) to a torque of 11 N·m (97 lb in).

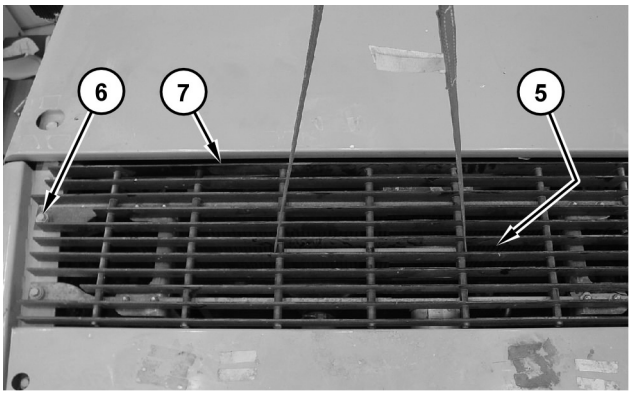


Illustration 253 g01234996

4. Use a suitable lifting device in order to position grate assembly (7) and fuel cooler assembly (5). The weight of grate assembly (6) and fuel cooler (5) is approximately 61 kg (135 lb). Install bolts (6).

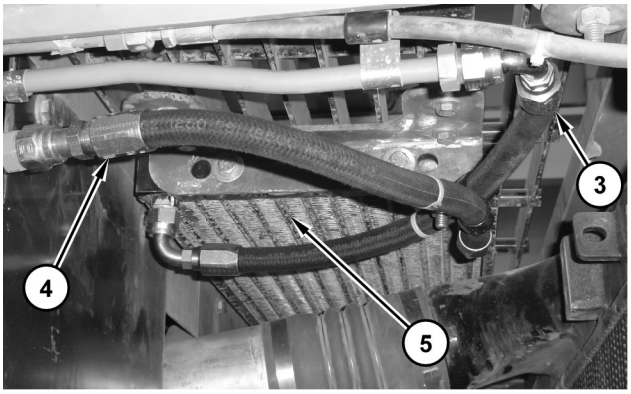


Illustration 254 g01234993

5. Connect hose assembly (4) and connect hose assembly (3) onto fuel cooler (5).

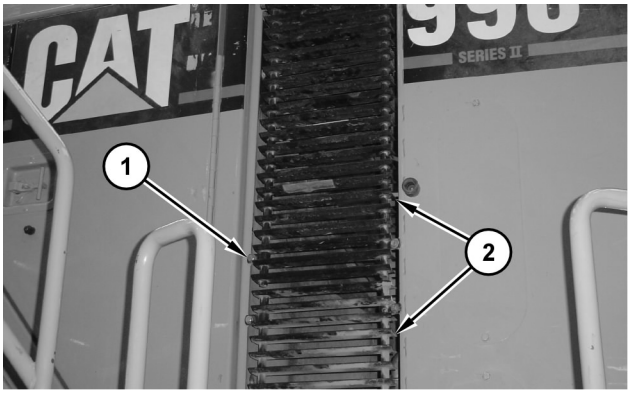


Illustration 255 g01234990

6. Close grill assemblies (2). Install bolts (1).

i02475269

Hydraulic Oil Cooler (Implement, Brake) - Remove

SMCS Code: 1374-011-II; 1374-011-BRK

Removal Procedure

Table 24

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT-1115	Vacuum Cap	1
	5P-0306	Vacuum Transducer	1
	6V-4142	Fitting	1
	5K-5068	Fitting	1
B	138-7573	Link Bracket	4

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "System Pressure - Release".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

At operating temperature, the hydraulic tank is hot and under pressure.

Hot oil and components can cause personal injury. Do not allow hot oil or components to contact skin.

Remove the filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand. Remove the filler cap slowly in order to relieve pressure.

Note: Put identification marks on the hose assemblies for installation purposes. Plug the hose assemblies. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Install Tooling (A) onto the hydraulic tank. Attach an air supply hose onto Tooling (A). Apply 276 to 414 kPa (40 to 60 psi) of air. This procedure will pull vacuum on the hydraulic system.

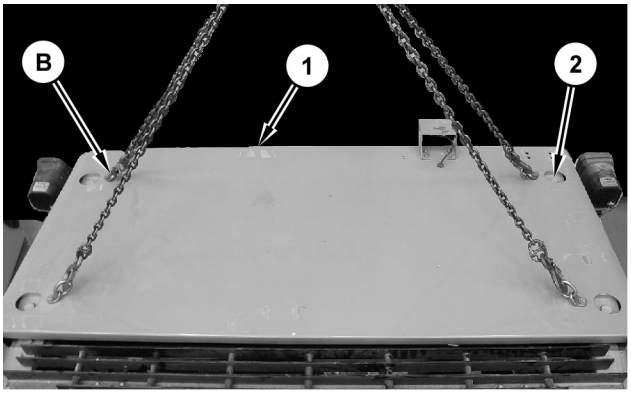


Illustration 256 g01235342

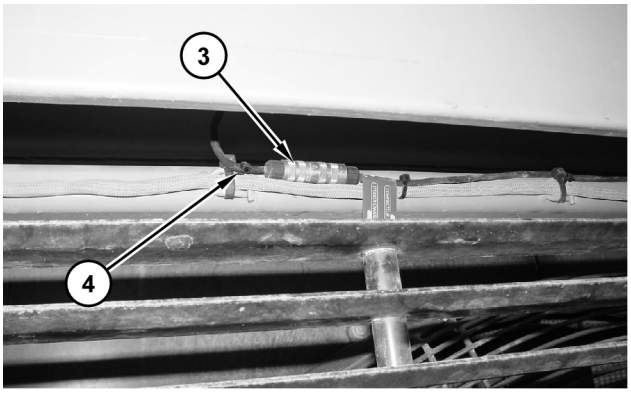


Illustration 257 g01235398

2. Attach Tooling (B) and a suitable lifting device onto panel assembly (1). The weight of panel assembly (1) is approximately 66 kg (145 lb).

3. Remove bolts (2) and raise panel assembly (1) slightly.

4. Disconnect harness assembly (3). Remove cable strap (4).

5. Remove panel assembly (1).

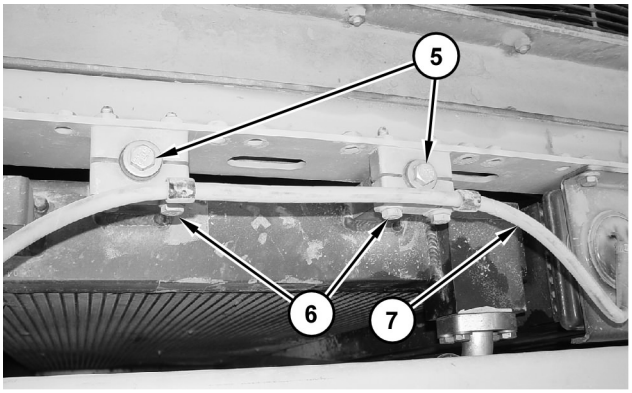


Illustration 258 g01235400

6. Remove bolts (6). Remove mount assemblies (5). Position hose (7) out of the way.

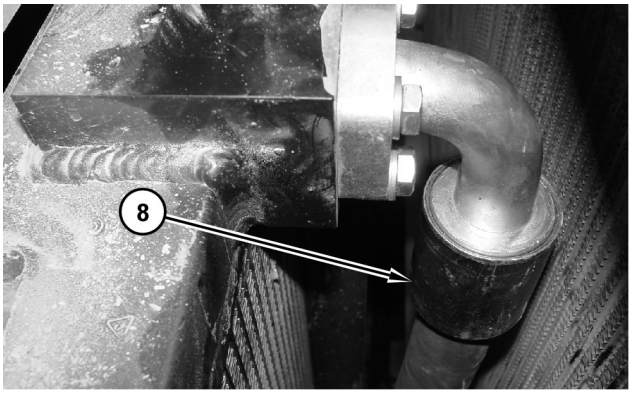


Illustration 259 g01235413

7. Disconnect hose assembly (8).

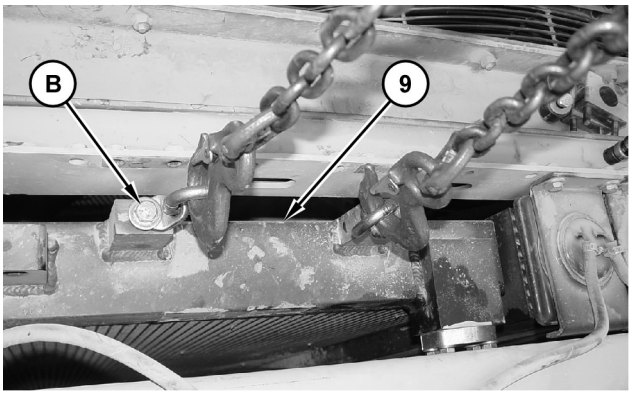


Illustration 260 g01235419

8. Attach Tooling (B) and a suitable lifting device onto hydraulic oil cooler (9). The weight of hydraulic oil cooler (9) is approximately 70 kg (155 lb).

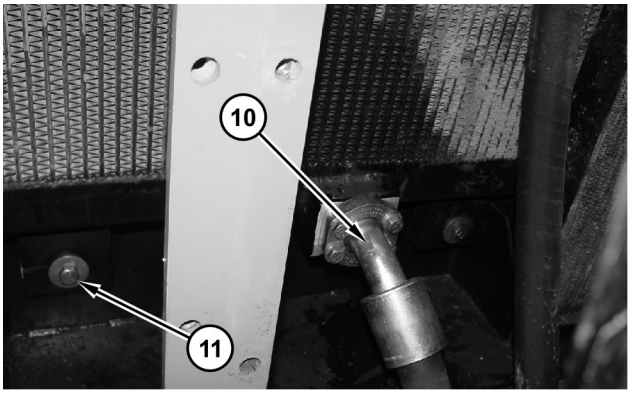


Illustration 261 g01235421

9. Disconnect hose assembly (10). Remove bolts (11).

Note: The air conditioning condenser is removed for photographic purposes.

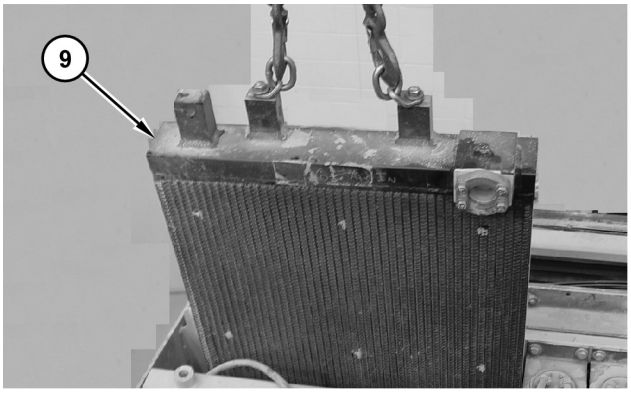


Illustration 262 g01235423

10. Remove hydraulic oil cooler (9).

i02475271

Hydraulic Oil Cooler (Implement, Brake) - Install

SMCS Code: 1374-012-II; 1374-012-BRK

Installation Procedure

Table 25

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	FT-1115	Vacuum Cap	1

(continued)

(Table 25, contd)

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
	5P-0306	Vacuum Transducer	1
	6V-4142	Fitting	1
	5K-5068	Fitting	1
B	138-7573	Link Bracket	4

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

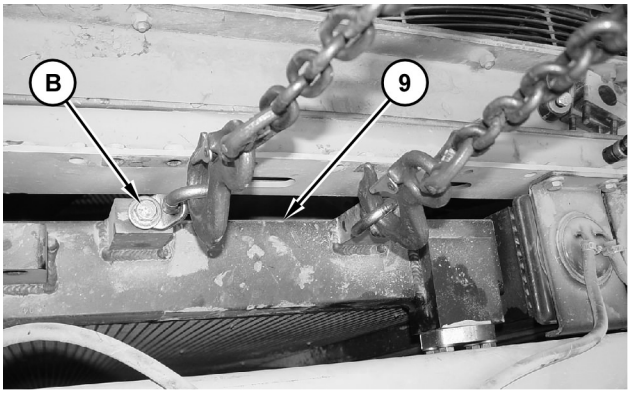


Illustration 263 g01235419

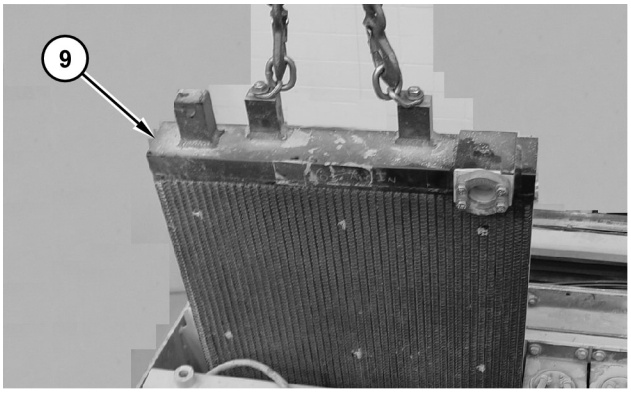


Illustration 264 g01235423

1. Use Tooling (B) and a suitable lifting device in order to position hydraulic oil cooler (9) into the machine. The weight of hydraulic oil cooler (9) is approximately 70 kg (155 lb).

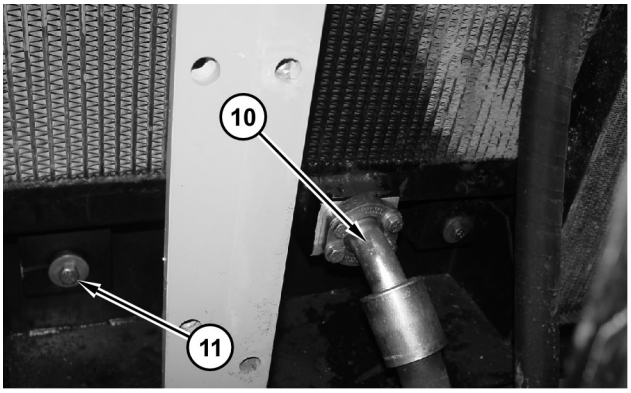


Illustration 265 g01235421

2. Install bolts (11). Connect hose assembly (10).

Note: The air conditioning condenser is removed for photographic purposes.

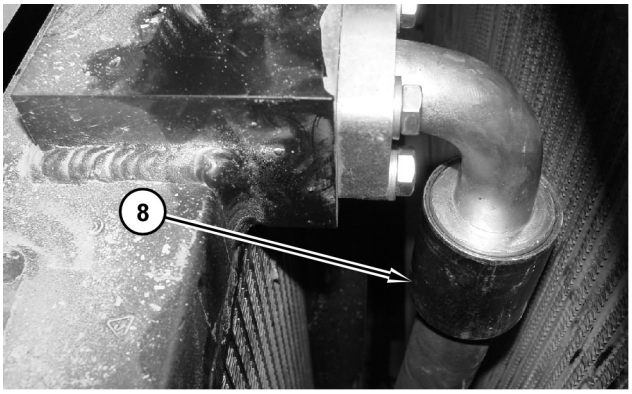


Illustration 266 g01235413

3. Connect hose assembly (8).

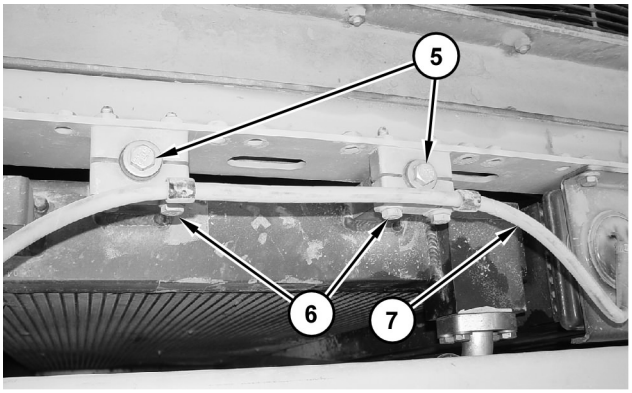


Illustration 267 g01235400

4. Install mount assemblies (5). Position hose (7) and install bolts (6).

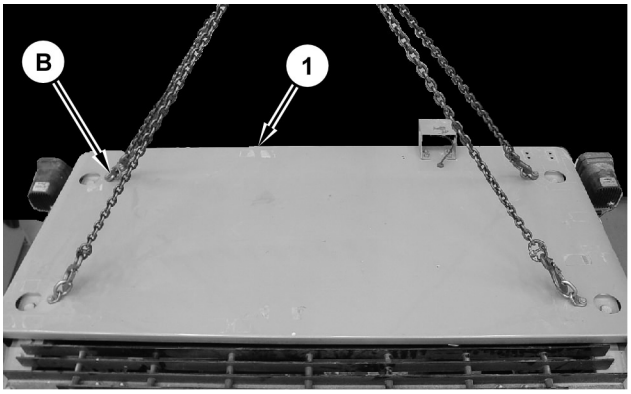


Illustration 268 g01235492

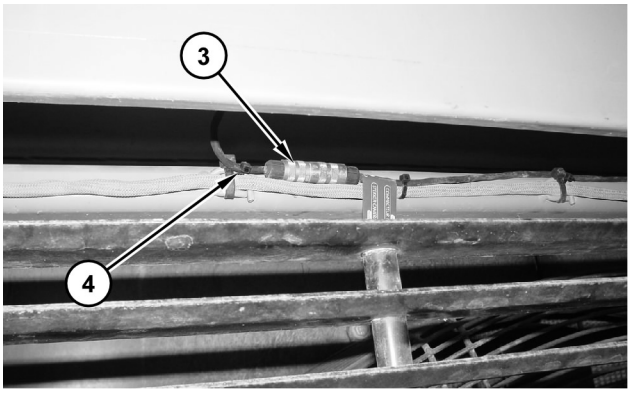


Illustration 269 g01235398

5. Attach Tooling (B) and a suitable lifting device onto panel assembly (1). The weight of panel assembly (1) is approximately 66 kg (145 lb).

6. Position panel assembly in order to connect harness assembly (3). Install cable strap (4).

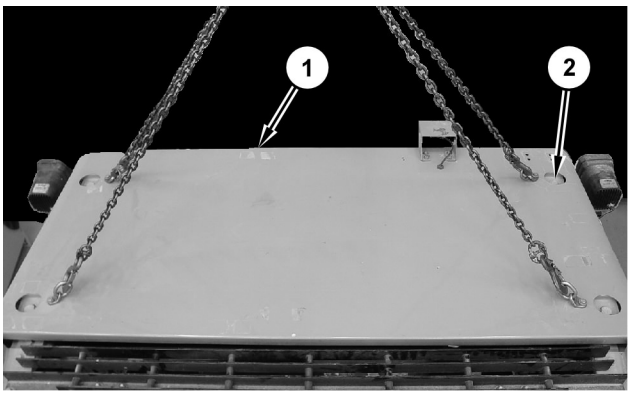


Illustration 270 g01235494

7. Lower panel assembly (1) and install bolts (2).

8. Remove Tooling (A).

i02479154

Hydraulic Oil Cooler (Steering, Hydraulic Fan) - Remove

SMCS Code: 1374-011-ZH; 1374-011-HFN

Removal Procedure

Start By:

a. Remove the side grates, baffles, and the floor panels. Refer to Disassembly and Assembly, "Hood Side Panels and Side Doors - Remove".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Note: Put identification marks on the hose assemblies for installation purposes. Plug the hose assemblies. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

Note: The hydraulic tank for the steering and the hydraulic fan is located on the left side of the machine.

1. Drain the hydraulic tank into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Capacities (Refill)".

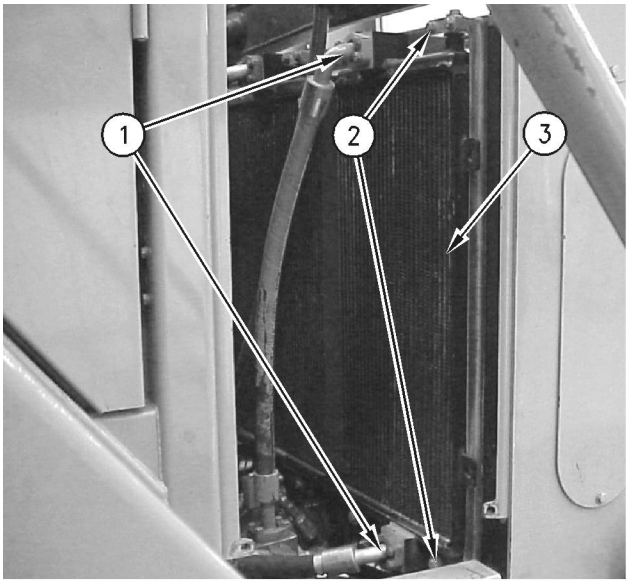


Illustration 271 g00846797

2. Disconnect hose assemblies (1).

3. Remove mounts (2).

4. Remove hydraulic oil cooler (3). The weight of hydraulic oil cooler (3) is approximately 13 kg (30 lb).

i02479152

Hydraulic Oil Cooler (Steering, Hydraulic Fan) - Install

SMCS Code: 1374-012-ZH; 1374-012-HFN

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

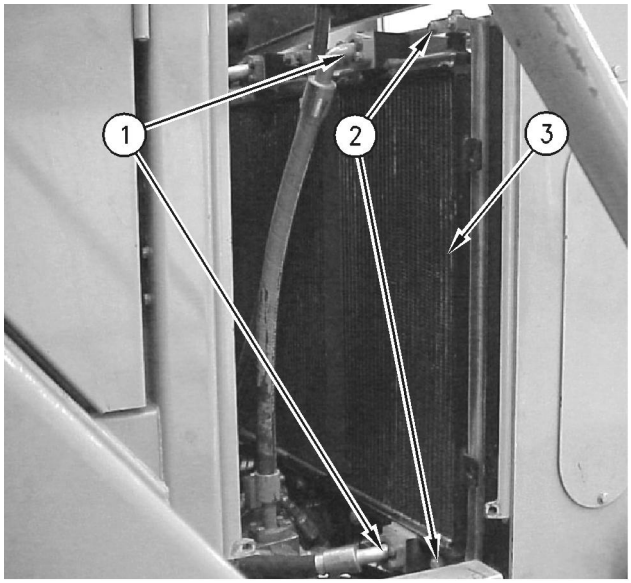


Illustration 272 g00846797

1. Install hydraulic oil cooler (3). The weight of hydraulic cooler (3) is approximately 13 kg (30 lb).

2. Install mounts (2).

3. Connect hose assemblies (1).

4. Fill the hydraulic tank. Refer to Operation and Maintenance Manual, “Capacities (Refill)”.

End By:

a. Install the side grates, baffles, and the floor panels. Refer to Disassembly and Assembly, “Hood Side Panels and Side Doors - Install”.

i02475507

Air Cleaner - Remove

SMCS Code: 1051-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

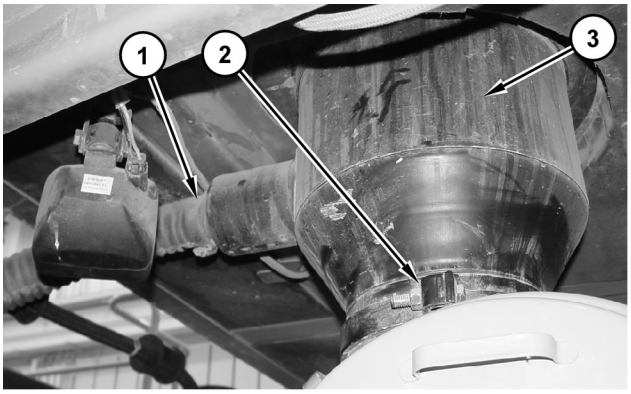


Illustration 273 g01235527

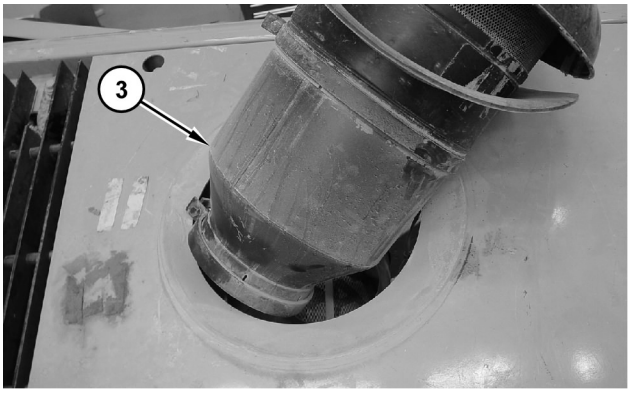


Illustration 274 g01235529

1. Disconnect hose (1). Loosen clamp (2) from precleaner (3). Remove precleaner (3).

2. Remove the primary air filter. Refer to Operation and Maintenance Manual, “Engine Air Filter Primary Element - Clean/Replace” .

3. Remove the secondary air filter. Refer to Operation and Maintenance Manual, “Engine Air Filter Secondary Element - Replace” .

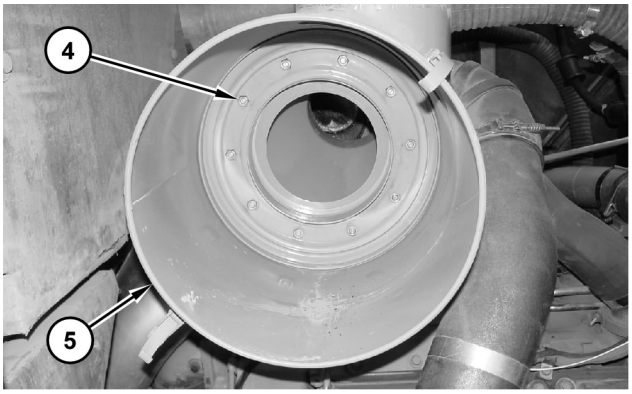


Illustration 275 g01235543

4. Remove nuts (4). Remove air cleaner housing (5).

i02475508

Air Cleaner - Install

SMCS Code: 1051-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

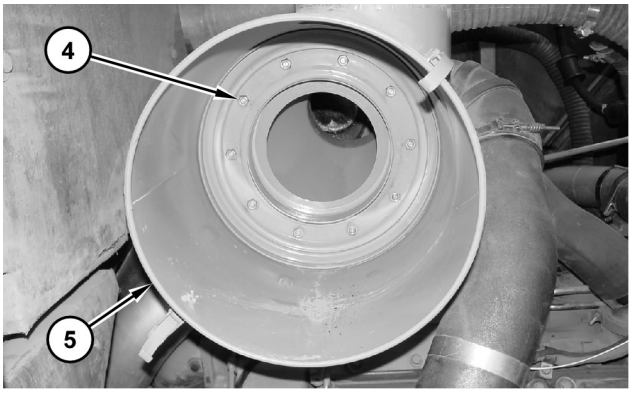


Illustration 276 g01235543

1. Install air cleaner housing (5). Install nuts (4).

2. Install the secondary air filter. Refer to Operation and Maintenance Manual, “Engine Air Filter Secondary Element - Replace” .

3. Install the primary air filter. Refer to Operation and Maintenance Manual, “Engine Air Filter Primary Element - Clean/Replace” .

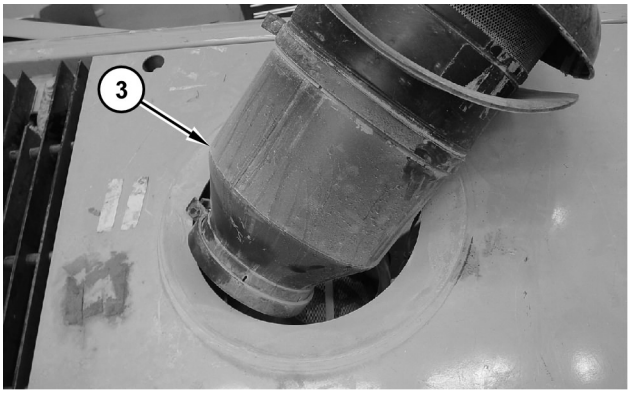


Illustration 277 g01235529

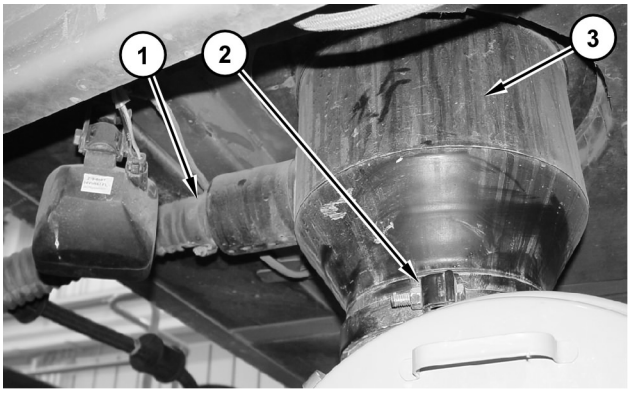


Illustration 278 g01235527

4. Install precleaner (3). Tighten clamp (2). Connect hose (1).

i02474633

Muffler - Remove

SMCS Code: 1062-011

Removal Procedure

Start By:

a. Remove the hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

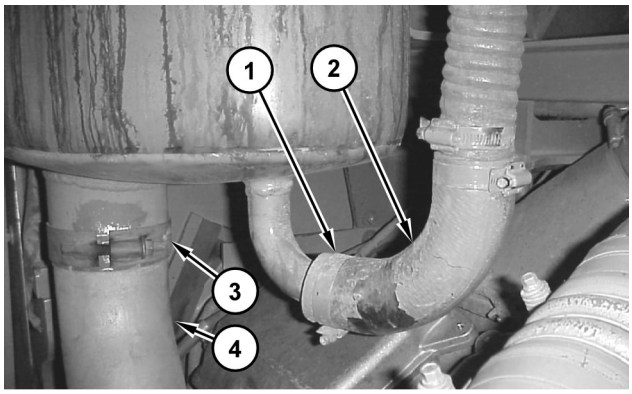


Illustration 279 g01234875

1. Loosen clamp (1) and disconnect hose (2).

2. Loosen clamp (3) and disconnect elbow (4).

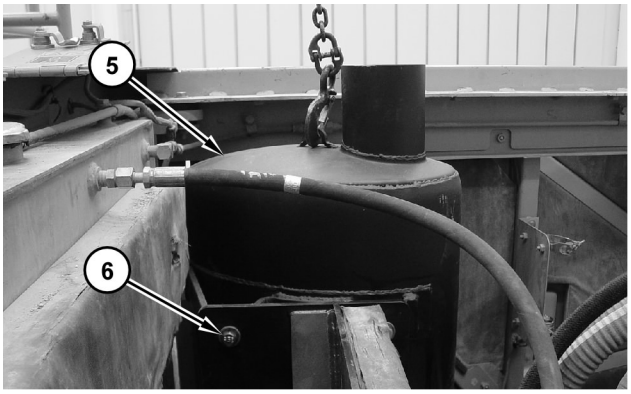


Illustration 280 g01234834

3. Attach a suitable lifting device onto muffler assembly (5). The weight of muffler assembly (5) is 30 kg (65 lb). Remove bolts (6). Remove muffler assembly (5).

i02474634

Muffler - Install

SMCS Code: 1062-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

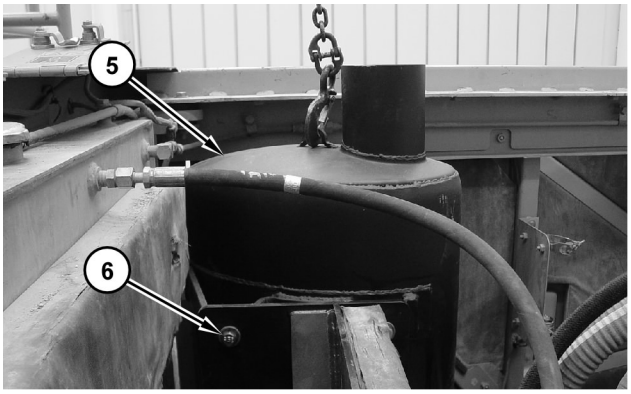


Illustration 281 g01234834

1. Use a suitable lifting device in order to position muffler assembly (5). The weight of the muffler assembly (5) is 30 kg (65 lb).

2. Install bolts (6).

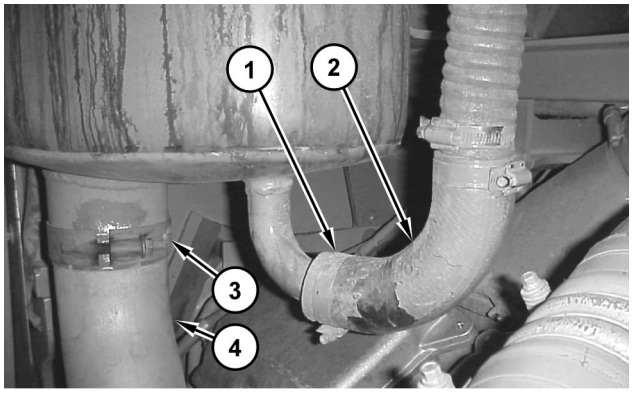


Illustration 282 g01234875

3. Connect elbow (4).

4. Tighten clamp (3).

5. Connect hose (2).

6. Tighten clamp (1).

End By:

a. Install the hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Install”.

i02474525

Turbocharger - Remove

SMCS Code: 1052-011

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the cooling system pressure cap is cool enough to touch with your bare hand.

Remove the cooling system pressure cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

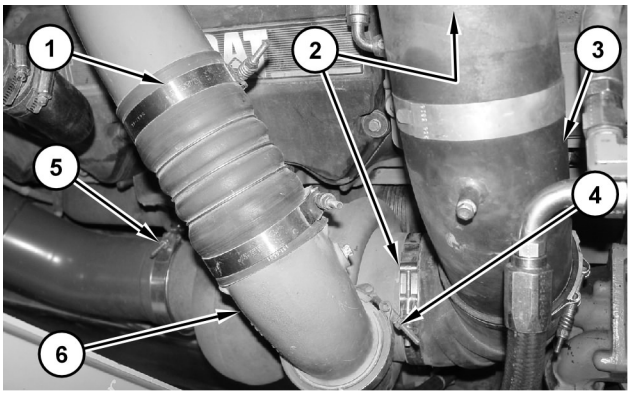


Illustration 283 g01234740

1. Loosen clamp (1). Disconnect clamp (4) and remove elbow (6).

2. Loosen clamps (2) and remove elbow (3).

3. Disconnect clamp (5).

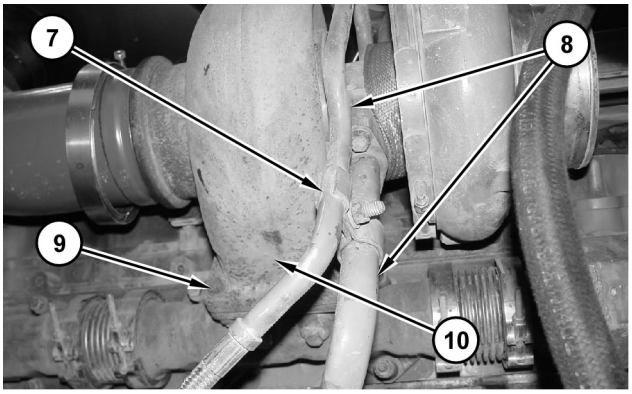


Illustration 284 g01234746

4. Loosen clamps (7). Disconnect tube assemblies (8).

5. Attach a suitable lifting device onto turbocharger assembly (10). Remove bolts (9). Remove turbocharger assembly (10). The weight of turbocharger assembly (10) is approximately 32 kg (70 lb).

i05807235

Turbocharger - Remove

SMCS Code: 1052-011

S/N: BTW1–99999

S/N: BWX1–Up

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

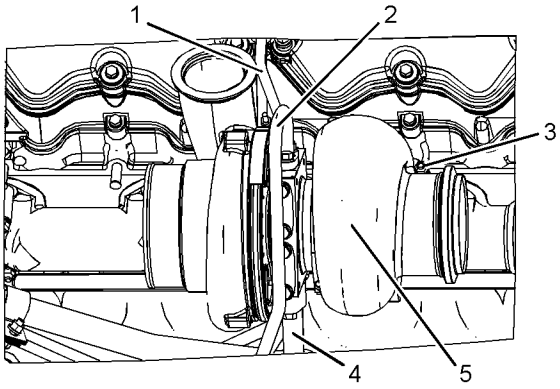


Illustration 285 g01145002

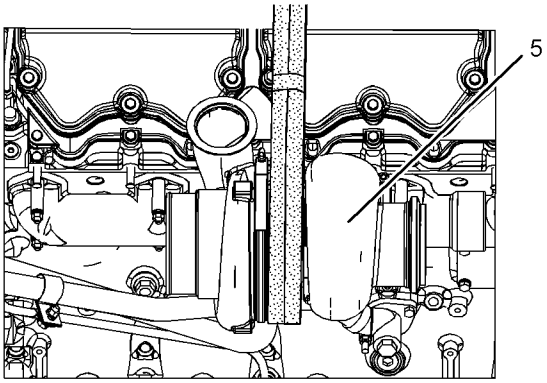


Illustration 286 g01148173

2. Remove tube assembly (2).

3. Disconnect tube assemblies (1) and tube assembly (4).

Note: Before you remove the turbocharger, mark the location and the orientation of the turbocharger for installation purposes.

4. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 45 kg (100 lb).

5. Remove nuts (3). Remove turbocharger (5) and the gasket.

i02474528

Turbocharger - Install

SMCS Code: 1052-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

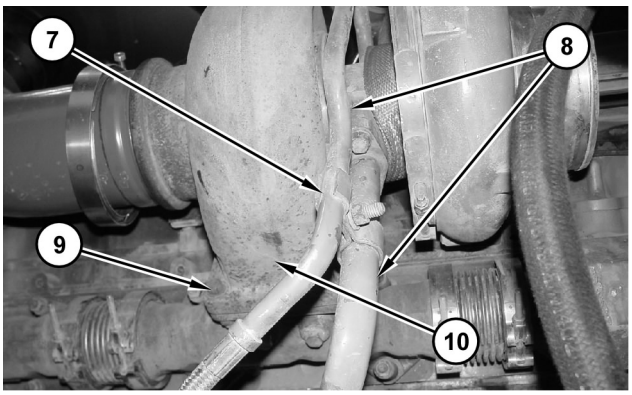


Illustration 287 g01234746

1. Attach a suitable lifting device onto turbocharger assembly (10). Position turbocharger assembly (10). The weight of turbocharger assembly (10) is approximately 32 kg (70 lb). Install bolts (9).

2. Connect tube assemblies (8). Install clamps (7).

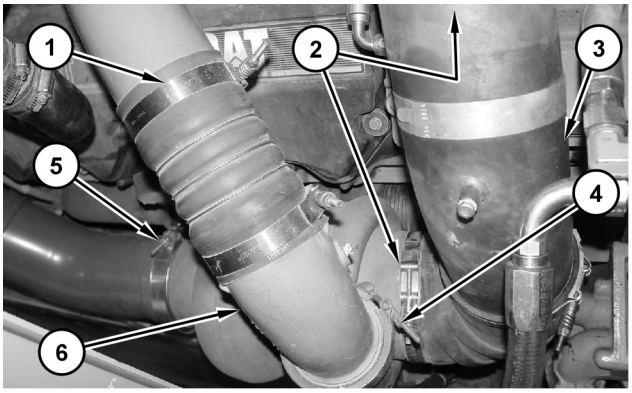


Illustration 288 g01234740

3. Install elbow (3). Tighten clamps (2) to a torque of 11 N·m (97 lb in).

4. Install elbow (6). Connect clamp (4). Tighten clamp (4) to a torque of 11 N·m (97 lb in). Connect clamp (5). Tighten clamp (5) to a torque of 11 N·m (97 lb in). Tighten clamp (1) to a torque of 11 N·m (97 lb in).

i05806855

Turbocharger - Install

SMCS Code: 1052-012

S/N: BTW1–99999

S/N: BWX1–Up

Installation Procedure

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

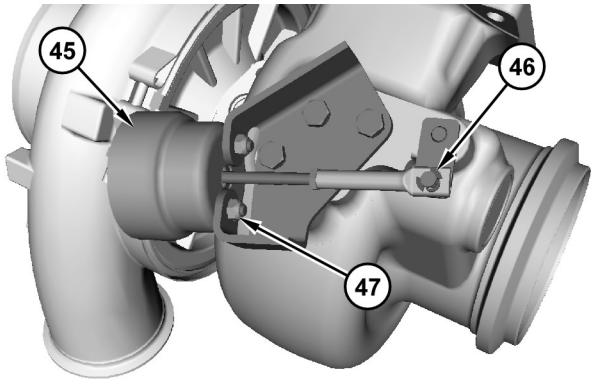


Illustration 289 g03401977
Typical Example

Note: After actuator can (45) has been installed on the turbocharger, actuator can (45) will need to be calibrated. Refer to Special Instruction, REHS5721.

1. Position actuator can (45) on the turbocharger. Install nuts (47) and clip (46).

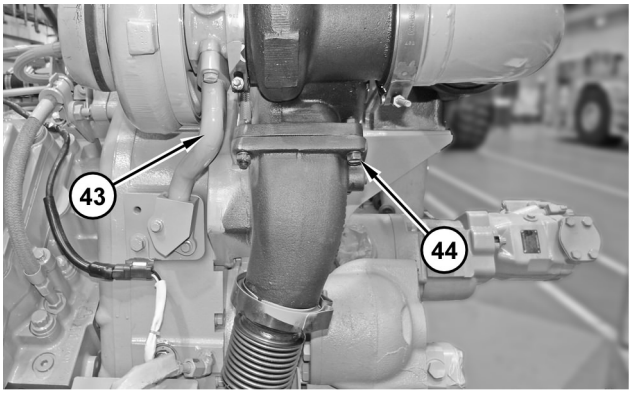


Illustration 290 g02592339
View of the left side turbocharger

Note: Install the turbocharger in the original location and at the original orientation that was marked during the removal procedure.

2. Using two people, install the turbocharger. The weight of the turbocharger is approximately 24 kg (53 lb).

3. Install the gasket, four bolts (44) and the nuts.

4. Install two gaskets and tube (43).

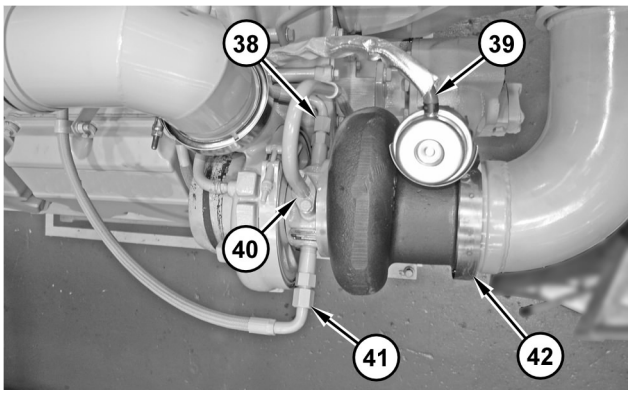


Illustration 291 g03294077
View of the left side turbocharger

5. Tighten clamp (42).

6. Install the gasket and connect tube assembly (40).

7. Connect hose assembly (38), hose (39), and hose assembly (41).

8. Repeat Step 2 through 7 for the right side turbocharger.

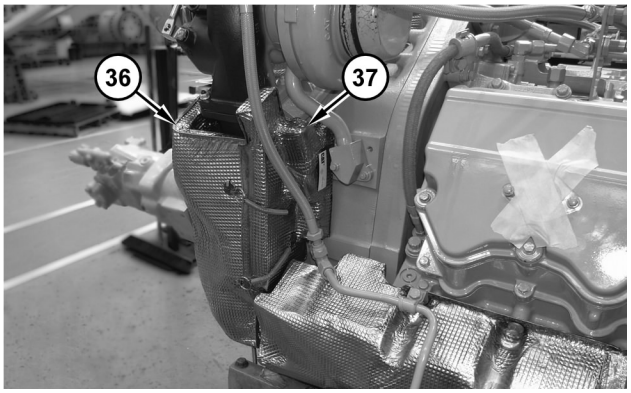


Illustration 292 g03294036
View of the right side turbocharger

9. Install cover (36) and cover (37).

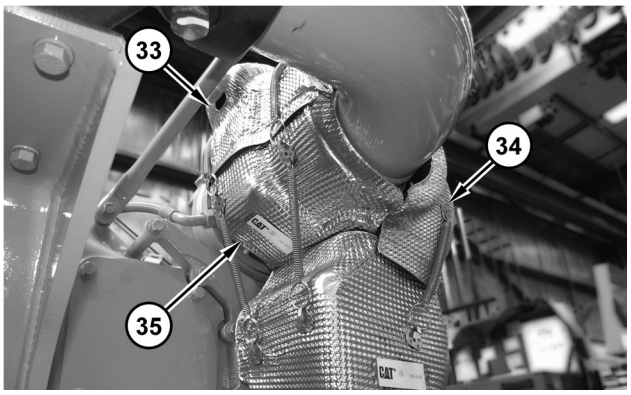


Illustration 293 g03294016
View of the right side turbocharger

10. Install cover (33), cover (34), and cover (35).

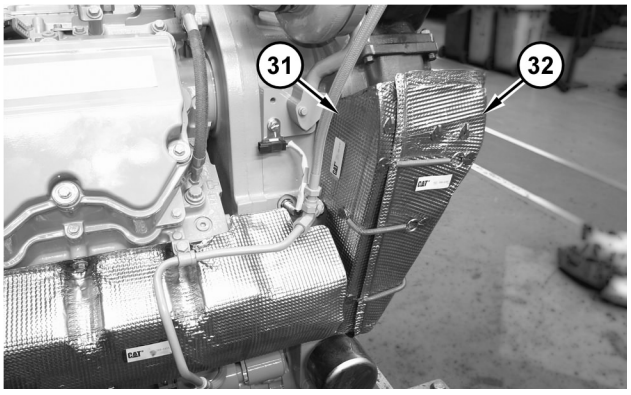


Illustration 294 g03293997
View of the left side turbocharger

11. Install cover (31) and cover (32).

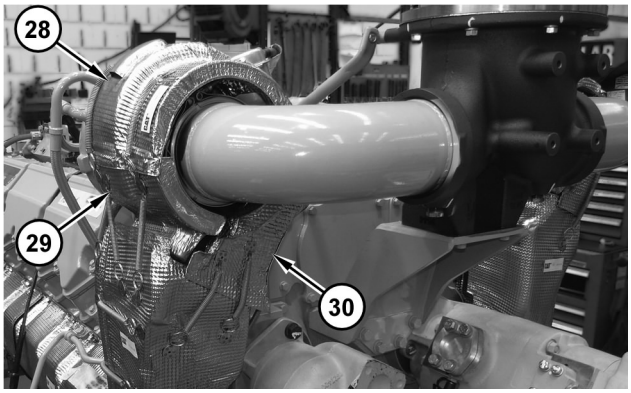


Illustration 295 g03293981

View of the left side turbocharger

12. Install cover (28), cover (29), and cover (30).

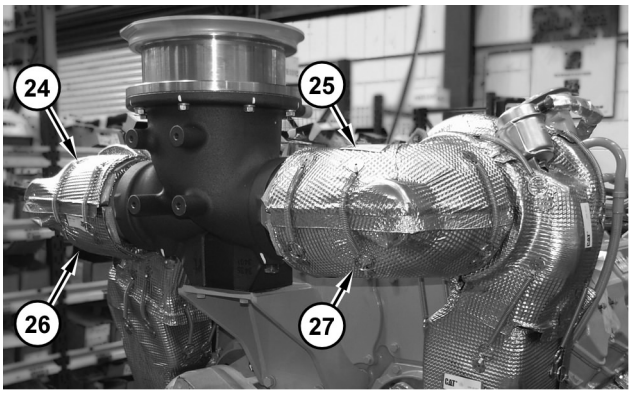


Illustration 296 g03293979

13. Install cover (24), cover (25), cover (26) and cover (27).

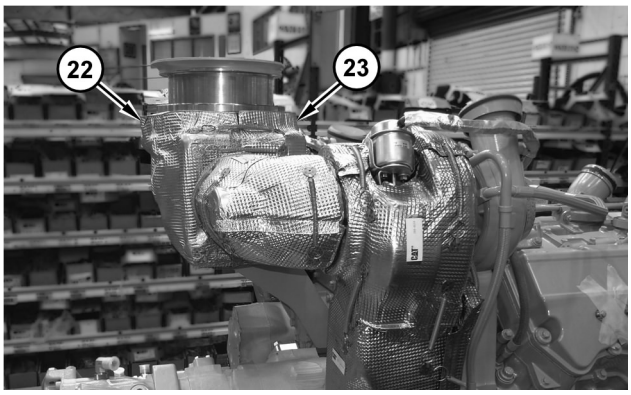


Illustration 297 g03293976

14. Install cover (22) and cover (23).

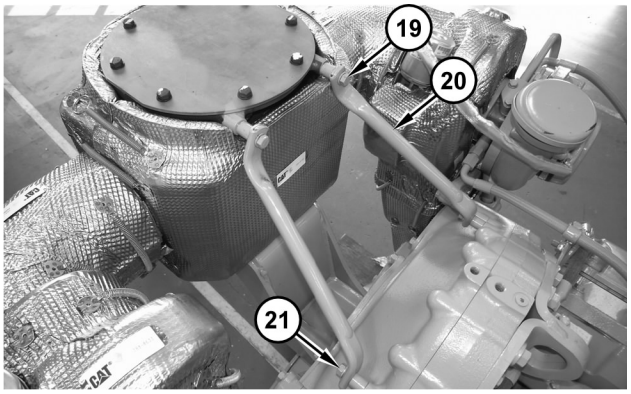


Illustration 298 g03293957

15. Install two support brackets (20), two bolts (19) and the spacers

16. Tighten two bolts (21).

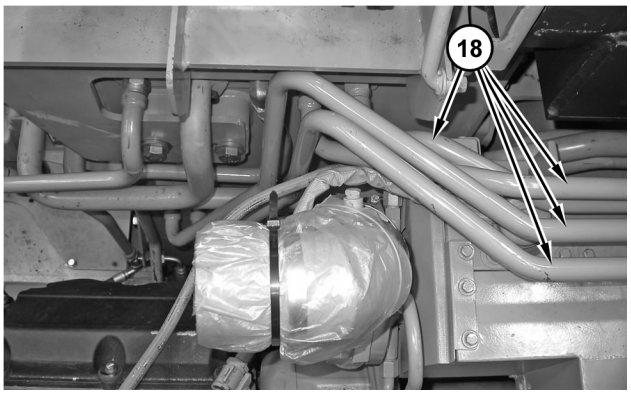


Illustration 299 g02569977

Typical example

17. Install four tube assemblies (18).

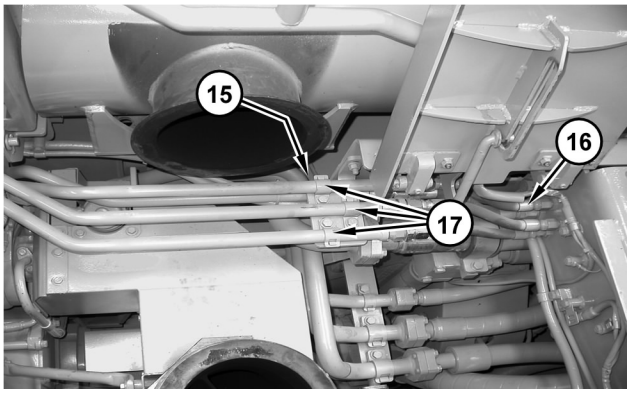


Illustration 300 g02569976

Typical example

18. Connect four hose assemblies (16). Install three clamp assemblies (17) and clamp assembly (15) (not shown).



Illustration 301 g02567482

19. Install tube assembly (14) and tighten clamp (13).

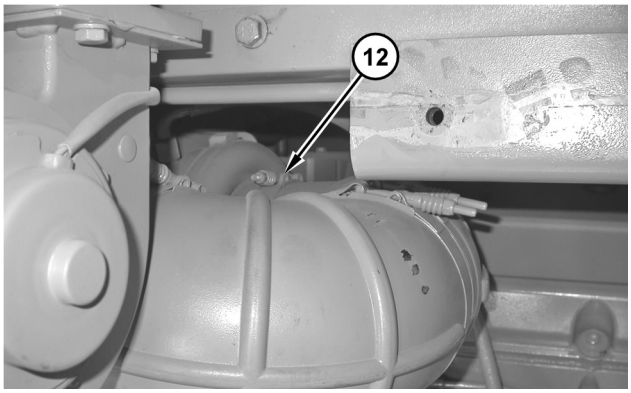


Illustration 302 g02567481

20. Tighten clamp (12).

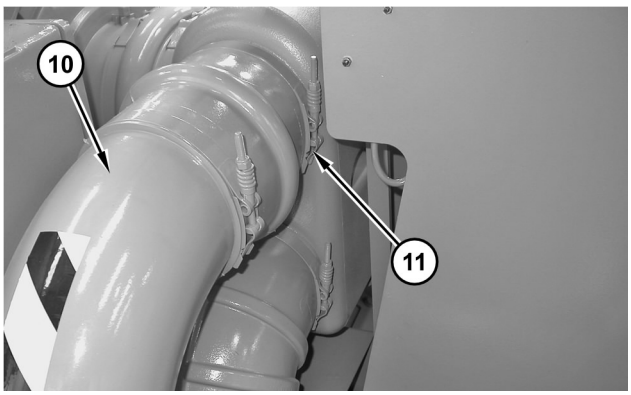


Illustration 303 g02567480

21. Install tube assembly (10) and tighten clamp (11).

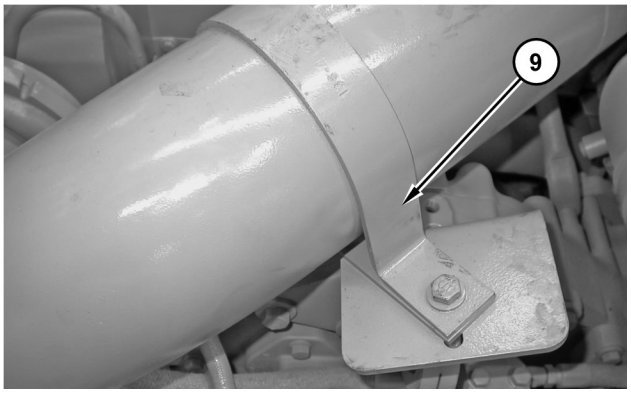


Illustration 304 g02567479

22. Install clamp assembly (9).



Illustration 305 g02567478

23. Tighten clamp (8).

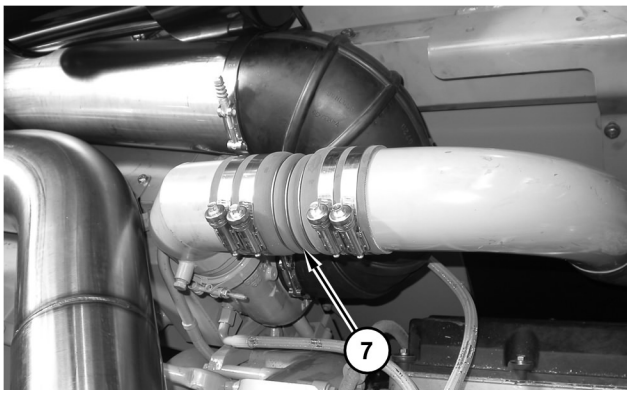


Illustration 306 g02592359
View of the left side turbocharger

24. Connect hose (7) to the elbow and tighten the clamps.

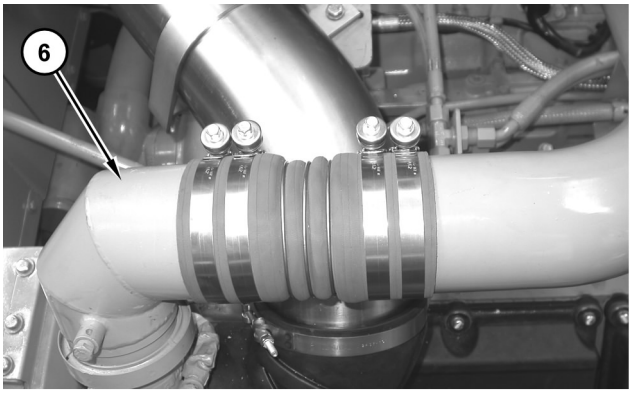


Illustration 307 g02592358

View of the right side of the engine

25. Connect elbow (6) to the turbocharger.



Illustration 308 g02567477

26. Install cover (5).

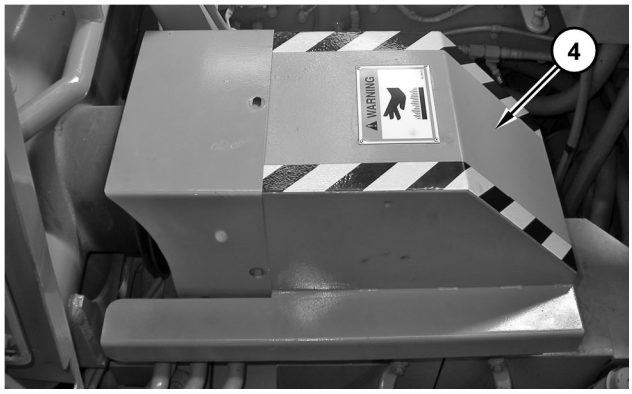


Illustration 309 g02567476

27. Using two people, install tube assembly (4). The weight of tube assembly (4) is approximately 27 kg (60 lb).

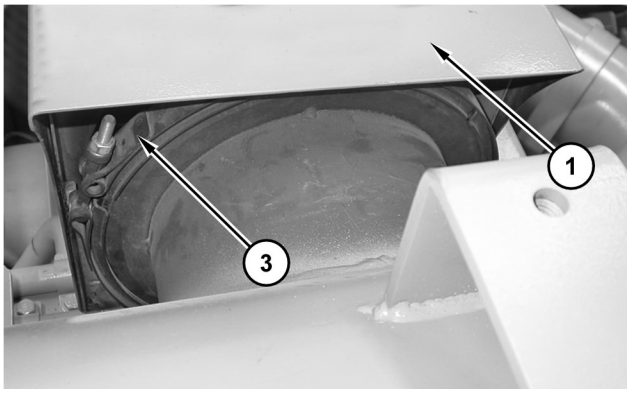


Illustration 310 g02567457

28. Install clamp (3) below cover (1).

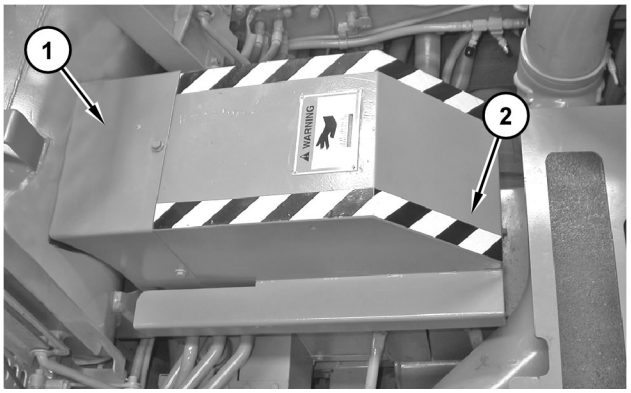


Illustration 311 g02567456

29. Install four bolts (2). Position cover (1) (as shown).

End By:

a. Fill the cooling system. Refer to Operation and Maintenance Manual, “Capacities (Refill)” for the capacity of the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change”.

b. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i05807185

Turbocharger - Install

SMCS Code: 1052-012

S/N: BTW1–99999

S/N: BWX1–Up

Installation Procedure

Table 26

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

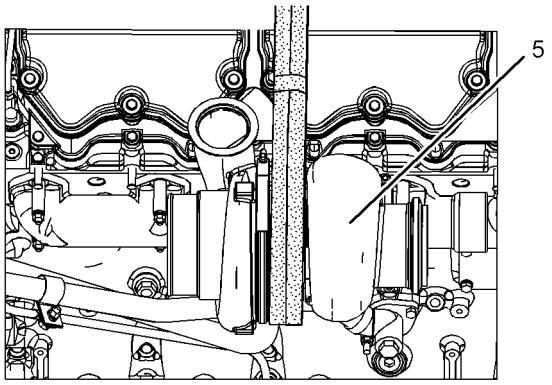


Illustration 312 g01148173

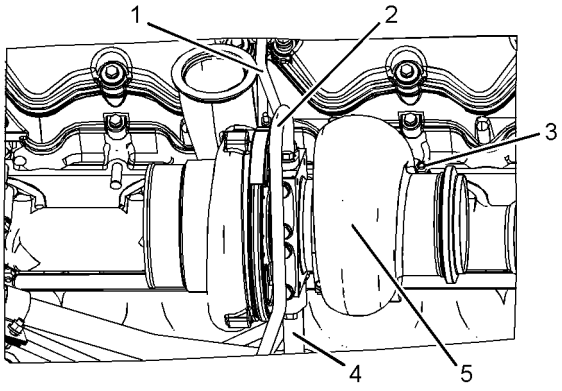


Illustration 313 g01145002

1. Position the gasket on the exhaust manifold.

2. Apply Tooling (A) to the threads of the exhaust manifold studs.

Note: Install turbocharger (5) in the original location and the original orientation that was noted in the removal procedure.

3. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 45 kg (100 lb). Position turbocharger (5) on the exhaust manifold.

4. Install nuts (3) and tighten to a torque of 55 ± 9 N·m (41 ± 7 lb ft).

5. Connect tube assemblies (1) and tube assembly (4).

6. Install tube assembly (2).

7. Fill the cooling system. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change”.

i02471010

Refrigerant Compressor - Remove
(Engine in Machine)

SMCS Code: 1802-011

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Effective July 1, 1992 regulations prohibit the venting of any refrigerant into the atmosphere. Refer to Caterpillar publications Service Manuals, SENR3334, SENR5664, and NEDG5065 for the proper procedure, the proper equipment, and the proper tools needed in order to reclaim refrigerant from any Caterpillar equipment.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Recover the air conditioner refrigerant from the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.
2. Turn the disconnect switch to the OFF position.
3. Remove the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

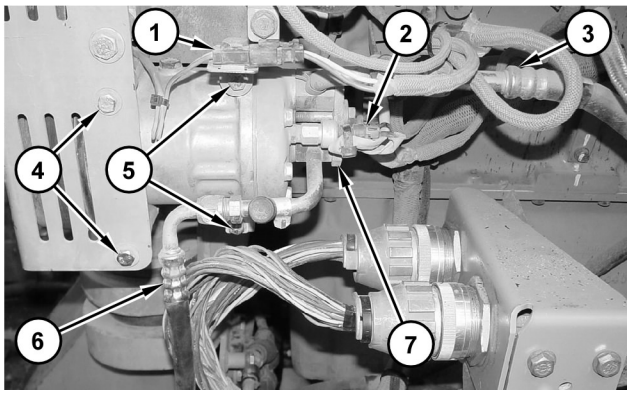


Illustration 314 g01241824

4. Disconnect harness assembly (1).
5. Disconnect harness assembly (2).
6. Disconnect hose assembly (3).
7. Disconnect hose assembly (6).
8. Remove bolts (4).
9. Remove bolts (5).

10. Remove refrigerant compressor (7).

i02471015

Refrigerant Compressor - Install
(Engine in Machine)

SMCS Code: 1802-012

Installation Procedure

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

NOTICE
Effective July 1, 1992 regulations prohibit the venting of any refrigerant into the atmosphere. Refer to Caterpillar publications Service Manuals, SENR3334, SENR5664, and NEDG5065 for the proper procedure, the proper equipment, and the proper tools needed in order to reclaim refrigerant from any Caterpillar equipment.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

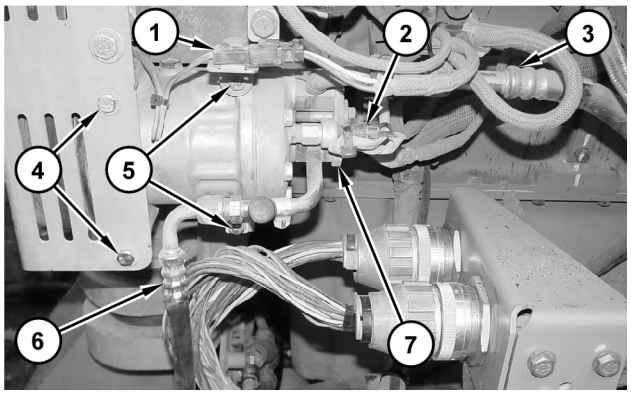


Illustration 315 g01241824

1. Position compressor (7). Install bolts (5) and bolts (4).

2. Connect hose assembly (6).

3. Connect hose assembly (3).

4. Connect harness assembly (2).

5. Connect harness assembly (1).

6. Evacuate the air conditioner system. Charge the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.

7. Install the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/ Replace”.

8. Turn the disconnect switch to the ON position.

i02504598

Engine and Torque Converter - Remove

SMCS Code: 1003-011

Removal Procedure

Table 27

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-6146	Load Leveler	1
B	180-3034	Repair Stand Set	2

Start By:

a. Remove the front and rear hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Remove”.

b. Remove the side panels. Refer to Disassembly and Assembly, “Hood Side Panels and Side Doors - Remove”.

c. Remove the input drive shaft. Refer to Disassembly and Assembly, “Input Drive Shaft - Remove and Install”.

d. Remove the implement hydraulic pump. Refer to Disassembly and Assembly, “Piston Pump (Tandem, Implement) - Remove”.

e. Remove the steering pump. Refer to Disassembly and Assembly, “Piston Pump (Steering) - Remove”.

Note: Move the machine to a smooth, level area in order to properly release the implement hydraulic pressure.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

⚠ WARNING

At operating temperature the implement hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible injury, release the pressure in the implement hydraulic system before hydraulic lines or components are disconnected or removed.

⚠ WARNING

At operating temperature, the steering and brake hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible personal injury, release the pressure in the steering and brake hydraulic system before hydraulic lines or components are disconnected or removed.

NOTICE
Effective July 1, 1992 regulations prohibit the venting of any refrigerant into the atmosphere. Refer to Caterpillar publications Service Manuals, SENR3334, SENR5664, and NEDG5065 for the proper procedure, the proper equipment, and the proper tools needed in order to reclaim refrigerant from any Caterpillar equipment.

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

1. Engage the parking brake.

2. Deactivate the electrical system. Refer to Operation and Maintenance Manual, “Battery Disconnect Switch”.

3. Drain the coolant into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, “Capacities (Refill)”.

4. Remove the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace”.

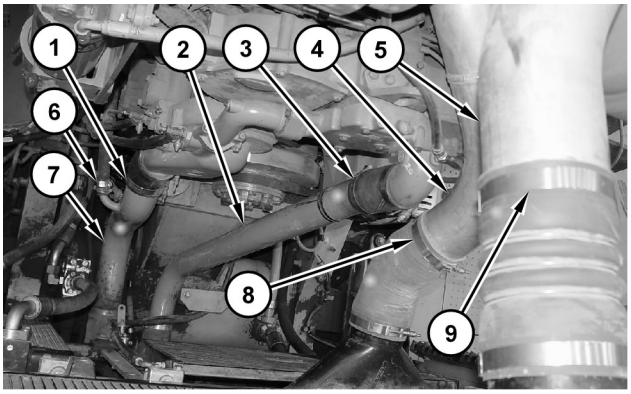


Illustration 316 g01241296

5. Loosen clamps (1) from both ends of tube (7). Loosen clamps (3) from both ends of tube (2). Remove tube (2). Disconnect hose (6). Remove tube (7).

6. Loosen clamps (8) from both ends of tube (4). Remove tube (4). Loosen clamps (9) from both ends of tube (5). Remove tube (5).

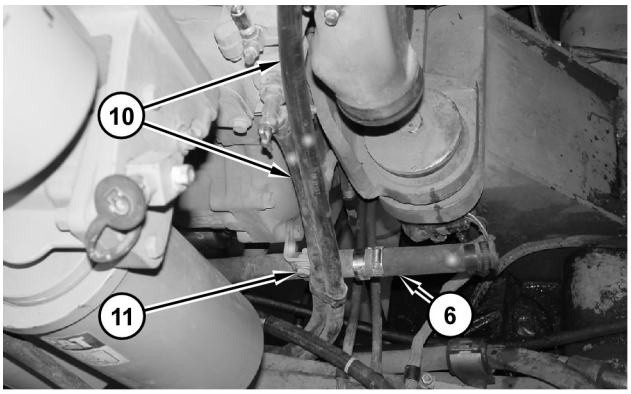


Illustration 317 g01241398

7. Disconnect hoses (10). Remove bolt (11) in order to position hoses (10) and hose (6) out of the way.

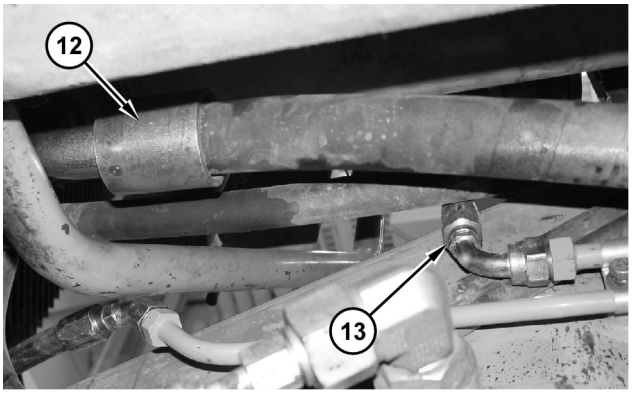


Illustration 318 g01241415

8. Disconnect hose assembly (12). Disconnect hose assembly (13).

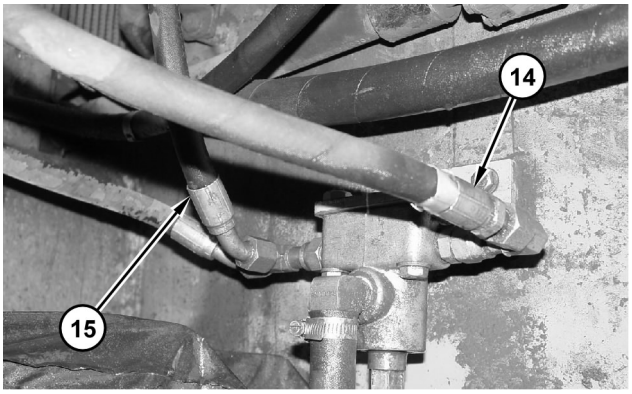


Illustration 319 g01241418

9. Disconnect hose assembly (14). Disconnect hose assembly (15).

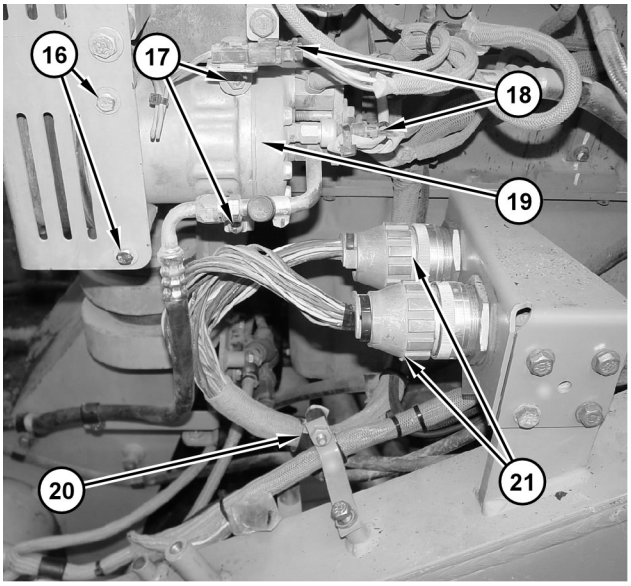


Illustration 320 g01241426

10. Remove bolts (16). Remove bolts (17). Disconnect harness assemblies (18). Position compressor (19) out of the way. Remove clip (20). Disconnect harness assembly (21).

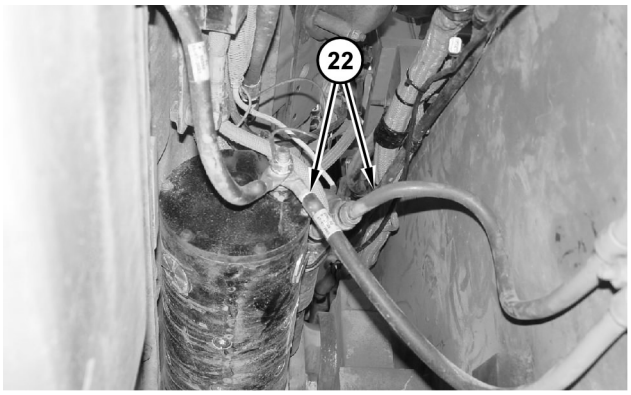


Illustration 321 g01241443

11. Remove cable assemblies (22).

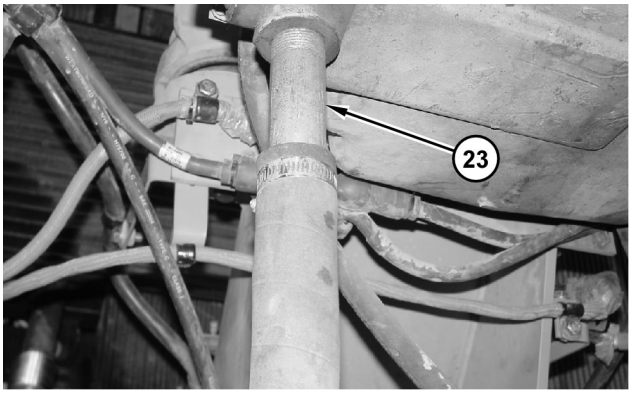


Illustration 322 g01246423

12. Remove drain tube (23).

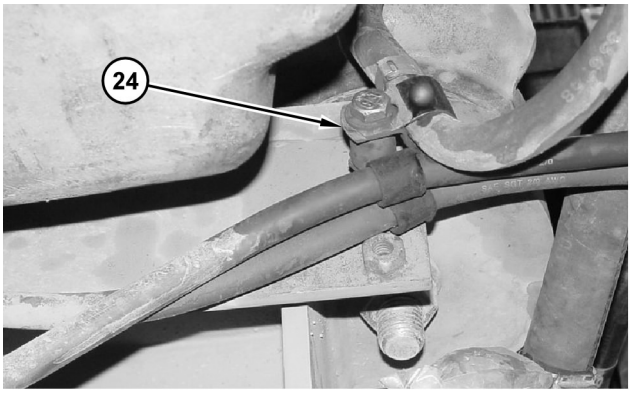


Illustration 323 g01241461

13. Remove clip (24).

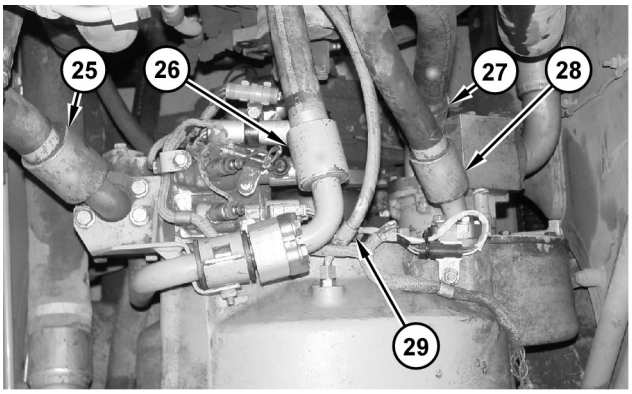


Illustration 324 g01241492

14. Disconnect hose assembly (25), hose assembly (26), hose assembly (27), hose assembly (28), and hose assembly (29).

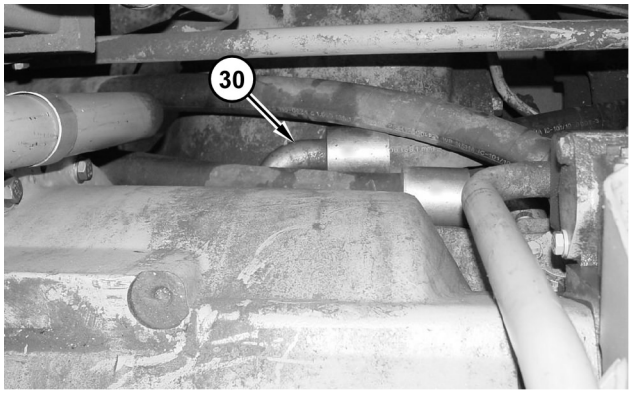


Illustration 325 g01241500

15. Disconnect hose assembly (30).

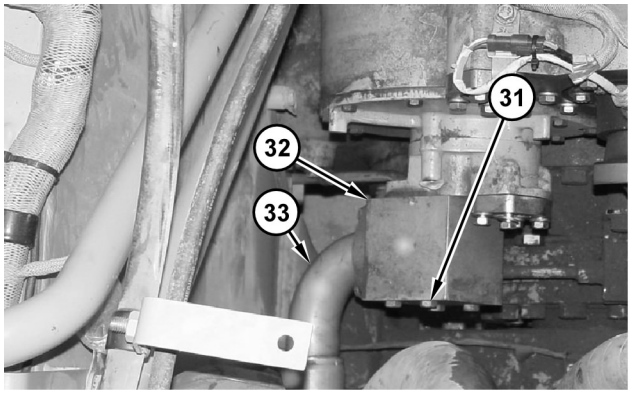


Illustration 326 g01241502

16. Remove bolts (31) in order to disconnect adapter block (32) and hose assembly (33).

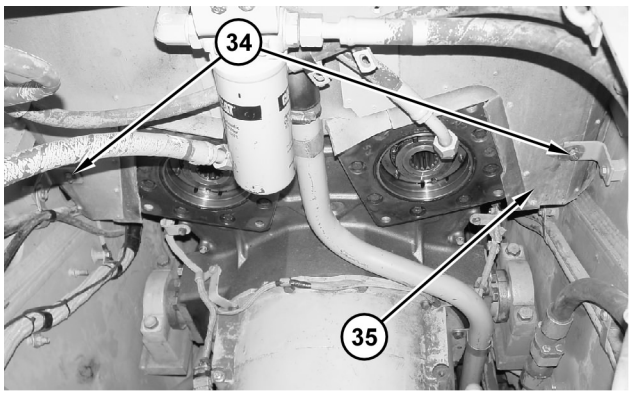


Illustration 327 g01246431

17. Remove bolts (34). Remove panel assembly (35).

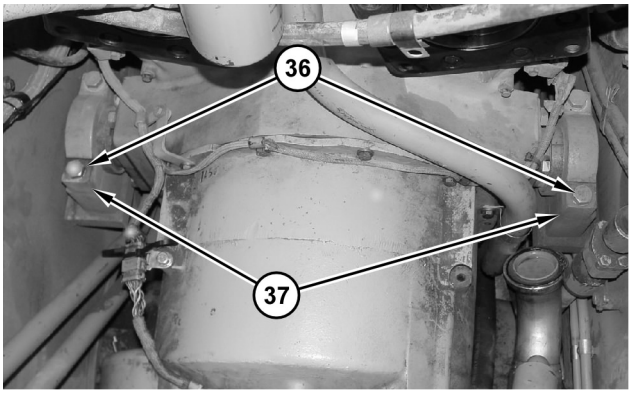


Illustration 328 g01241496

18. Remove bolts (36) and trunnion caps (37).

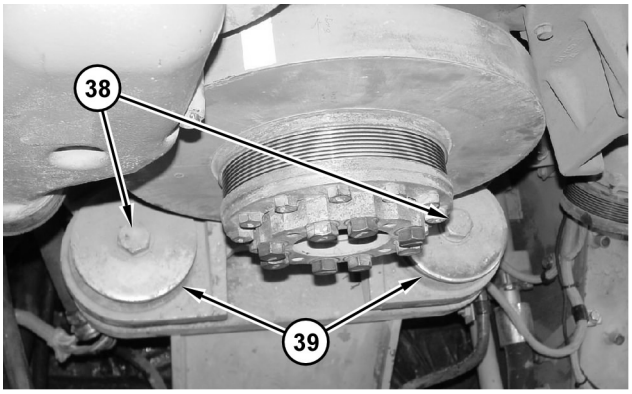


Illustration 329 g01241514

19. Remove bolts (38) and mount assemblies (39).

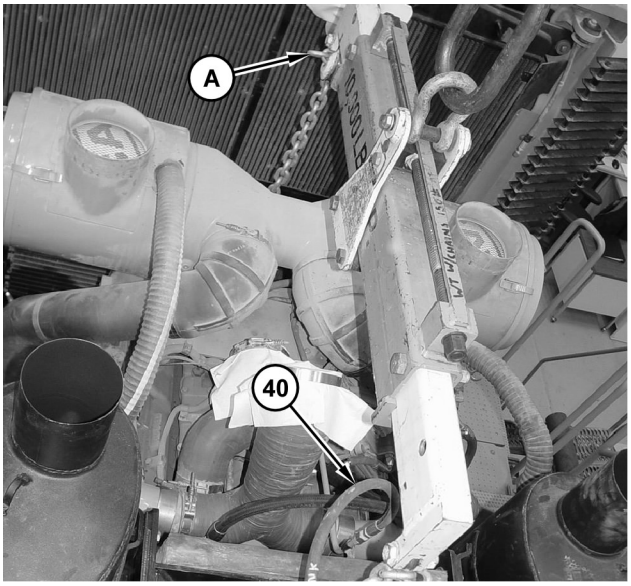


Illustration 330 g01241481

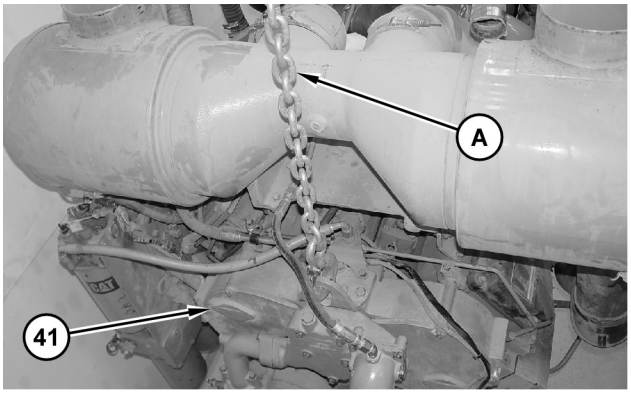


Illustration 331 g01241604

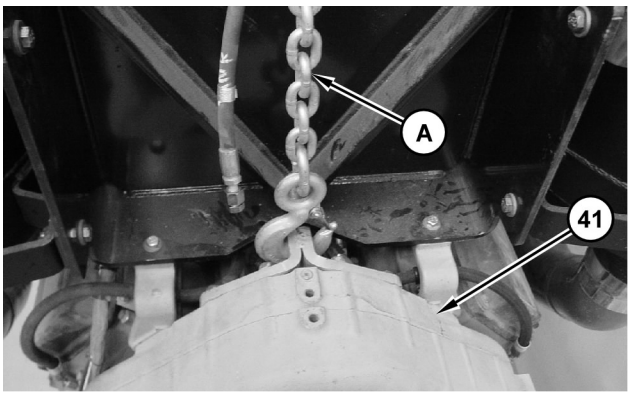


Illustration 332 g01241632

20. Disconnect hose assembly (40).

21. Attach Tooling (A) and a suitable lifting device onto the engine and torque converter (41). The weight of engine and torque converter (41) is approximately 3810 kg (8400 lb).

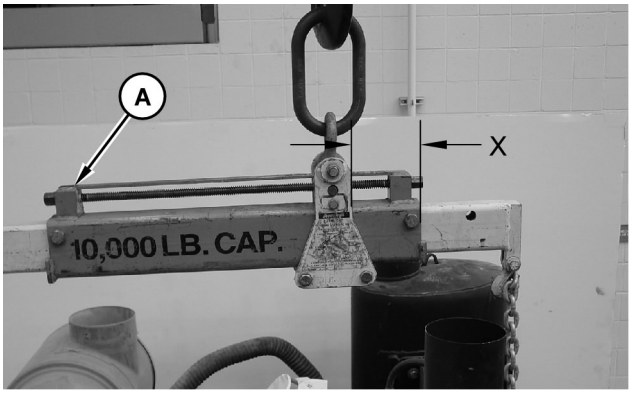


Illustration 333 g01241643

22. Adjust Tooling (A) to approximately 145 cm (57.0 inch), as shown.

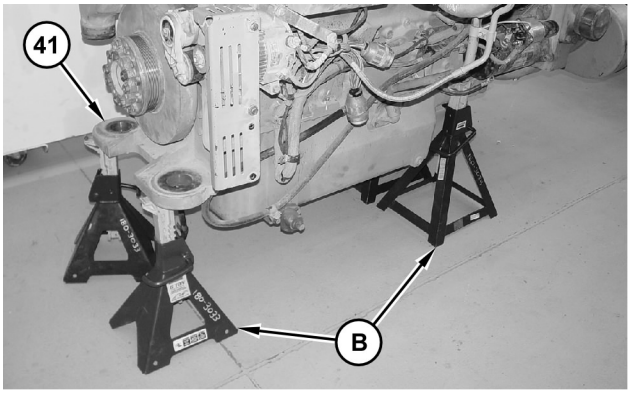


Illustration 334 g01241577

23. Remove the engine and torque converter (41). Position the engine and torque converter (41) onto Tooling (B), as shown.

i02504602

Engine from Torque Converter - Separate

SMCS Code: 1003-076

Separation Procedure

Table 28

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	3
B	1U-9200	Lever Puller Hoist	1

Start By:

a. Remove the engine and the torque converter assembly. Refer to Disassembly and Assembly, "Engine and Torque Converter - Remove".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

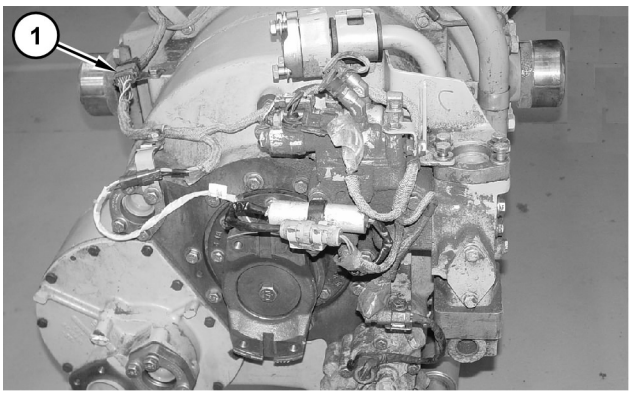


Illustration 335 g01241694

1. Disconnect harness assembly (1).

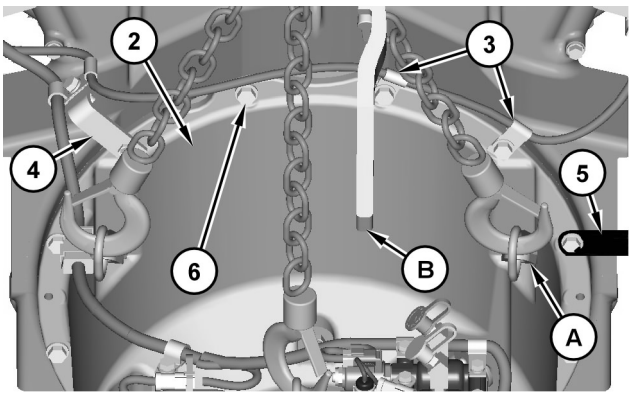


Illustration 336 g01241778

2. Attach Tooling (A), Tooling (B), and a suitable lifting device onto torque converter (2). The weight of torque converter (2) is approximately 476 kg (1050 lb).

3. Remove clips (3). Remove bracket (4). Remove clip (5).

4. Remove bolts (6) and remove torque converter (2) from the engine.

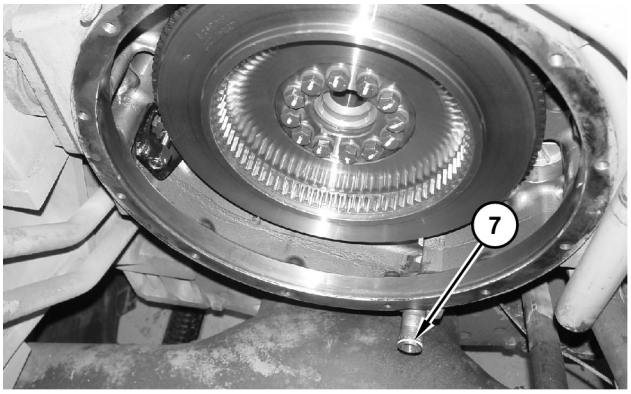


Illustration 337 g01241801

5. Remove O-ring seal (7).

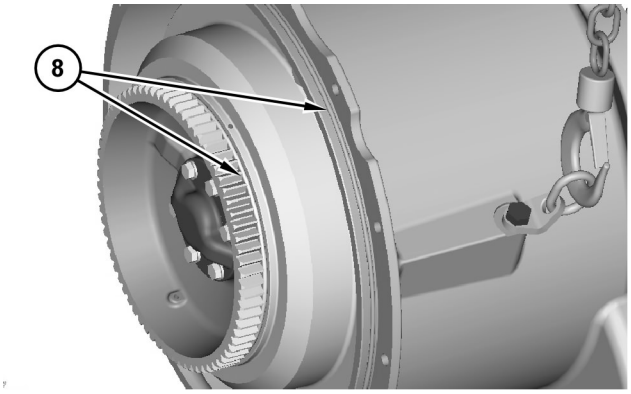


Illustration 338 g01241799

6. Remove O-ring seals (8).

i02504605

Engine to Torque Converter - Connect

SMCS Code: 1003-077

Connection Procedure

Table 29

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	3
B	1U-9200	Lever Puller Hoist	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Replace O-ring seals that are worn or damaged.

1. Clean the mating surfaces of the torque converter and of the engine.

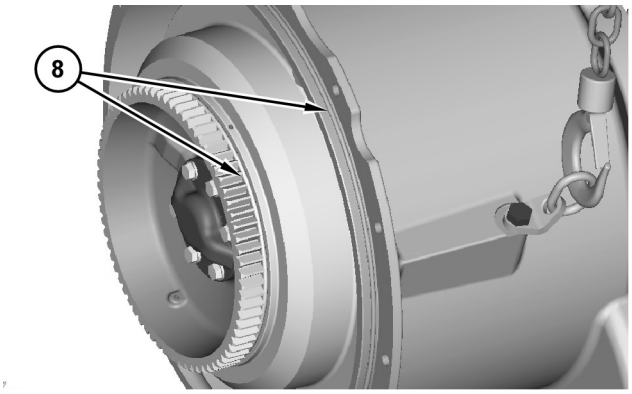


Illustration 339 g01241799

2. Lubricate O-ring seals (8) with clean transmission oil.

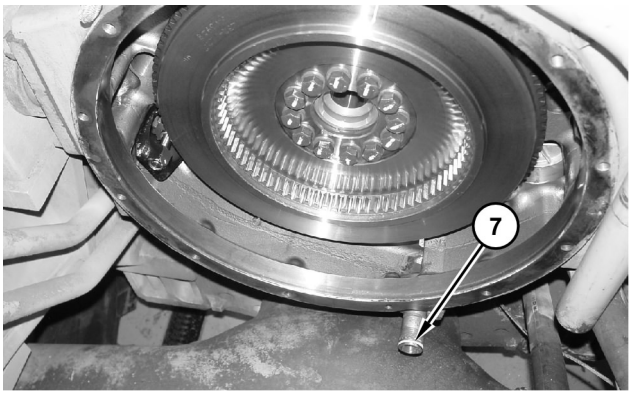


Illustration 340 g01241801

3. Lubricate O-ring seal (7) with clean transmission oil.

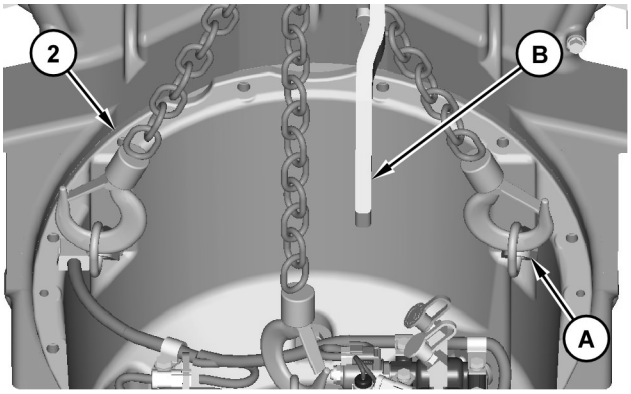


Illustration 341 g01241803

4. Use Tooling (A), Tooling (B), and a suitable lifting device in order to install torque converter (2) onto the engine. The weight of torque converter (2) is approximately 476 kg (1050 lb).

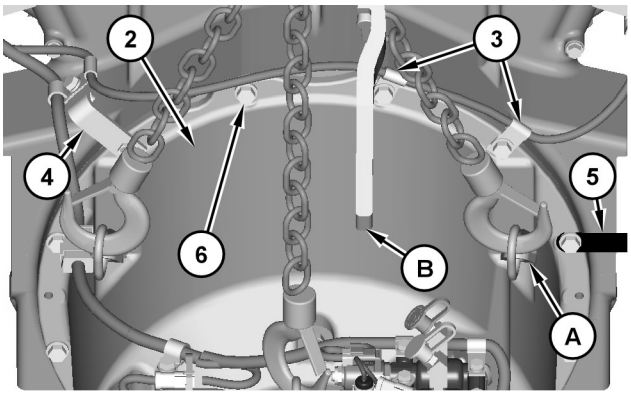


Illustration 342 g01241810

5. Position bracket (4), clips (3), and clip (5) onto torque converter (2). Install bolts (6).

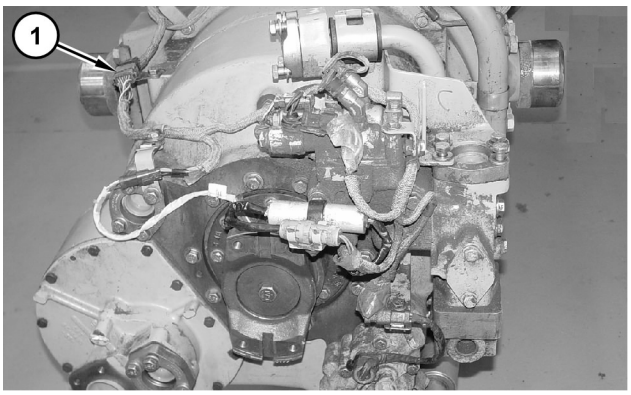


Illustration 343 g01241694

6. Connect harness assembly (1).

End By:

a. Install the engine and the torque converter assembly. Refer to Disassembly and Assembly, “Engine and Torque Converter - Install”.

i02504601

Engine and Torque Converter - Install

SMCS Code: 1003-012

Installation Procedure

Table 30

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-6146	Load Leveler	1
B	180-3034	Repair Stand Set	2

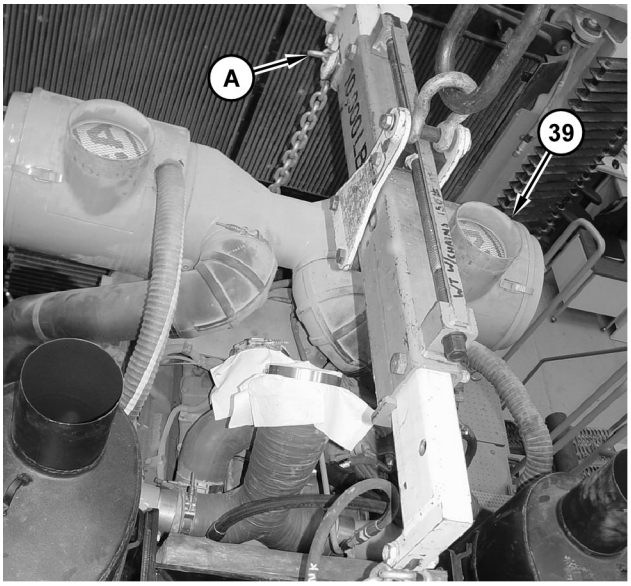


Illustration 344 g01242419

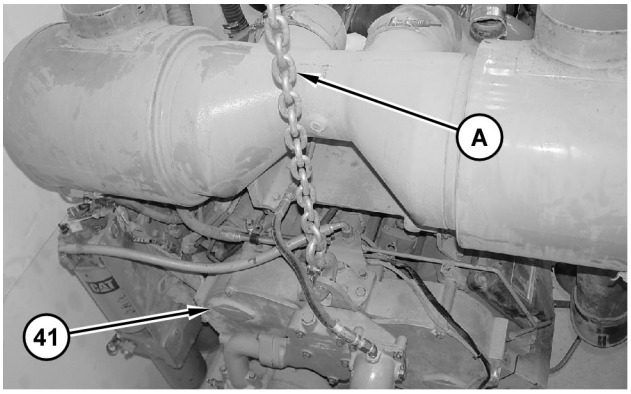


Illustration 345 g01241604

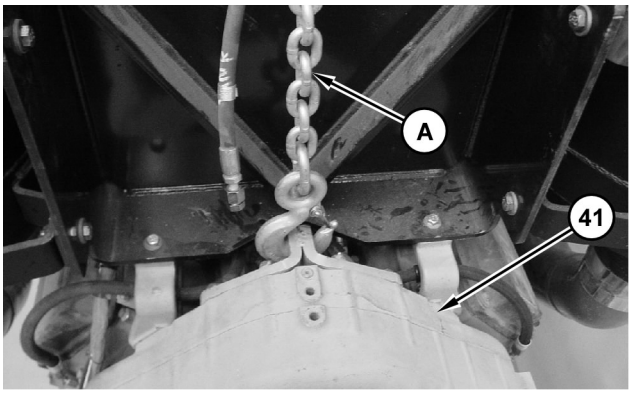


Illustration 346 g01241632

1. Attach Tooling (A) and a suitable lifting device onto the engine and torque converter (39). The weight of engine and torque converter (39) is approximately 3810 kg (8400 lb).

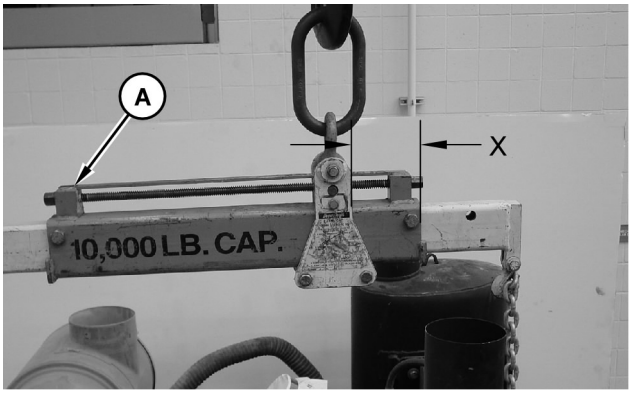


Illustration 347 g01241643

2. Adjust Tooling (A) to approximately 145 cm (57.0 inch), as shown.

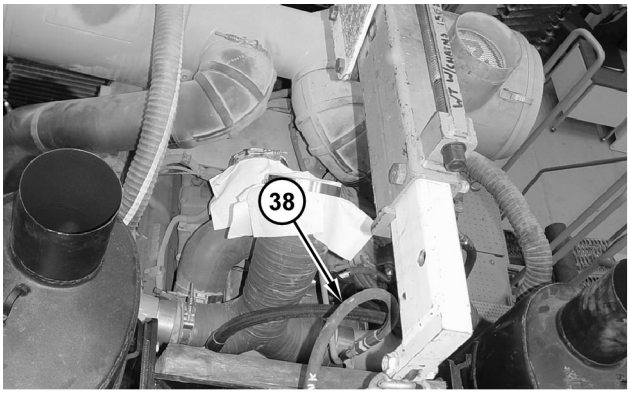


Illustration 348 g01242420

3. Connect hose assembly (38).

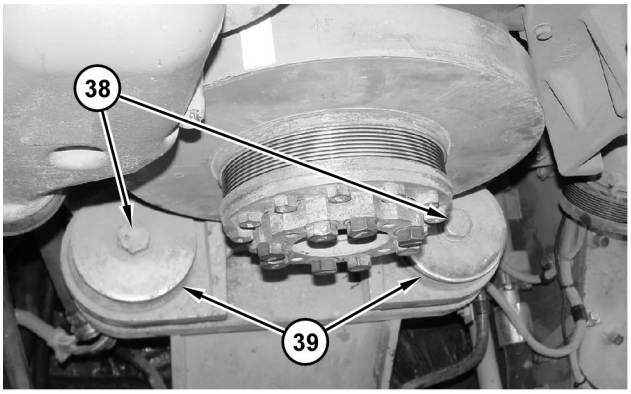


Illustration 349 g01241514

4. Install mount assemblies (37) and install bolts (36).

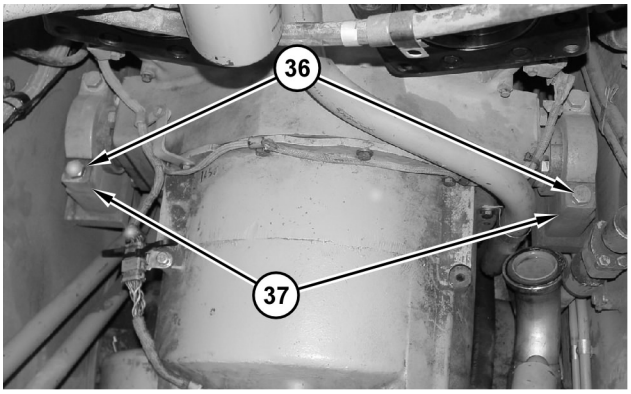


Illustration 350 g01241496

5. Install trunnion caps (35) and install bolts (34).

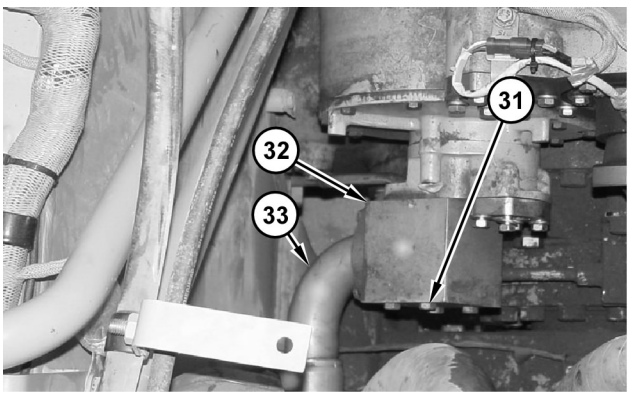


Illustration 351 g01241502

6. Position adapter block (32) and hose assembly (33). Install bolts (31).

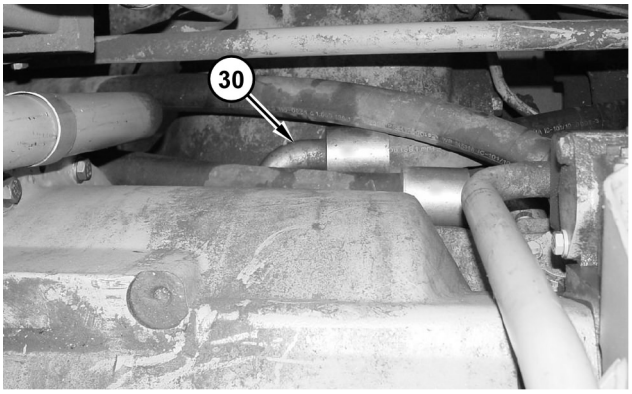


Illustration 352 g01241500

7. Connect hose assembly (30).

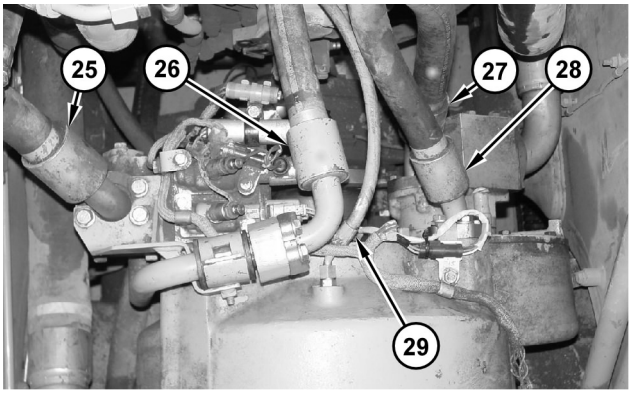


Illustration 353 g01241492

8. Connect hose assembly (29), hose assembly (28), hose assembly (27), hose assembly (26), and hose assembly (25).

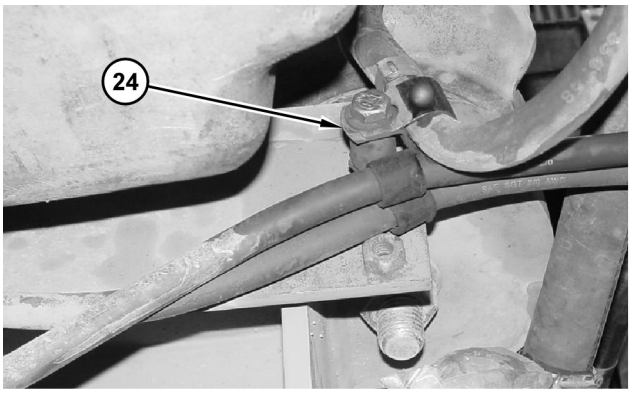


Illustration 354 g01241461

9. Install clip (24).

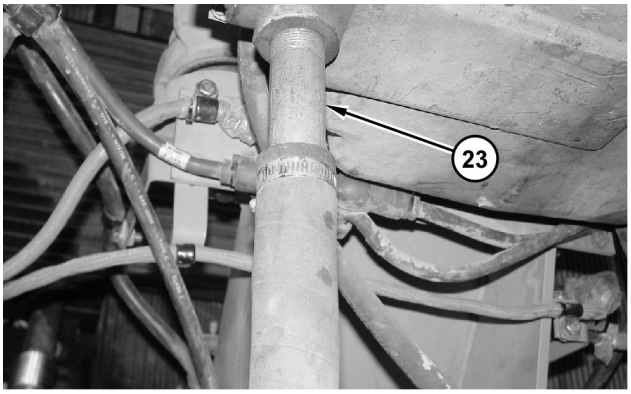


Illustration 355 g01246423

10. Install drain tube (23).

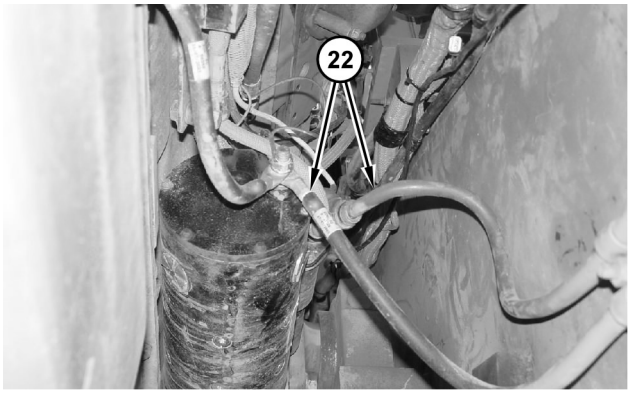


Illustration 356 g01241443

11. Install cable assemblies (22).

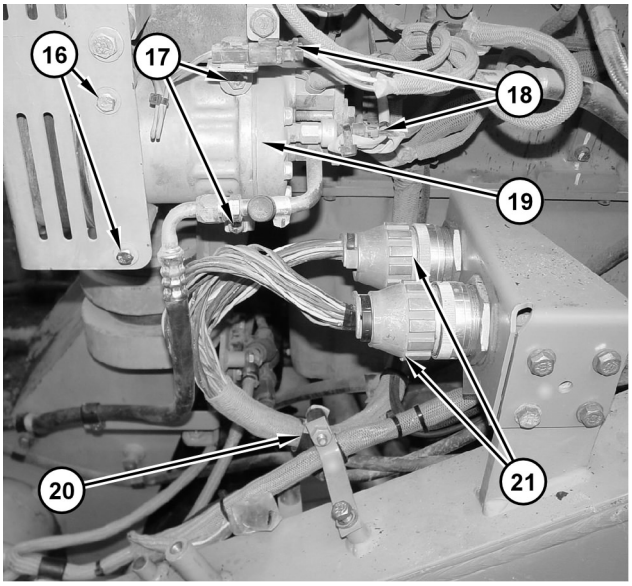


Illustration 357 g01241426

12. Position compressor (19). Install bolts (17) and bolts (16). Connect harness assembly (21). Install clip (20). Connect harness assemblies (18).

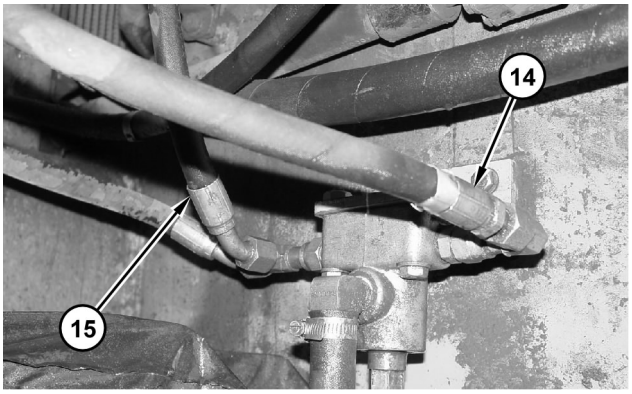


Illustration 358 g01241418

13. Connect hose assembly (15). Connect hose assembly (14).

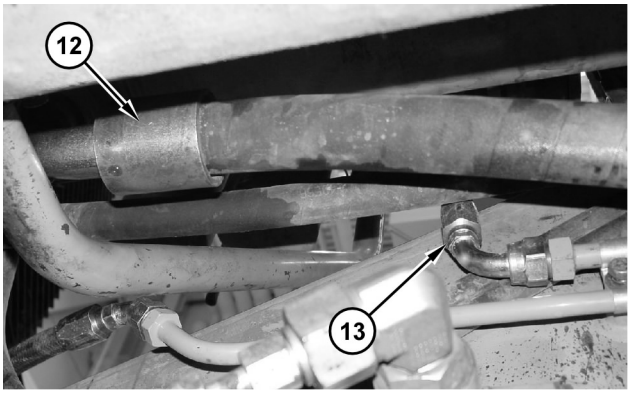


Illustration 359 g01241415

14. Connect hose assembly (13). Connect hose assembly (12).

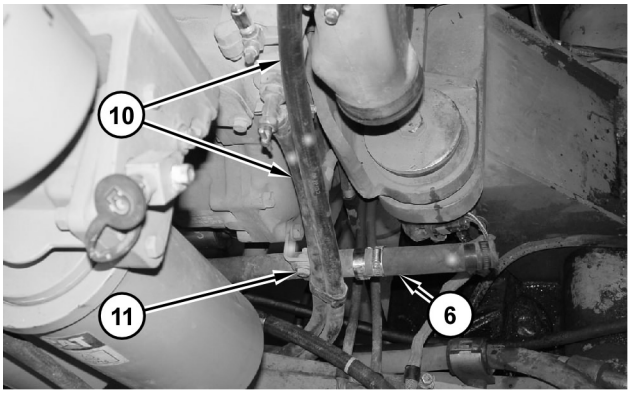


Illustration 360 g01241398

15. Position hoses (10) and hose (6). Install bolts (11). Connect hoses (10) and hose (6).

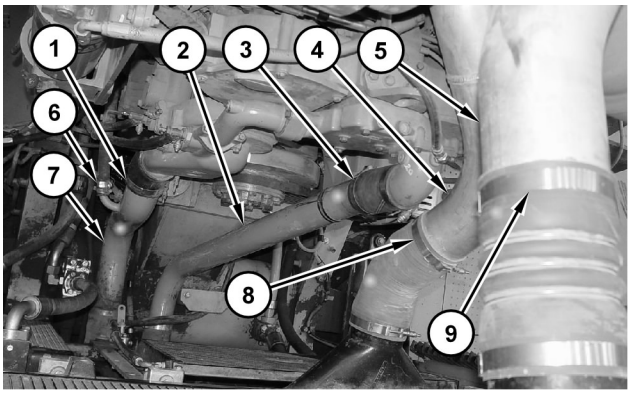


Illustration 361 g01241296

16. Loosen clamps (1) from both ends of tube (7). Loosen clamps (3) from both ends of tube (2). Remove tube (2). Disconnect hose (6). Remove tube (7).

17. Loosen clamps (8) from both ends of tube (4). Remove tube (4). Loosen clamps (9) from both ends of tube (5). Remove tube (5).

18. Install the belt. Refer to Operation and Maintenance Manual, “Belts - Inspect/Adjust/ Replace”.

19. Fill the cooling system. Refer to Operation and Maintenance Manual, “Capacities (Refill)”.

20. Activate the electrical system. Refer to Operation and Maintenance Manual, “Battery Disconnect Switch”.

21. Disengage the parking brake.

End By:

a. Install the hood and engine enclosure. Refer to Disassembly and Assembly, “Hood and Engine Enclosure - Install”.

b. Install the steering pump. Refer to Disassembly and Assembly, “Piston Pump (Steering) - Install”.

c. Install the implement hydraulic pump. Refer to Disassembly and Assembly, “Piston Pump (Tandem, Implement) - Install”.

d. Install the input drive shaft. Refer to Disassembly and Assembly, “Input Drive Shaft - Remove and Install”.

e. Install the side panels. Refer to Disassembly and Assembly, “Hood Side Panels and Side Doors - Remove”.

f. Install the front and rear hood panels. Refer to Disassembly and Assembly, “Hood Panels (Front and Rear) - Remove”.

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CATERPILLAR®

RENR8815
October 2005



Specifications

990H Wheel Loader and 844H Wheel Dozer Steering System

BTW1-Up (Machine)
BWX1-Up (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Specifications Section

i02373340

Hydraulic Tank and Filter (Steering, Hydraulic Fan)

SMCS Code: 5056-HFN; 5056-ZH

Part No.: 6E-4683

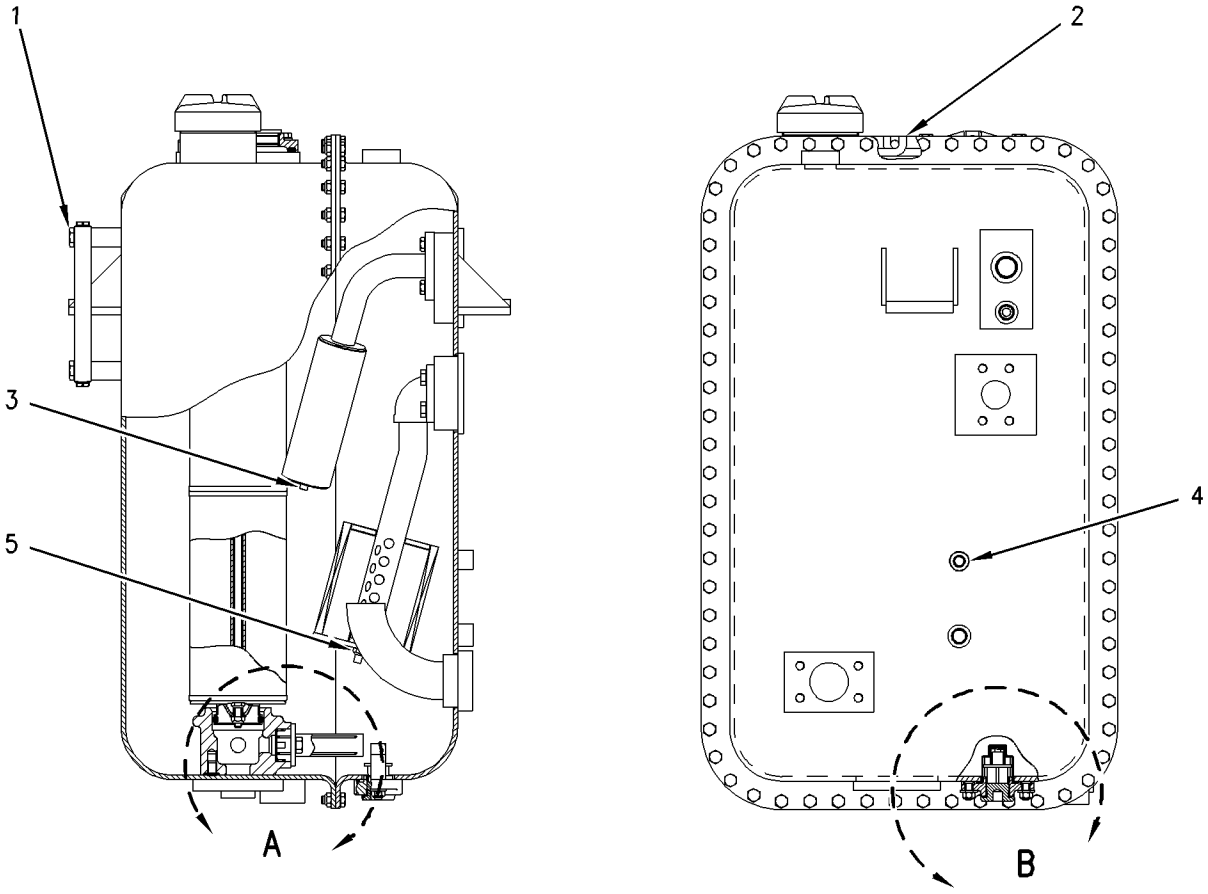


Illustration 1 g00846375

(1) Torque for the gauge bolts. ..... 7 ± 1 N·m (5 ± 1 lb ft)

(2) 3G-4090 Sealant .. 3200 ± 32 mm (125 ± 1 inch)

Note: Refer to illustration 1 in order to complete the installation of the seal.

(3) Tightening torque for nut ..... 20 ± 5 N·m (15 ± 4 lb ft)

(4) Use air and pressure test the tank. ..... 150 ± 35 kPa (22 ± 5 psi)

(5) Tightening torque for nut ..... 20 ± 5 N·m (15 ± 4 lb ft)

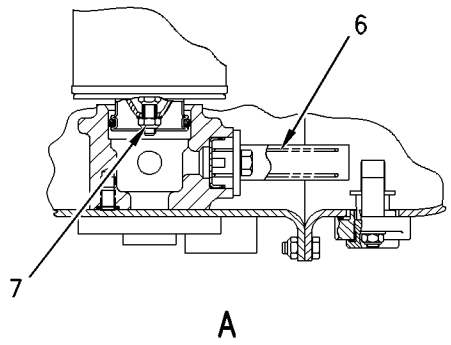


Illustration 2 g00846431

(6) 1L-4349 Spring

Length under test force ..... 106 mm (4.2 inch)
Test force ..... 84 ± 7 N (19 ± 1.6 lb)
Free length after test ..... 139.7 mm (5.5 inch)
Outside diameter ..... 24.4 mm (0.96 inch)

(7) Tightening torque for nut ..... 10 ± 1.5 N·m (7 ± 1 lb ft)

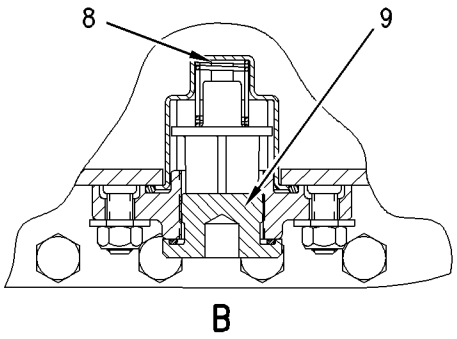


Illustration 3 g00846461

(8) 7B-3039 Spring

Length under test force ..... 26.2 mm (1.03 inch)
Test force ..... 15.55 ± 1.5 N (3.5 ± 0.3 lb)
Free length after test ..... 36.5 mm (1.4 inch)
Outside diameter ..... 16.5 mm (0.7 inch)

(9) Tightening torque for plug ..... 68 ± 7 N·m (50 ± 5 lb ft)

i02368717

Breaker Relief Valve

SMCS Code: 5118

Part No.: 220-0812
S/N: BTW1-Up

Part No.: 133-1963, 220-0812
S/N: BWX1-Up

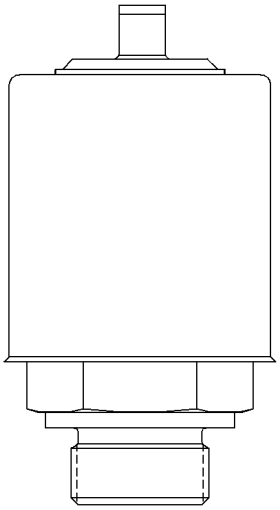


Illustration 4 g01047312

Vacuum relief cracking pressure ..... 1 kPa (0.2 psi)

Pressure relief cracking pressure for the 133-1963 Breaker Relief Valve ..... 130 ± 20 kPa (19 ± 3 psi)

Pressure relief cracking pressure for the 220-0812 Breaker Relief Valve ..... 35 ± 7 kPa (5 ± 1 psi)

Burst Pressure ..... 620 kPa (90 psi)

Temperature Range ... −40 to 121 °C (−40 to 250 °F)

i02361263

Temperature Switch (Steering, Hydraulic Fan Oil)

SMCS Code: 1435-HFN; 1435-ZH

Part No.: 131-4135

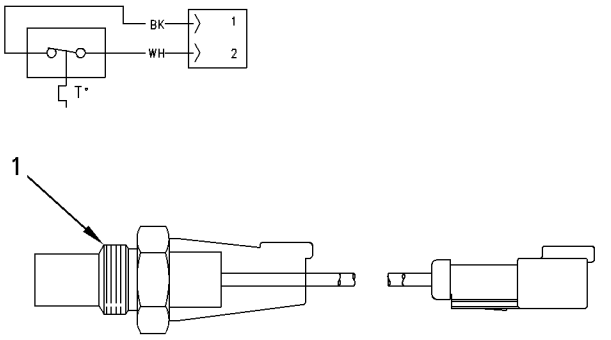


Illustration 5 g00274508

The switch has a normally closed position.

Actuation temperature ..... 102° ± 3°C (216° ± 5°F)

Minimum deactuation temperature ..... 90°C (194°F)

(1) Final installation torque .. 82 ± 8 N·m (60 ± 6 lb ft)

i02368255

Piston Pump (Steering)

SMCS Code: 4306-QP; 5070-ZH

Part No.: 229-8604

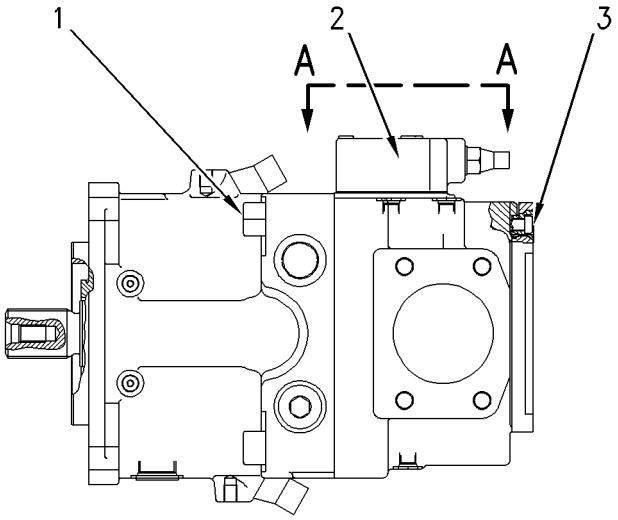


Illustration 6 g00848734

The rotation of the shaft is counterclockwise when the rotation of the shaft is viewed from the drive end.

The pump is a slipper type axial piston pump.

(1) Torque for the four bolts ..... 620 N·m (460 lb ft)

(2) Compensator valve group

(3) Torque for the four bolts ..... 215 N·m (160 lb ft)

For the test, use SAE 10 oil that is at 65 °C (150 °F).

Test at full speed

Output ..... 396 L/min (105 US gpm)
Pressure ..... 690 kPa (100 psi)
Pump speed ..... 2130 rpm
Engine speed ..... 2000 rpm

Output ..... 384 L/min (101 US gpm)
Pressure ..... 6900 kPa (1000 psi)
Pump speed ..... 2130 rpm
Engine speed ..... 2000 rpm

Test at half speed

Output ..... 198 L/min (52 US gpm)
Pressure ..... 690 kPa (100 psi)
Pump speed ..... 1065 rpm
Engine speed ..... 1000 rpm

Output ..... 192 L/min (50 US gpm)
Pressure ..... 6900 kPa (1000 psi)
Pump speed ..... 1065 rpm
Engine speed ..... 1000 rpm

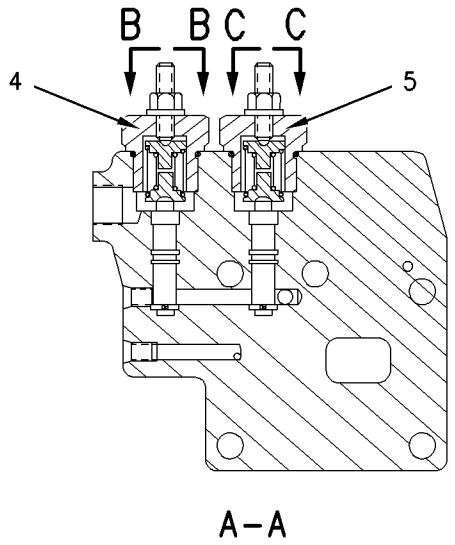


Illustration 7 g00848574

Pressure Compensator Valve and Flow Compensator Valve

(4) Flow compensator valve

(5) Pressure compensator valve

Pressure Compensator Valve

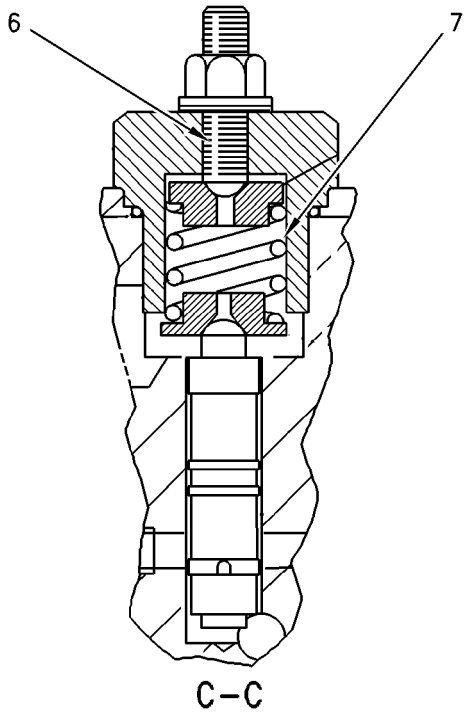


Illustration 8 g00848450

(6) High pressure stall with the pump at rated speed ..... 31000 ± 1000 kPa (4500 ± 145 psi)

(7) 6E-3858 Spring

Free length ..... 20.7 mm (0.81 inch)
Outside diameter ..... 13.75 mm (0.54 inch)

Pressure and Flow Compensator Valve

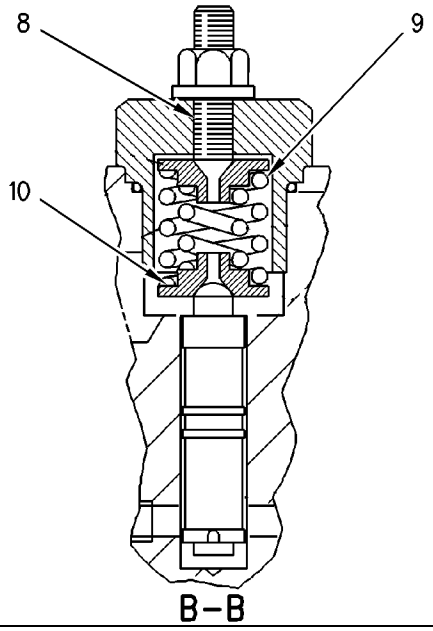


Illustration 9 g00848414

(8) Low pressure standby ..... 3755 ± 1240 kPa (545 ± 180 psi)

(9) 179-6922 Spring

Free length ..... 17.1 mm (0.67 inch)
Assembled length ..... 13.6 mm (0.54 inch)
Load at assembly ..... 92 ± 13.5 N (21 ± 3 lb)
Outside diameter ..... 8.6 mm (0.33 inch)

(10) 165-9383 Spring

Free length ..... 19.4 mm (0.76 inch)
Outside diameter ..... 12 mm (0.5 inch)

i01633661

Gear Pump (Secondary Steering)

SMCS Code: 4324-GT; 5073-SST

Part No.: 101-4007

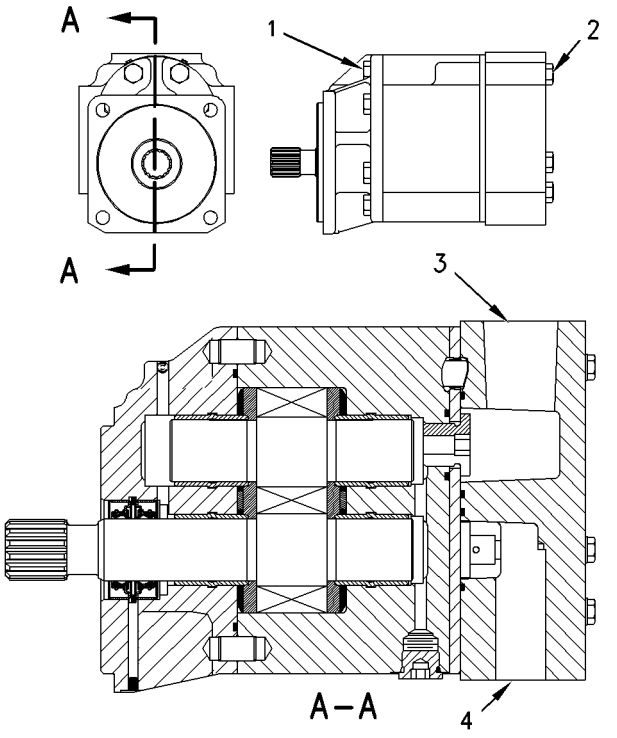


Illustration 10 g00801666

The secondary steering pump is a gear type pump.

For the test, use SAE 10 oil at 65°C (150°F).

Test at full speed:

Output ..... 166 L/min (44 US gpm)
Pressure ..... 690 kPa (100 psi)
Pump speed ..... 2000 rpm

Output ..... 149 L/min (40 US gpm)
Pressure ..... 6900 kPa (1000 psi)
Pump speed ..... 2000 rpm

Test at half speed:

Output ..... 83 L/min (22 US gpm)
Pressure ..... 690 kPa (100 psi)
Pump speed ..... 1000 rpm

Output ..... 75 L/min (20 US gpm)
Pressure ..... 6900 kPa (1000 psi)
Pump speed ..... 1000 rpm

(1) Torque for the eight bolts ..... 115 ± 5 N·m (85 ± 4 lb ft)

(2) Torque for the six bolts .. 115 ± 5 N·m (85 ± 4 lb ft)

(3) Inlet port.

(4) Outlet port.

i02373414

Oil Filter (Case Drain)

SMCS Code: 5091-ZH

Part No.: 166-4647

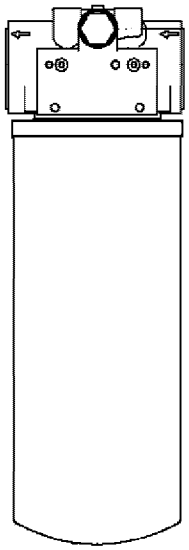


Illustration 11 g00678486

Maximum operating pressure ..... 2758 kPa (400 psi)

Pressure setting for the hydraulic oil filter bypass valve ..... 172 kPa (25 psi)

i02235548

STIC Control

SMCS Code: 3033

Part No.: 4E-8413

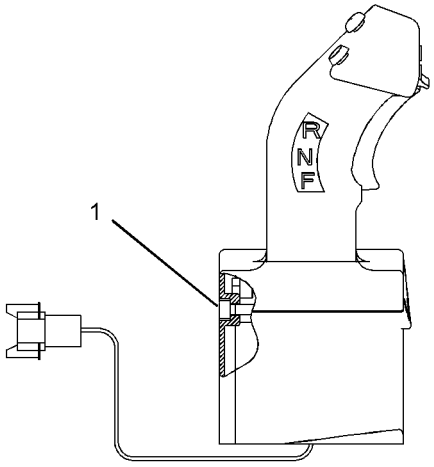


Illustration 12 g01127328

(1) Torque for the four bolts .. 6 ± 1 N·m (53 ± 9 lb in)

STIC Lockout Control

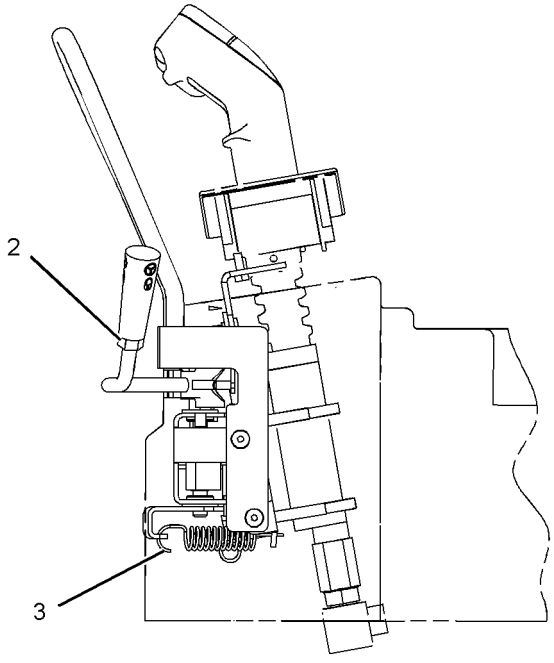


Illustration 13 g01127329
Left Side View

(2) Apply 155-0695 Thread Lock Compound to the threads.

(3) 8C-3442 Coil Spring

Length under test force ..... 57.9 mm (2.28 inch)
Test force ..... 71.2 ± 5.8 N (16.00 ± 1.30 lb)
Free length after test ..... 50.3 mm (1.98 inch)
Outside diameter ..... 17.48 ± 0.25 mm (0.688 ± 0.010 inch)

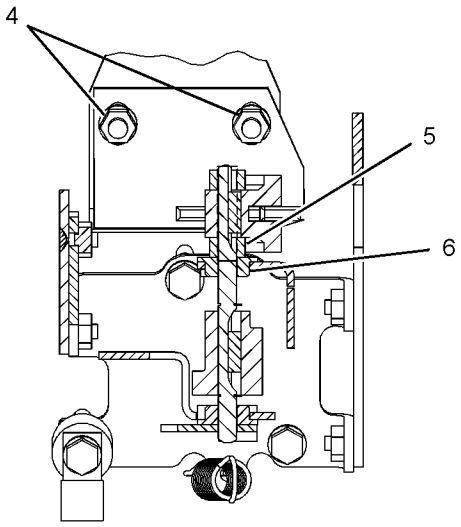


Illustration 14 g01127330
View A-A

(4) Torque for the two nuts .. 15 ± 3 N·m (11 ± 2 lb ft)

Note: Be sure that there is no space between bearing (6) and nut (5).

Limit Switch (STIC Lockout Control)

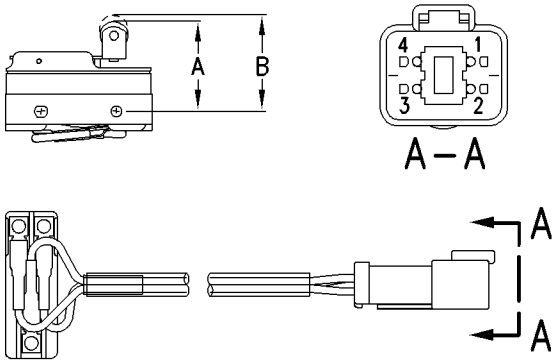


Illustration 15 g00657164

Maximum actuating force ..... 1.7 N (0.38 lb)

Minimum force for overtravel .... 2.39 N·m (21.2 lb in)

(A) Operating position ..... 30.18 ± 0.38 mm (1.188 ± 0.015 inch)

Contact (2) and contact (1) are closed when the switch is in the operating position.

(B) Free position ..... 32.16 ± 0.38 mm (1.266 ± 0.015 inch)

Contact (2) and contact (4) are closed when the switch is in the free position.

Temperature range ..... −40 °C to 85 °C (−40 °F to 185 °F)

i02369417

Pilot Valve (STIC Steering)

SMCS Code: 4342

Part No.: 249-5615

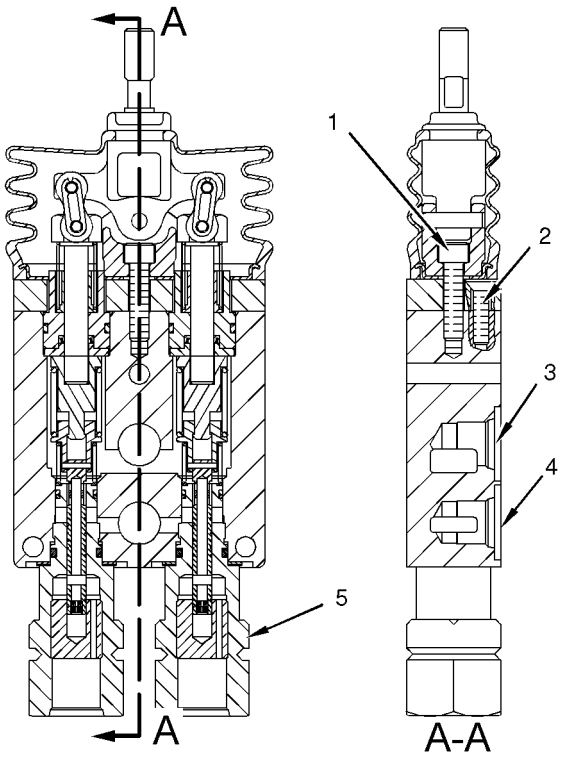


Illustration 16 g01052833

(1) Apply 154-9731 Thread Lock Compound to the threads of the bolt.

Torque for the bolt ..... 25 ± 2.5 N·m (18 ± 2 lb ft)

(2) Torque for the screw. ... 13 ± 1.5 N·m (10 ± 1 lb ft)

(3) Outlet port

(4) Inlet port

(5) Torque for the two pilot valve bodies .. 35 ± 3 N·m (25 ± 2 lb ft)

i01632764

Check Valve (Steering Quad)

SMCS Code: 5067-ZH; 5067-PS

Part No.: 111-7775

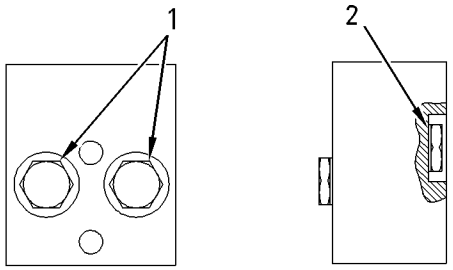


Illustration 17 g00845711

(1) Torque for the two 176-9369 Check Valves ..... 40.5 N·m (30 lb ft)

(2) Torque for the two 176-9371 Check Valves ..... 40.5 N·m (30 lb ft)

i01632288

Check Valve (Steering Pilot)

SMCS Code: 5067-ZH

Part No.: 104-7108

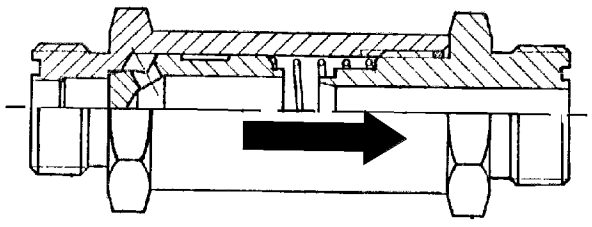


Illustration 18 g00102164

Cranking pressure for the check valve .... 35 ± 4 kPa (5 ± 1 psi)

i02373493

Selector and Pressure Control Valve (Steering)

SMCS Code: 4349

Part No.: 6E-5566

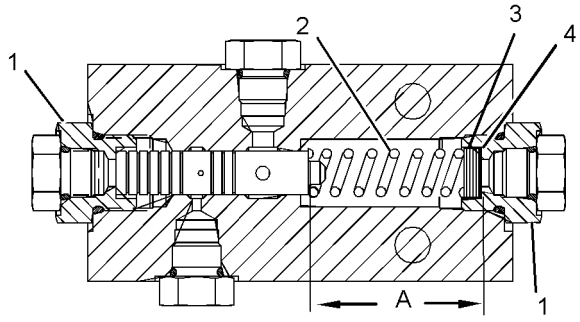


Illustration 19 g01184116

Primary steering pressure ..... 3300 ± 400 kPa (479 ± 58 psi)

Secondary steering pressure ..... 1650 ± 100 kPa (239 ± 15 psi)

(1) Torque for the 108-3866 Adapter .... 65 ± 7 N·m (48 ± 5 lb ft)

(2) 7S-8553 Spring (one blue stripe)

Length under test force ... 44.07 mm (1.735 inch)
Test force ..... 267 ± 21 N (60.0 ± 4.8 lb)
Free length after test ..... 50.55 mm (1.990 inch)
Outside diameter ..... 14.27 mm (0.562 inch)

(3) 5S-7001 Spacer

Thickness of one spacer ... 0.90 mm (0.035 inch)

The addition of one 5S-7001 Spacer (3) will increase the pressure approximately. ..... 290 kPa (42.0 psi)

Note: The 5S-7001 Spacer (3) must contact spring (1).

(4) 5S-7018 Spacer

Thickness of one spacer ... 0.25 mm (0.010 inch)

The addition of one 5S-7018 Spacer (4) will increase the pressure approximately. ..... 80 kPa (11.6 psi)

Note: The 5S-7018 Spacer (4) must contact adapter (1).

Note: Use spacers (3) and (4) to attain an assembled load of 125 ± 10 N·m (92± 7 lb ft). Maintain dimension (A).

Dimension (A) ..... 51.0 ± 0.5 mm (2.01 ± .02 inch)

i02370419

Steering Control Valve

SMCS Code: 4307

Part No.: 6E-2925

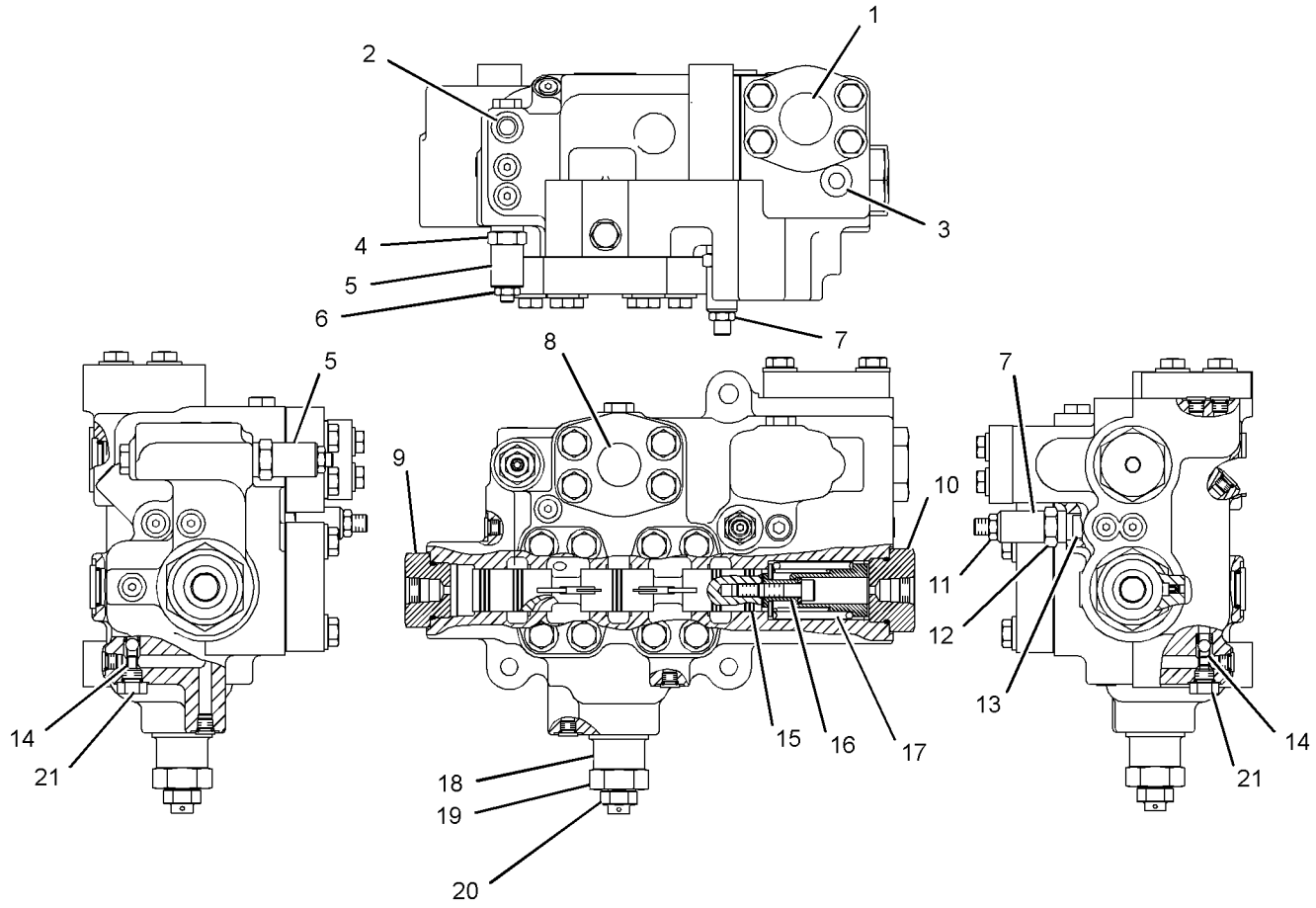


Illustration 20

g01182773

(1) Tank port

(2) Pilot oil supply port from the pressure reducing valve.

(3) Load sensing port

(4) Installation torque for the pressure regulating valve ..... 60 ± 7 N·m (44 ± 5 lb ft)

(5) Pressure regulating valve

(6) Torque for the locknut ..... 13 ± 2 N·m (115 ± 15 lb in)

(7) Steering cylinder crossover relief valve

(8) Pressure port from the steering pump

(9) Torque for the O-ring adapter ..... 430 ± 40 N·m (317 ± 30 lb ft)

(10) Torque for the O-ring adapter ..... 430 ± 40 N·m (317 ± 30 lb ft)

(11) Torque for the locknut ..... 13 ± 2 N·m (115 ± 15 lb in)

(12) Installation torque for the steering cylinder crossover relief valve ..... 60 ± 7 N·m (44 ± 5 lb ft)

(13) Installation torque for the load sensing shuttle valve ..... 35 ± 3 N·m (25 ± 2 lb ft)

(14) 2S-2596 Springs in two locations for the makeup valves

Length under test force ..... 8.0 mm (0.31 inch)
Test force ..... 4.20 ± 0.30 N (0.950 ± 0.076 lb)
Free length after test ..... 33.3 mm (1.31 inch)
Outside diameter ..... 8.40 mm (0.332 inch)

(15) 4J-8224 Shim and 5J-4776 Shim are cylinder flow balance shims.

Thickness of one 4J-8224 Shim ..... 0.25 mm (0.010 inch)

Thickness of one 5J-4776 Shim ..... 0.30 mm (0.012 inch)

Two shims will change the timing of the steering at high idle by the following amount. ..... 0.1 second

Note: The addition of one 4J-8224 Shim and of one 5J-4776 Shim will cause a faster right turn and a slower left turn. The removal of the shims will cause a slower right turn and a faster left turn.

(16) 6E-4499 Spring (Inner spring for the retainer)

Length under test force .. 44.45 mm (1.750 inch)
Test force ..... 62.0 ± 5.0 N (13.94 ± 1.12 lb)
Free length after test ..... 54.0 mm (2.13 inch)
Outside diameter ..... 29.5 mm (1.16 inch)

(17) 6E-4500 Spring (Outer spring for the valve spool)

Length under test force .. 58.45 mm (2.301 inch)
Test force ..... 189 ± 9 N (42 ± 2 lb)
Free length after test ..... 62.0 mm (2.44 inch)
Outside diameter ..... 42.5 mm (1.67 inch)

(18) Relief valve for the steering pump

(19) Installation torque for the relief valve for the steering pump ..... 100 ± 10 N·m (73 ± 7 lb ft)

(20) Torque for the locknut .. 50 ± 7 N·m (36 ± 5 lb ft)

(21) Torque for the two plugs ..... 48 ± 5 N·m (35 ± 4 lb ft)

i02370569

Steering Control Valve (with Secondary Steering)

SMCS Code: 4307-SST

Part No.: 6E-2923

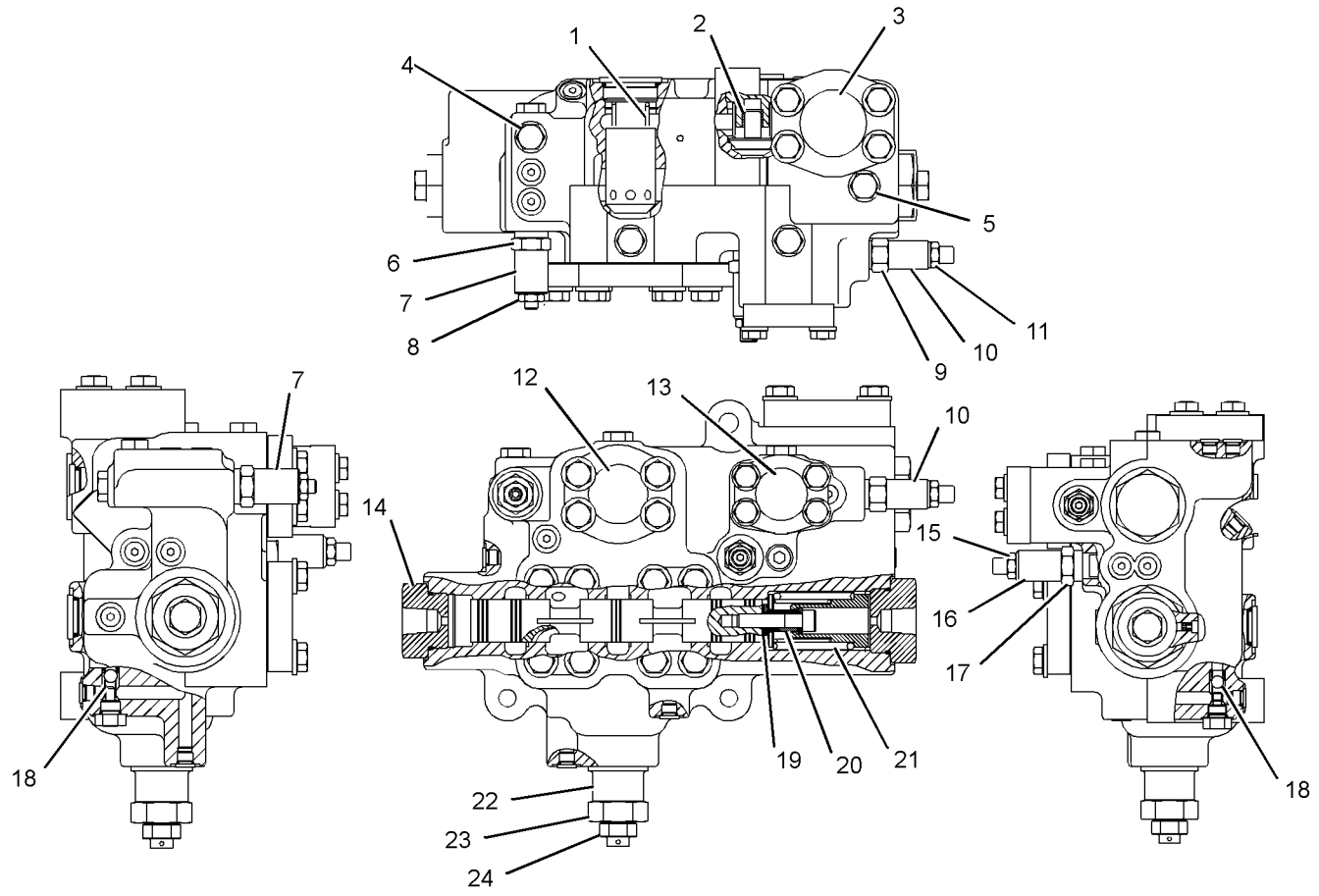


Illustration 21

g01182881

(1) 5J-3419 Spring (For the main pump check valve)

Length under test force ..... 47.2 mm (1.86 inch)
Test force ..... 95 ± 8 N (21.4 ± 1.7 lb)
Free length after test ..... 94.0 mm (3.70 inch)
Outside diameter ..... 28.58 mm (1.125 inch)

(2) 7S-8491 Spring (For the secondary check valve)

Length under test force ..... 25.4 mm (1.00 inch)
Test force ..... 19.2 ± 1.6 N (4.31 ± .35 lb)
Free length after test ..... 41.1 mm (1.62 inch)
Outside diameter ..... 30.18 mm (1.188 inch)

(3) Tank port

(4) Pilot oil supply port from the pressure reducing valve

(5) Load sensing port

(6) Installation torque for the pressure reducing valve ..... 60 ± 7 N·m (44 ± 5 lb ft)

(7) Pressure reducing valve

(8) Torque for the locknut ..... 13 ± 2 N·m (9 ± 1 lb ft)

(9) Installation torque for the relief valve for the secondary steering pump ..... 50 ± 7 N·m (36 ± 5 lb ft)

(10) Relief valve for the secondary steering pump

(11) Torque for the locknut .... 13 ± 2 N·m (9 ± 1 lb ft)

(12) Pressure port from the steering pump

(13) Pressure port from the secondary steering pump

(14) Pilot oil port

(15) Torque for the locknut .... 13 ± 2 N·m (9 ± 1 lb ft)

(16) Steering cylinder crossover relief valve

(17) Installation torque for the steering cylinder crossover relief valve ..... 60 ± 7 N·m (44 ± 5 lb ft)

(18) 2S-2596 Springs In two locations for the makeup valves

Length under test force ..... 8.0 mm (0.31 inch)
Test force ..... 4.20 ± 0.30 N (0.950 ± 0.076 lb)
Free length after test ..... 33.3 mm (1.31 inch)
Outside diameter ..... 8.40 mm (0.332 inch)

(19) 4J-8224 Shim and 5J-4776 Shim are cylinder flow balance shims.

Thickness of one 4J-8224 Shim ..... 0.25 mm (0.010 inch)

Thickness of one 5J-4776 Shim ..... 0.30 mm (0.012 inch)

Two shims will change the timing of the steering at high idle by the following amount. ..... 0.1 second

Note: The addition of one 4J-8224 Shim and of one 5J-4776 Shim will cause a faster right turn and a slower left turn. The removal of the shims will cause a slower right turn and a faster left turn.

(20) 6E-4499 Spring (Inner spring for the retainer)

Length under test force .. 44.45 mm (1.750 inch)
Test force ..... 62.0 ± 5.0 N (13.94 ± 1.12 lb)
Free length after test ..... 54.0 mm (2.13 inch)
Outside diameter ..... 29.5 mm (1.16 inch)

(21) 6E-4500 Spring (Outer spring for the valve spool)

Length under test force .. 58.45 mm (2.301 inch)
Test force ..... 189 ± 9 N (42 ± 2 lb)
Free length after test ..... 62.0 mm (2.44 inch)
Outside diameter ..... 42.5 mm (1.67 inch)

(22) Relief valve for the steering pump

(23) Installation torque for the relief valve for the steering pump ..... 100 ± 10 N·m (73 ± 7 lb ft)

(24) Torque for the locknut .. 50 ± 7 N·m (36 ± 5 lb ft)

i01188892

Relief Valve (Pump Backup)

SMCS Code: 4322

Part No.: 100-4335

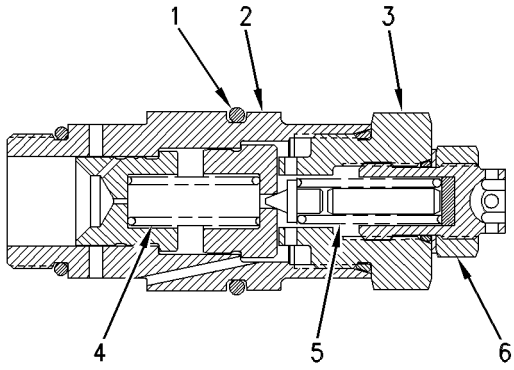


Illustration 22 g00102205

Relief valve pressure setting ..... 34500 ± 700 kPa (5000 ± 100 psi)

Oil flow rate of the relief valve ..... 20 ± 1 L/min (5.0 ± .3 US gpm)

(1) Lubricate the seal with a minimal amount of the lubricant that is being sealed.

(2) Torque for installing the relief valve ..... 110 ± 10 N·m (80 ± 7 lb ft)

(3) Torque for the cap ..... 110 ± 10 N·m (80 ± 7 lb ft)

(4) 8H-3532 Spring

Length under test force ..... 25.4 mm (1.00 inch)
Test force ..... 95.6 ± 7.6 N (21.50 ± 1.70 lb)
Free length after test ..... 42.07 mm (1.656 inch)
Outside diameter ..... 11.91 mm (.469 inch)

(5) 4T-2770 Spring

Length under test force ..... 33 mm (1.3 inch)
Test force ..... 328 ± 26 N (74 ± 6 lb)
Free length after test ..... 45.8 mm (1.80 inch)
Outside diameter ..... 11.2 mm (.44 inch)

(6) Torque for the locknut .... 50 ± 7 N·m (37 ± 5 lb ft)

i01188847

Relief Valve (Steering Cylinder Crossover)

SMCS Code: 4322

Part No.: 6E-3985

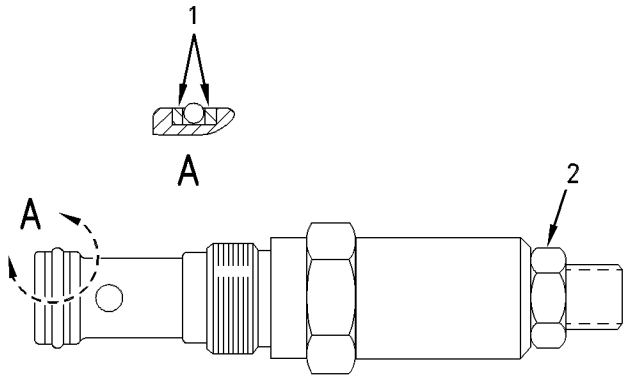


Illustration 23 g00102175

Torque for the installation of the crossover relief valve for the steering cylinders ..... 60 ± 7 N·m (45 ± 5 lb ft)

Pressure setting for the relief valve .. 34000 ± 500 kPa (4950 ± 75 psi)

Rate of flow for the relief valve ..... 5.0 ± 0.5 L/min (1.32 ± .13 US gpm)

Oil temperature for the relief valve test ..... 49° ± 3°C (120° ± 5°F)

(1) Lubricate the O-ring seal and lubricate the backup rings with the lubricant that is being sealed.

(2) Torque for the locknut ..... 13 ± 2 N·m (10.0 ± 1.5 lb ft)

i02372292

Relief Valve (Secondary Steering)

SMCS Code: 4322-SE

Part No.: 6E-3986

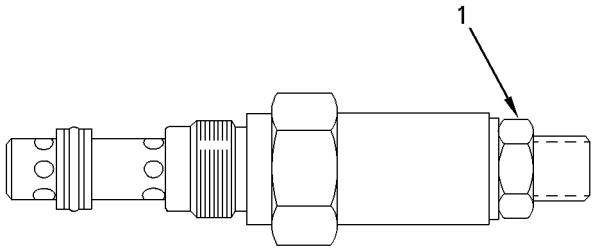


Illustration 24 g00102186

Pressure setting for the relief valve .. 17300 ± 700 kPa (2510 ± 100 psi)

Rate of flow for the relief valve ..... 21 ± 2 L/min (5.5 ± 0.5 US gpm)

Oil temperature for the relief valve test ..... 49° ± 3°C (120° ± 18°F)

(1) Torque for the locknut ..... 13 ± 2 N·m (116 ± 18 lb in)

Torque for the installation of the secondary steering relief valve ..... 50 ± 7 N·m (37 ± 5 lb ft)

i02029161

Pressure Switch (Primary Steering Oil)

SMCS Code: 4304-ZS

Part No.: 3E-6450

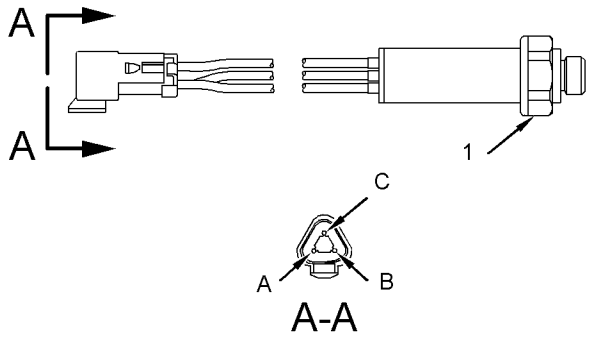


Illustration 25 g01052835

(1) Torque for the pressure switch ..... 75 ± 7 N·m (55 ± 5 lb ft)

Maximum actuation pressure at −40° to +121°C (−40° to +250°F) ..... 1200 kPa (175 psi)

Deactuation pressure at −40° to +121°C (−40° to +250°F) ..... 700 ± 100 kPa (100 ± 15 psi)

Contacts (A) and (C) are normally closed below the deactuation pressure of the pressure switch.

Contacts (A) and (B) are normally open below the deactuation pressure of the pressure switch.

i02088398

Steering Neutralizer Valve

SMCS Code: 4330

Part No.: 9T-7426

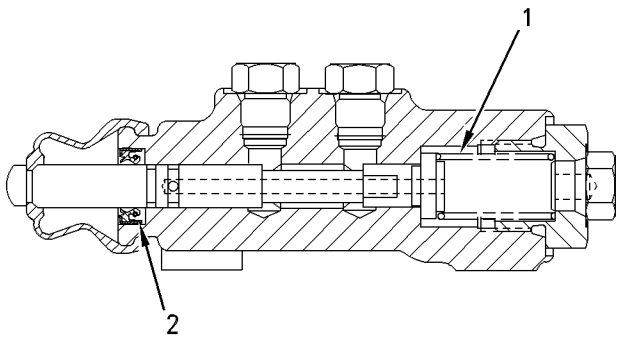


Illustration 26 g00101955

Pressure drop at a temperature of 49°C (120°F) with a flow of 9 L/min (2.4 US gpm) equals 80 kPa (12 psi).

(1) 5F-9035 Spring (for the stem)

Length under test force ..... 38.9 mm (1.53 inch)
Test force ..... 31.6 to 37.2 N (7.10 to 8.36 lb)
Free length after test ..... 50.8 mm (2.00 inch)
Outside diameter ..... 19.1 mm (0.75 inch)

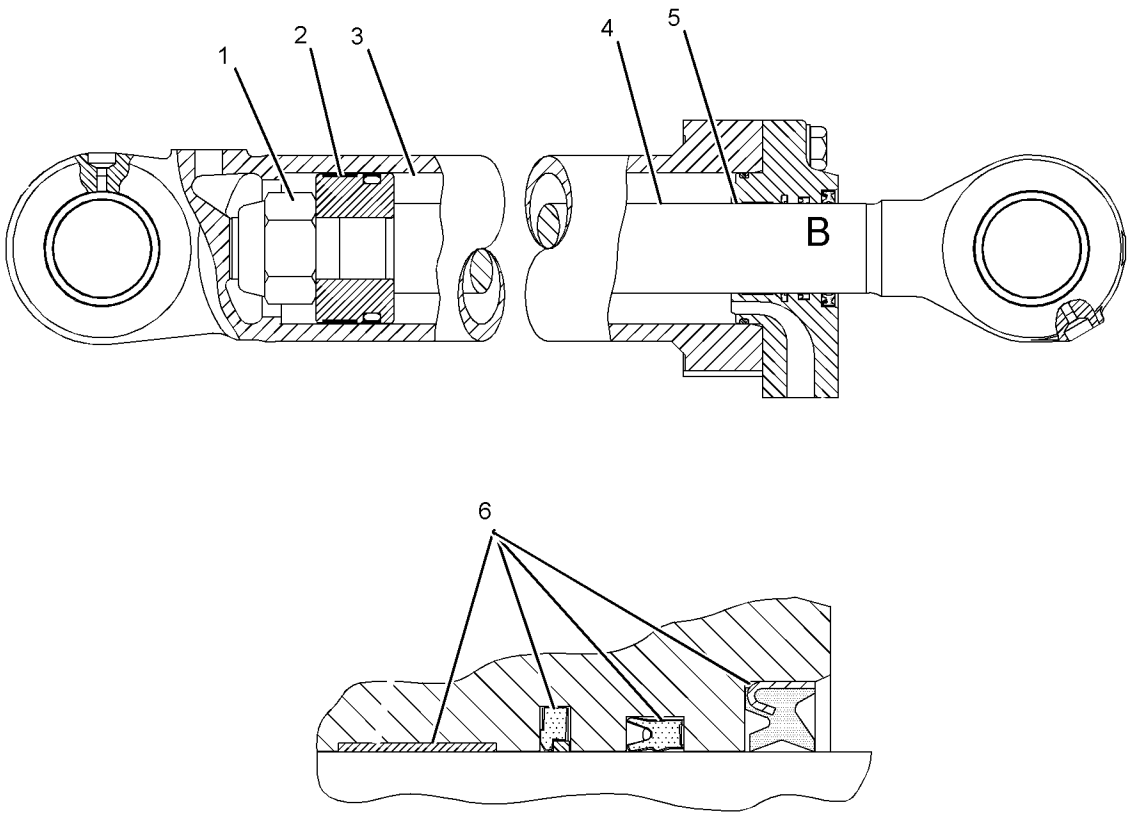
(2) Lubricate the seal with the lubricant that is being sealed.

i02373077

Steering Cylinder

SMCS Code: 4303

Part No.: 6E-1244, 9T-9568



VIEW OF AREA B

Illustration 27

g01183816

Steering Cylinder (Left Hand)

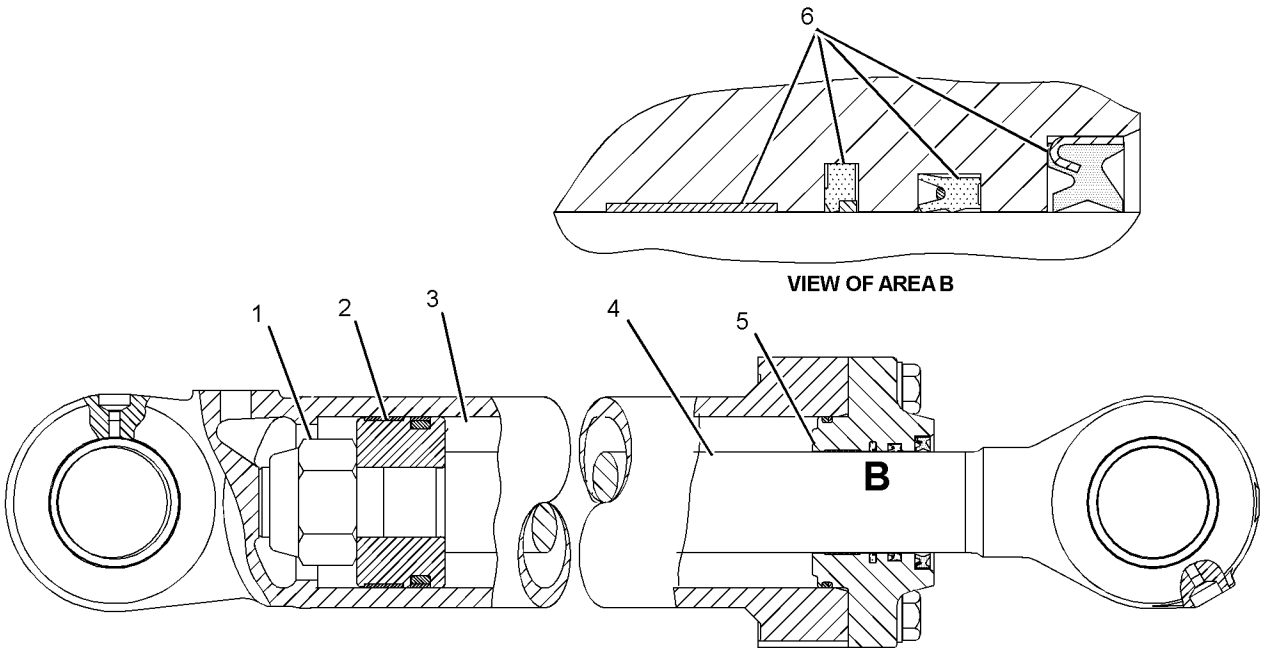


Illustration 28 g01183820

Steering Cylinder (Right Hand)

(1) Torque for the bolt ..... 6000 ± 600 N·m (4425 ± 440 lb ft)

(2) Diameter of new piston ..... 139.2 ± 0.03 mm (5.480 ± 0.001 inch)

(3) Bore diameter of new cylinder assembly ..... 139.75 ± 0.10 mm (5.502 ± 0.004 inch)

(4) Diameter of new rod assembly ..... 82.50 ± 0.038 mm (3.248 ± 0.0015 inch)

(5) Bore diameter of new cylinder head ..... 82.83 ± 0.030 mm (3.261 ± 0.0012 inch)

(6) Lubricate the sealing lip with a minimal amount of the lubricant that is being sealed.

i02029128

Articulated Hitch

SMCS Code: 7057; 7100

Part No.: 8R-5637

Upper Hitch

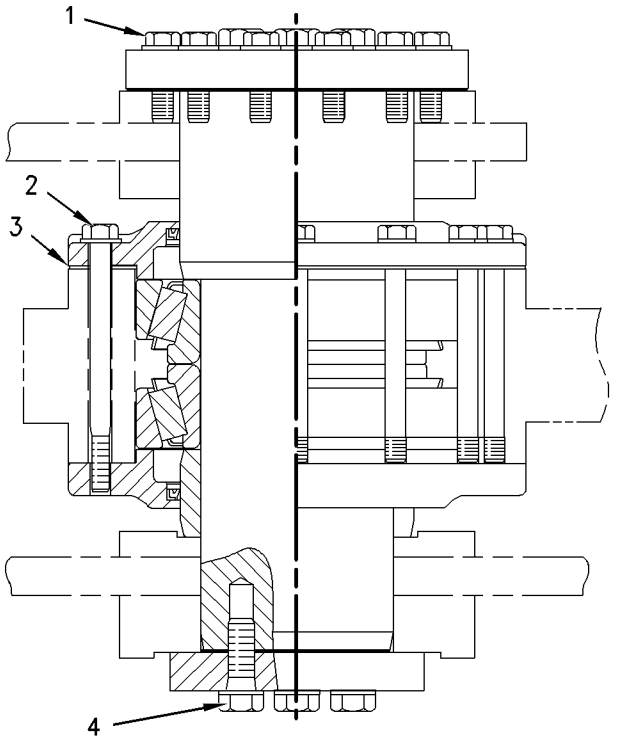


Illustration 29 g00850766

(1) Torque for the twelve bolts ..... 240 ± 40 N·m (177 ± 29.5 lb ft)

(2) Torque for the twelve bolts ..... 150 ± 20 N·m (110 ± 15 lb ft)

Turn bolts an additional (120° ± 10°).

(3) Thickness of the shim pack ..... 1.85 mm (0.0728 inch)

(4) Torque for the six bolts ..... 530 ± 70 N·m (390 ± 50 lb ft)

The rolling torque of the upper hitch should be between 15 N·m (11 lb ft) and 33 N·m (24 lb ft).

Lower Hitch

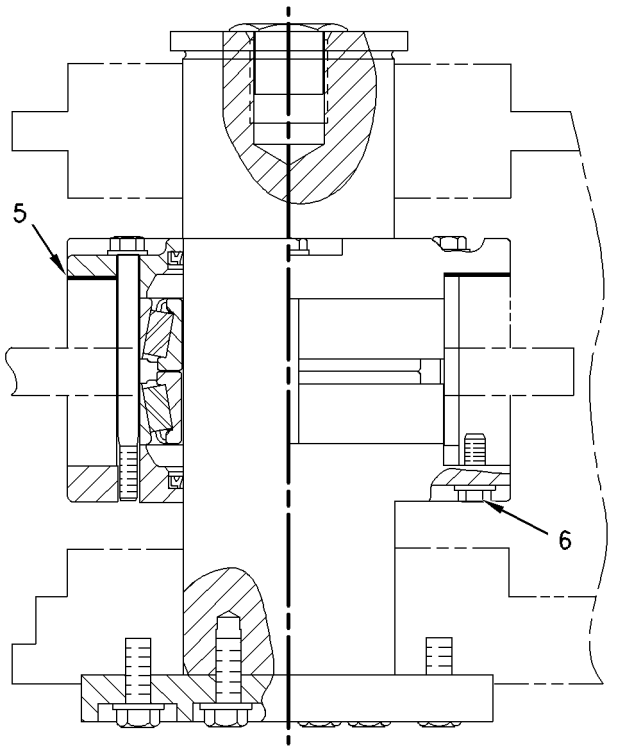


Illustration 30 g00636736

(5) Shim pack thickness ..... 1.58 mm (0.0622 inch)

(6) Torque for the three bolts ..... 100 ± 20 N·m (73.8 ± 14.8 lb ft)

The rolling torque of the lower hitch should be between 2.5 N·m (22 lb in) and 8 N·m (70 lb in).

Note: Lubricate the sealing lip lightly with 5P-0960 Molybdenum Grease prior to installation.

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Printed in U.S.A.

RENR8816-01 (en-us)
August 2018

Systems Operation

990H Wheel Loader and , 844H Wheel Dozer
Steering System

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

i02376656

General Information

SMCS Code: 4300

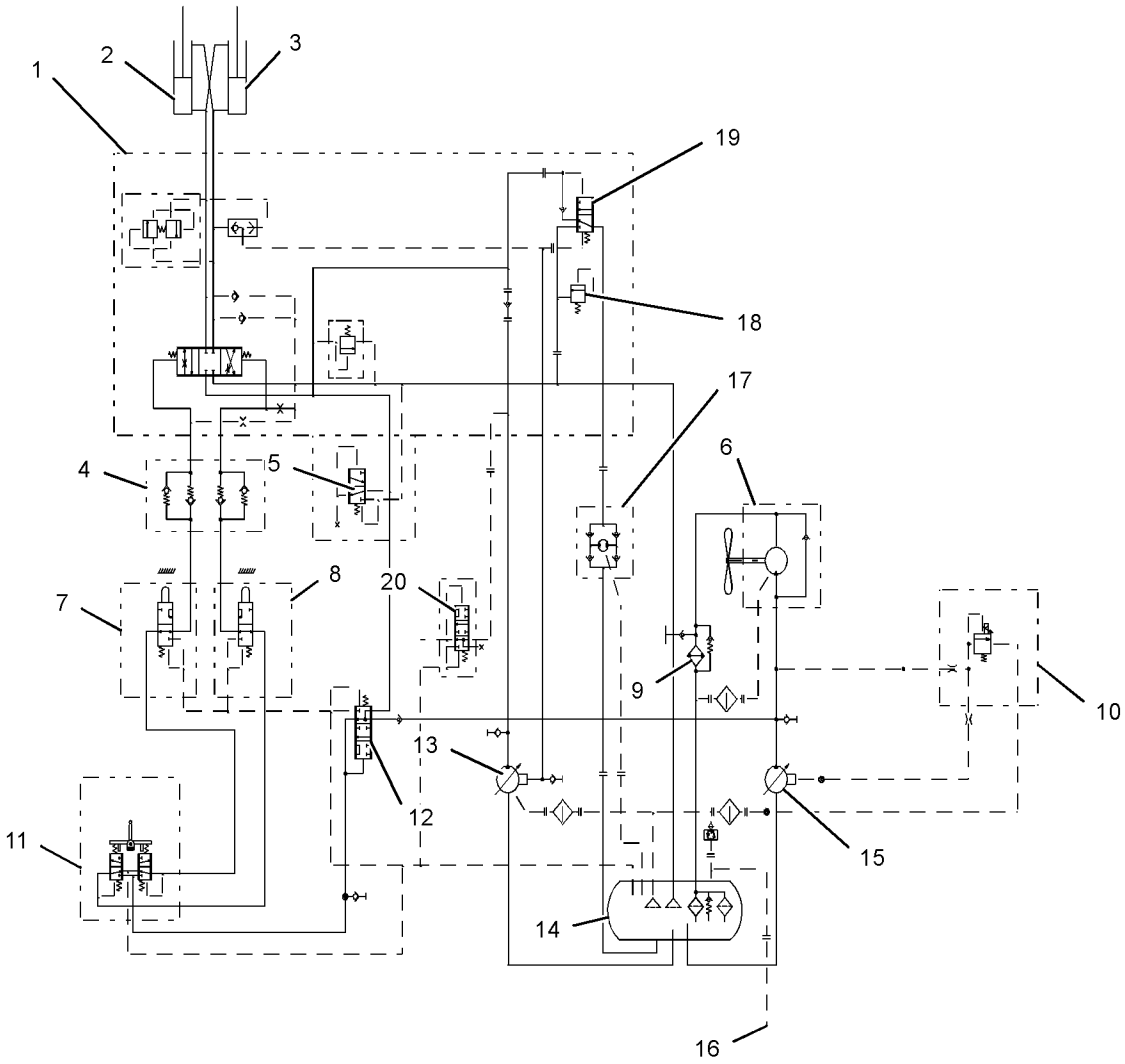


Illustration 1 g01185987

Hydraulic Schematic for the Steering System

(1) Steering control valve
(2) Left steering cylinder
(3) Right steering cylinder
(4) Dual check valve group
(5) Pressure reducing valve
(6) Fan motor
(7) Right neutralizer valve
(8) Left neutralizer valve
(9) Oil cooler
(10) Fan control valve
(11) Pilot control valve
(12) Pressure control and selector valve
(13) Steering pump
(14) Hydraulic tank and filter group
(15) Fan pump
(16) Air connector (machines with secondary steering)
(17) Secondary steering pump (machines with secondary steering)
(18) Relief valve (machines with secondary steering)
(19) Diverter Valve (machines with secondary steering)
(20) Warning switch (machines with secondary steering)

The steering hydraulic system is made up of three basic circuits: The fan circuit, the pilot circuit and the high pressure circuit. When the machine is equipped with optional secondary steering, the steering system also includes this circuit.

The main components of the pilot system include the following components: hydraulic tank (14), pressure reducing valve (5), pressure control and selector valve (12), pilot control valve (11), neutralizer valves (7) and (8), dual check valves (4) and various lines.

The main components of the high pressure system include the following components: hydraulic tank (14), steering pump (13), steering control valve (1), steering cylinders (2) and (3) and various lines.

The main components of the hydraulic fan system include the following components: hydraulic tank (14), fan pump (15), oil cooler (9), fan motor (6), control valve (10) and various lines.

Reference: For additional information about the fan, refer to Systems Operation, “Hydraulic Fan System” for the machine that is being serviced.

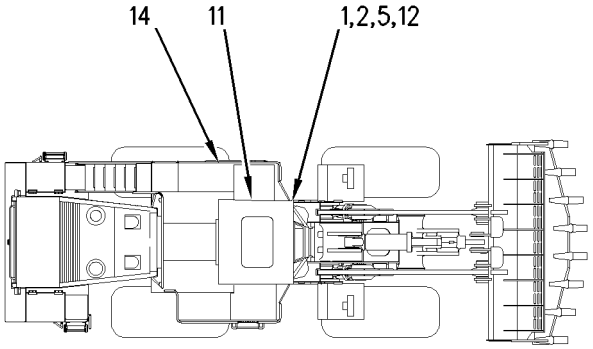


Illustration 2 g00850019

Hydraulic tank (14) is located on the left side of the machine and next to the operator's station. Access is gained by opening an access door. The oil filler cap is attached to the top of the tank.

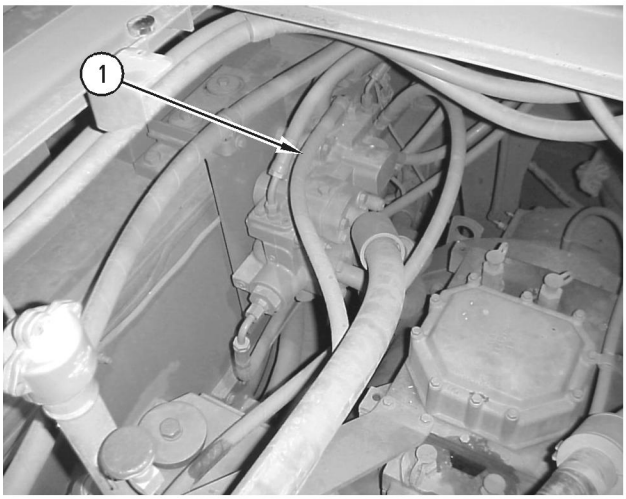


Illustration 3 g00850690

(1) Steering control valve.

Steering control valve (1), pressure reducing valve (5) and pressure control and selector valve (12) are located on the left side of the machine under the operator's station. Left steering cylinder (2) is located under the steering control valve.

Pilot control valve (11) is located in the operator's station.

Steering pump (13) is located behind the operator's station. Access is gained by opening an access door that is behind the cab. The pump is mounted to a pump drive.

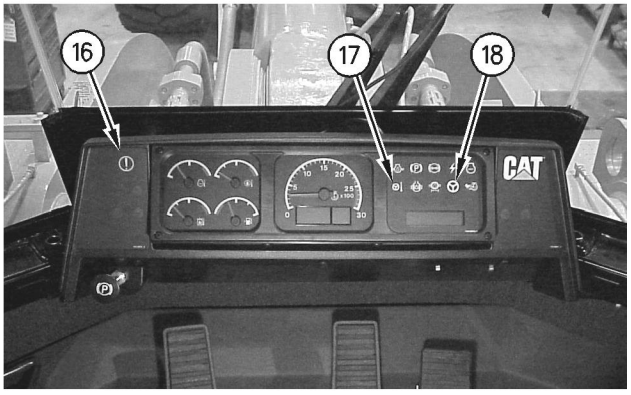


Illustration 4 g00850663

The alert system is activated when the disconnect switch key is ON and the engine switch key is ON.

Steering oil pressure indicator (18) will flash, and action light (16) will flash when there is low steering pressure. The action alarm will also sound if the engine is running.

The alert indicator for the steering oil temperature (17) will flash, when the temperature rises above 100 °C (212 °F).

i02378342

Monitoring System (Steering Functions)

SMCS Code: 7490

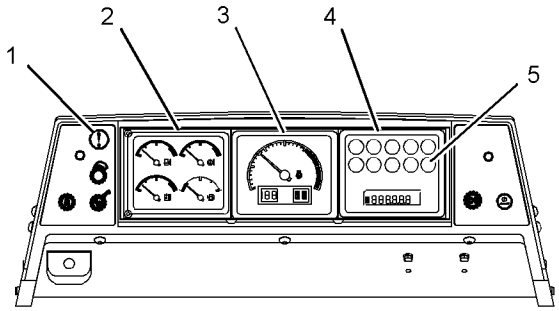


Illustration 5 g01187339

The monitoring system is an electronic monitoring system that continually monitors the machine systems. The monitoring system includes gauge display (2), speedometer/tachometer display (3), and monitoring system display (4). The monitoring system display has alert indicators which show any abnormal condition of the machine.

Primary Steering (5) – The alert indicator (5) and the action light (1) will flash and the action alarm will sound. This indicates a failure of the primary steering. The secondary steering (if equipped) should be automatically activated.

If this alert indicator flashes during operation, stop the machine immediately and engage the parking brake. Stop the engine and investigate the cause of the fault.

NOTICE
The immediate shutdown of the machine is required in order to prevent severe damage to the system and/or the machine. Do not operate the machine until the cause has been corrected.

Note: Secondary steering only works while the machine is moving. No directional changes can be made when the machine operates under secondary steering.

i02379224

Steering Pilot System

SMCS Code: 4300-PS

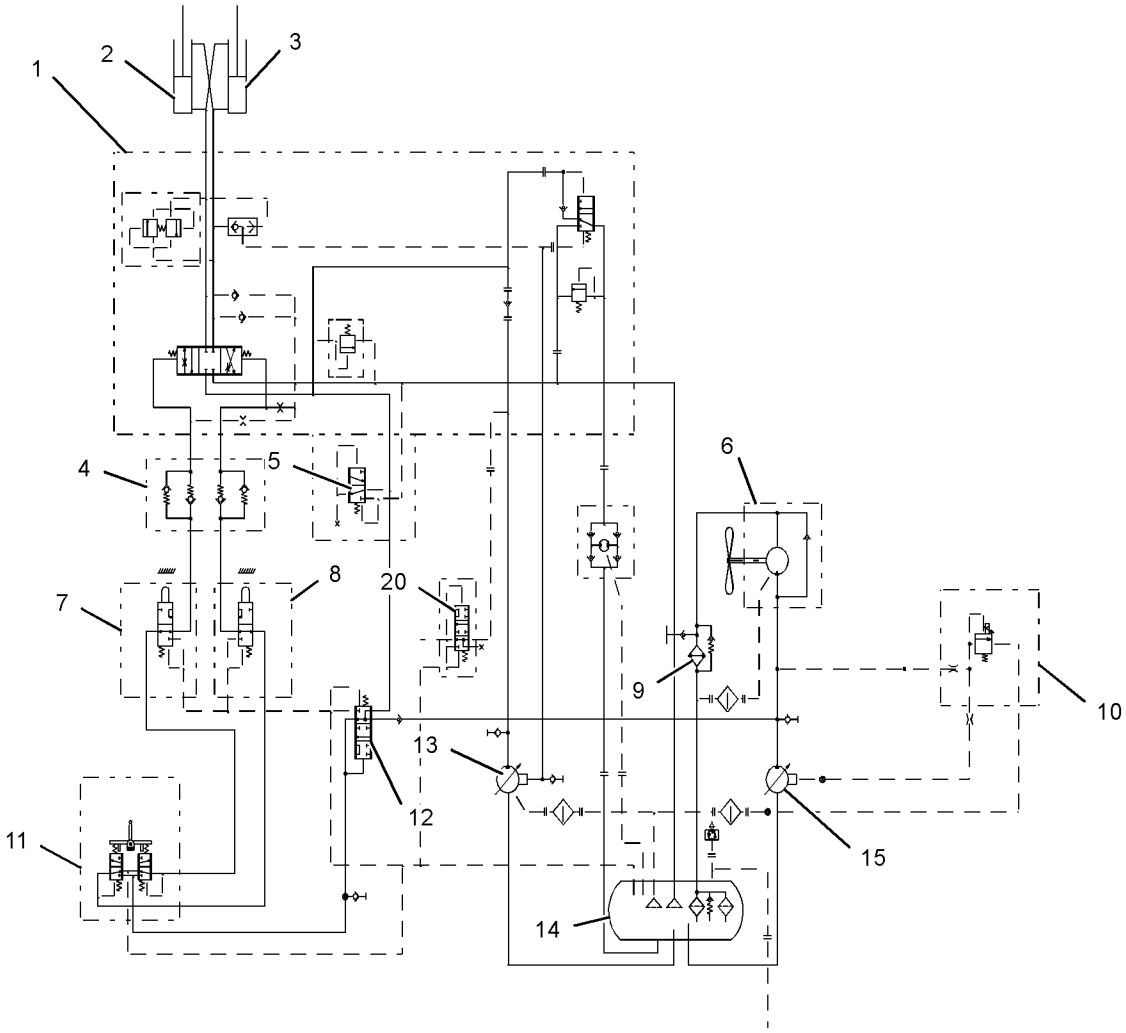


Illustration 6 g01187981

Hydraulic Schematic for the Steering System

(1) Steering control valve

(2) Left steering cylinder

(3) Right steering cylinder

(4) Dual check valve group

(5) Pressure reducing valve

(6) Fan motor

(7) Right neutralizer valve

(8) Left neutralizer valve

(9) Oil cooler

(10) Fan control valve

(11) Pilot control valve

(12) Pressure control and selector valve

(13) Steering pump

(14) Hydraulic tank and filter group

(15) Fan pump

The pilot circuit controls the movement of the valve spool in steering control valve (1). Pressure oil from the fan pump (15) flows to pressure control valve (12).

While the engine is running, oil flows from hydraulic tank (14) to hydraulic fan pump (15). The fan drive pump is a piston type pump.

Part of the oil flows from the pump to the fan drive motor and the oil cooler. The hydraulic fan motor is a fixed displacement bent axis motor. The rest of the oil flows through an oil line, past a check valve and into pressure control and selector valve (12).

The oil pressure is reduced to 3300 ± 400 kPa (480 ± 60 psi). The pilot oil then flows to the inlet of pilot valve (11).

Pilot oil pressure is supplied by steering pump (13) if the hydraulic fan pump fails. The pilot oil then flows into control valve (1). Next, the oil flows to pressure reducing and selector valve (5).

The reduced pressurized oil flows to the inlet of pilot control valve (11).

i05282688

Pilot Valve (STIC Steering)

SMCS Code: 4342

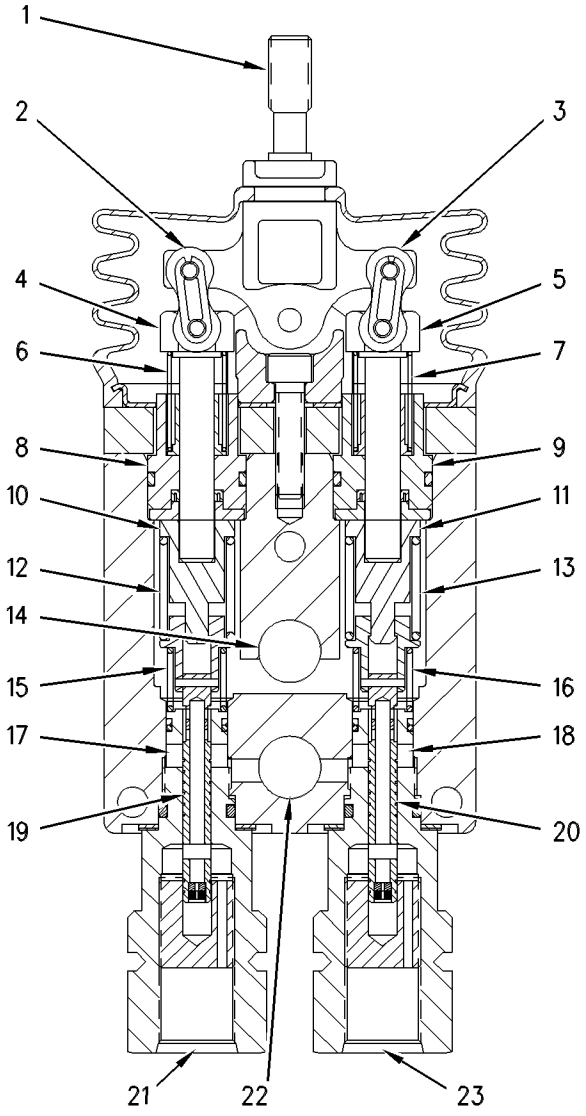


Illustration 7 g00555893

Pilot valve for a machine that is equipped with STIC steering

(1) Handle. (2) Link. (3) Link. (4) Plunger. (5) Plunger. (6) Spring. (7) Spring. (8) Cap. (9) Cap. (10) Spring seat. (11) Spring seat. (12) Spring. (13) Spring. (14) Outlet port to tank. (15) Spring. (16) Spring. (17) Passage. (18) Passage. (19) Spool valve. (20) Spool valve. (21) Port to the steering neutralizer valve for a right turn. (22) Inlet port. (23) Port to the steering neutralizer valve for a left turn.

When the machine engine is running, oil is drawn from the hydraulic tank by the pilot oil pump. The pilot oil pump sends pilot oil through the hydraulic oil filter to the pilot valve. Pilot oil enters the pilot valve at inlet port (22).

The STIC steering control lever is attached to handle (1). When the STIC steering control lever is in the STRAIGHT AHEAD position, centering springs (6), (7), (12), (13), (15) and (16) keep the pivot plate in the CENTERED position. Pilot oil flows through inlet (22) to metering spool valves (19) and (20). In this position, the spool valves block the flow of oil to the steering control valve. This action causes the oil to flow back to the hydraulic tank. Ports (21) and (23) are also open to the hydraulic tank.

When the STIC steering control lever is moved to the LEFT TURN position, the pivot plate causes link (2) to move plunger (4) downward. As the plunger moves downward, the plunger overcomes the force of spring (6). This action causes the spring to move downward. As the plunger moves downward through cap (8), the plunger also causes spring seat (10), spring (12), spring (15), and spool valve (19) to move downward. The other plunger remains stationary.

When spool valve (19) moves downward, passage (17) opens. Oil can now flow from inlet port (22) into passage (17). The oil then flows through passage (17) and past spool valve (19). The oil then moves out of port (21).

The oil flows from port (21) to the steering neutralizer valve for right turns. Next, the oil flows to the steering quad check valve and to the steering control valve.

Oil that flows from the steering control valve flows through the steering neutralizer valve for left turns. The oil then flows from the steering neutralizer valve for left turns to port (23).

When the control lever for the steering transmission integrated control (STIC) is moved to the RIGHT TURN position, the pivot plate causes link (3) to move plunger (5) downward. As the plunger moves downward, spring (7) moves downward. As the plunger moves downward through cap (9), the plunger causes spring seat (11), spring (13), spring (16), and spool valve (20) to move downward.

When spool valve (20) moves down, passage (18) opens. Oil can now flow from inlet port (22) into passage (18). The oil then flows through passage (18), past spool valve (20), and out port (23). Spool valve (19) remains stationary.

The oil flows from port (23) to the steering neutralizer valve for left turns. The oil then flows to the steering quad check valve and to the steering control valve.

Oil from the steering control valve flows through the steering neutralizer valve for right turns. The oil then flows from the steering neutralizer valve into port (21).

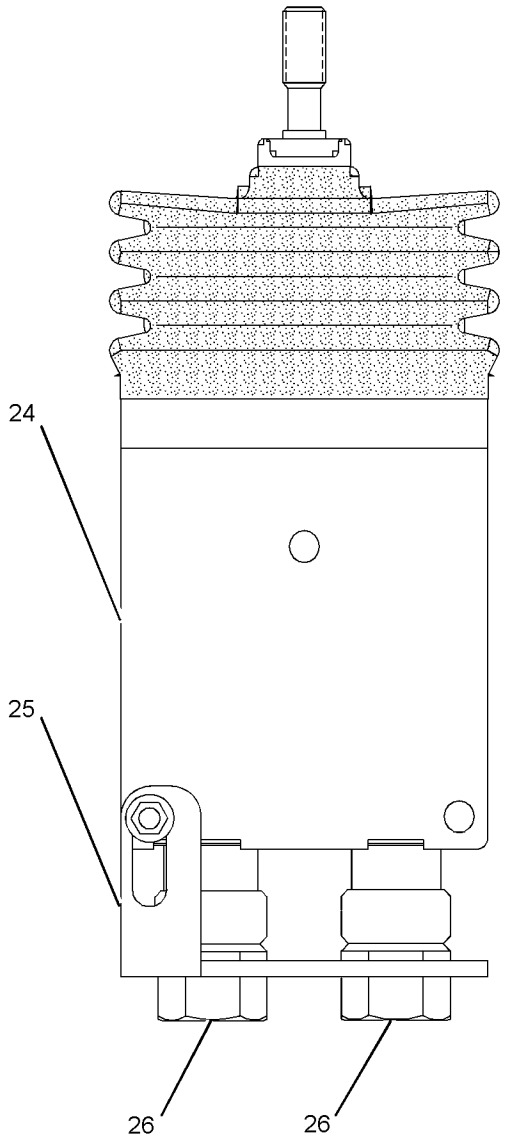


Illustration 8 g01110962

Pilot valve and bracket for STIC steering

(24) Pilot valve. (25) Bracket. (26) Capsules.

Bracket (25) on pilot valve (24) is adjustable. Correct adjustment of bracket (25) ensures the proper torquing of capsules (26).

i02916776

Steering Neutralizer Valve

SMCS Code: 4330

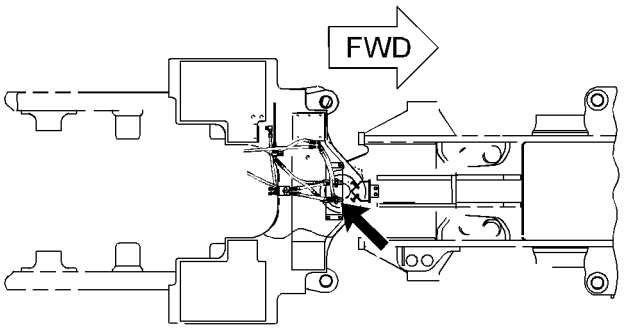


Illustration 9 g01057442

Top view of machine is shown with the location of neutralizer valves on engine end frame.

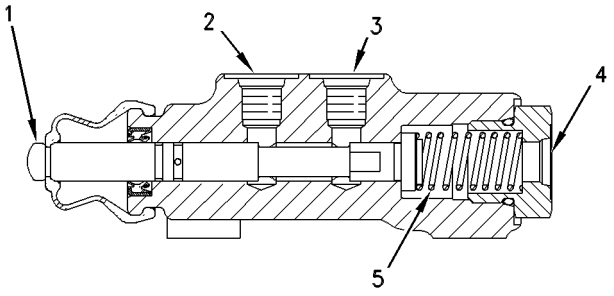


Illustration 10 g00118089

Neutralizer Valve in the CLOSED Position

(1) Stem
(2) Inlet port
(3) Outlet port
(4) Tank port
(5) Spring

When the steering neutralizer valves are engaged, the flow of pilot oil to the steering control valve is blocked. Pilot oil will then drain from the steering control valve. This causes the machine to stop articulating at the end of a complete turn. This occurs just before the front of the machine contacts the frame.

A left turn stop is used for the left neutralizer valve, and a right turn stop is used for the right neutralizer valve. Both the left turn stop and the right turn stop are mounted on the front of the frame. Both of the neutralizer valves are mounted on the rear frame. Both the right neutralizer valve and the left neutralizer valve are identical. Additionally, both the right turn stop and the left turn stop are identical.

Pilot oil flows from the STIC steering and transmission control to either the right neutralizer valve or to the left neutralizer valve. This happens before the oil flows to the steering control valve. Oil flows from the STIC steering and transmission control into the neutralizer valve through inlet port (2).

Spring (5) holds stem (1) to the left. Oil flows past stem (1) and through outlet port (3). The oil then flows to the steering control valve.

When the machine is turned to the far right, the right turn stop contacts stem (1) of the right neutralizer valve. This should only occur when the STIC steering and transmission control is moved to the full RIGHT TURN position and spring (5) compresses.

As the stem moves right, the stem blocks the flow of oil through port (2). Because pilot oil cannot flow from port (2) to port (3), no pilot oil can flow to the control valve.

As the stem moves right, pilot pressure is drained through port (3) and the flow of oil passes stem (1) to the tank port (4).

When the flow of pilot oil stops acting on the spool in the steering control valve, the control valve spool returns to the NEUTRAL position. This causes the steering action to stop.

When the STIC steering and transmission control is moved back to the left, the return oil from the end of the steering control valve spool flows through the line. The return oil then flows into port (3) of the right neutralizer valve. The oil then flows past the stem, through port (4), and back to the hydraulic oil tank for the steering and brake systems. This allows the steering control valve spool to move back to the CENTERED position, and the machine begins to turn to the left.

As the machine moves to the left, the right turn stop will move away from stem (1). The force of spring (5) acts against stem (1). This causes the stem to move left. As the stem moves left by a small amount, the stem opens port (2). This allows pilot oil to flow past the stem and through port (3).

The left neutralizer valve operates in the same manner as the right neutralizer valve.

i02379712

Steering High Pressure System

SMCS Code: 4300-HQ

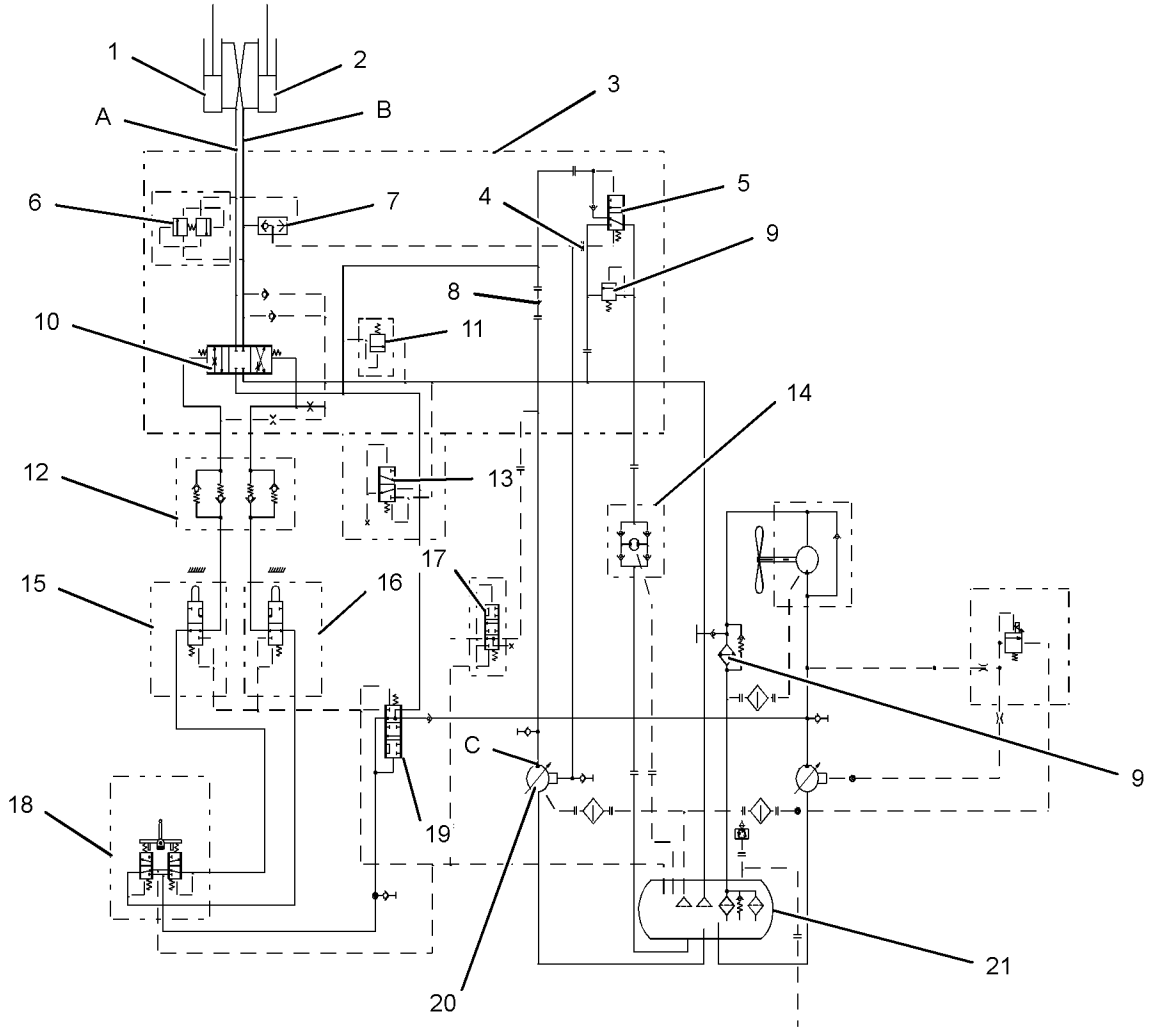


Illustration 11 g01188268

Hydraulic Schematic for the High Pressure Steering System

(1) Left steering cylinder assembly
(2) Right steering cylinder assembly
(3) Steering control valve
(4) Check valve
(5) Diverter valve
(6) Crossover relief valve
(7) Shuttle valve
(8) Check valve
(9) Relief valve
(10) Steering control valve (spool)
(11) Backup relief valve
(12) Dual check valves
(13) Pressure reducing valve
(14) Secondary steering pump
(15) Right neutralizer valve
(16) Left neutralizer valve
(17) Steering oil pressure sensor
(18) Pilot control valve
(19) Pressure control and selector valve
(20) Steering pump
(21) Hydraulic tank
(A) Pressure port for right steering cylinder
(B) Pressure port for left steering cylinder
(C) Pressure port for the steering pump

Steering pump (20) provides high pressure oil for the steering system. The steering pump can also supply secondary pilot oil for the pilot oil system.

Steering pump (20) withdraws oil from hydraulic oil tank (21). High pressure oil from the steering pump is then sent through three circuits.

High pressure oil can also flow to backup relief valve (11) and pressure reducing valve(13). The maximum allowable system pressure is controlled by the backup relief valve. The backup relief valve is set to 34500 kPa (5000 psi). The backup relief valve sends oil back to hydraulic oil tank (21) if the oil pressure increases to 34500 kPa (5000 psi). The pump cutoff pressure is set to 31000 ± 1000 kPa (4500 ± 145 psi). The backup relief valve prevents damage to the steering system if the steering pump fails to limit the system pressure to 31000 ± 1000 kPa (4500 ± 145 psi).

Pressure reducing valve (13) allows the steering pump to supply supplemental pilot oil for the pilot oil system. The pressure reducing valve lowers the high pressure steering oil to approximately 1650 kPa (240 psi).

When the operator moves the pilot control valve, pilot oil shifts valve spool (10). High pressure steering oil then flows through the valve spool to steering cylinders. The machine will then articulate.

An increase in pressure will occur if an outside force tries to steer the machine. The increase in pressure will open crossover relief valve (6). The crossover relief valve prevents the pressure in the steering cylinders from exceeding specifications.

Shuttle valve (7) allows high pressure oil to travel through a load sensing line. The load sensing line travels back to the steering pump.

i02387254

Piston Pump (Steering)

SMCS Code: 4306-QP; 5070-ZH

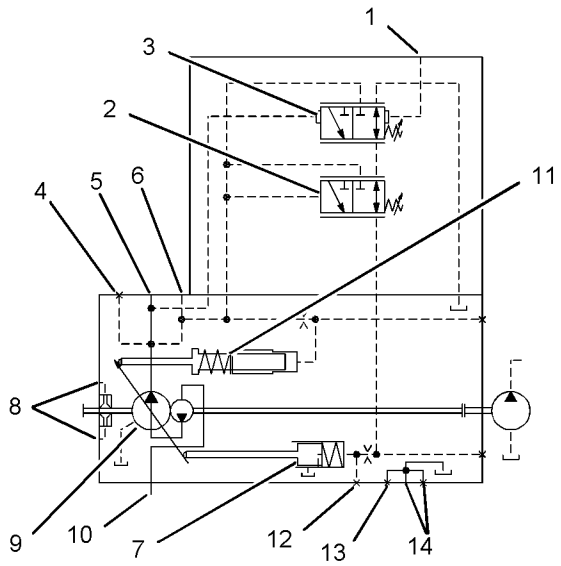


Illustration 12 g01191587

Schematic of the steering pump (drive-through feature)

(1) Load sensing port from the steering control valve
(2) Pressure Compensator
(3) Flow compensator
(4) Port for the discharge pressure
(5) Discharge port
(6) Boost pressure port
(7) Destroke piston
(8) Weep holes
(9) Steering pump
(10) Suction port
(11) Upstroke piston
(12) Port for Actuator pressure
(13) Drain port
(14) Case drain port

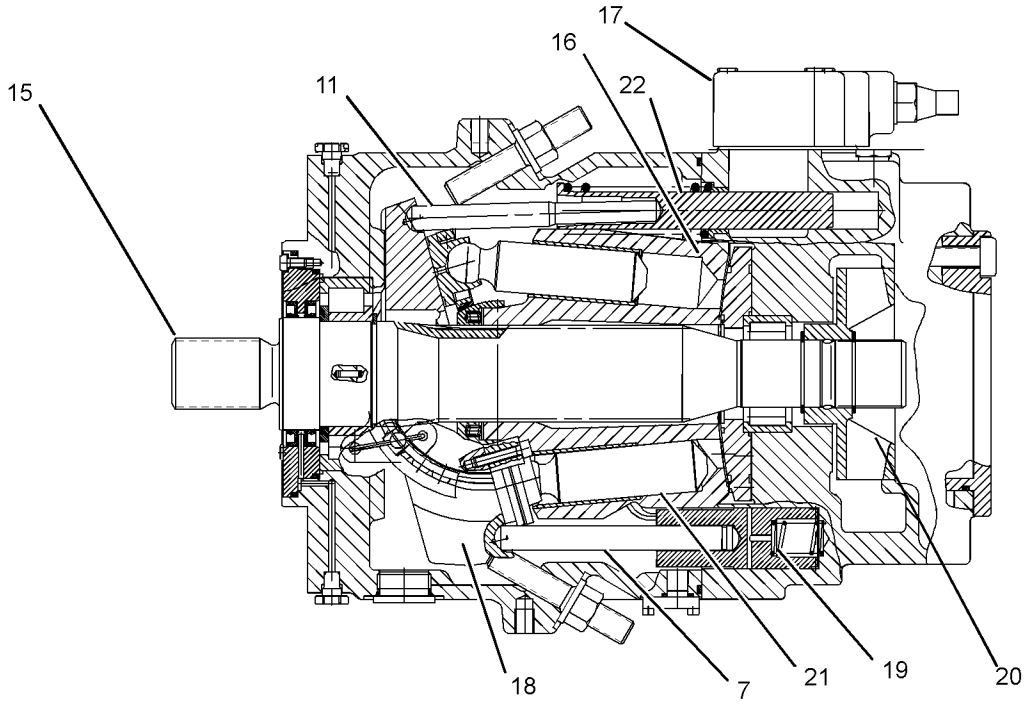


Illustration 13 g01191602

Cross section view of steering piston pump.

(15) Shaft
(7) Destroke piston
(16) Cylinder barrel
(17) Pressure and flow compensator
(18) Swashplate
(11) Upstroke piston
(19) Spring
(20) Impeller
(21) Piston
(22) Spring

The steering pump is an axial piston pump. The output of pump (9) is controlled by the pump control valve. The pump control valve includes pressure and flow compensators (2) and (3). The pump control valve senses pressure requirements for the system and flow requirements for the system. The pump provides the high pressure oil for the steering system. The pump also provides a backup source for pilot oil.

While the engine is running, drive shaft (15) turns. The drive shaft causes cylinder barrel (16) to also turn. Pistons (21) are held against swashplate (18). The swashplate (18) does not rotate.

As the swashplate (18) moves past zero angle, some of pistons are pulled out of cylinder barrel (16). At the same time, some of pistons (21) are pushed into the cylinder barrel. The rotation of the cylinder barrel causes the pistons to move in and out. As a piston moves out of the barrel, the piston draws oil into the pump. When the piston moves back into the barrel, the piston will force oil out of the pump.

The angle of swashplate (18) determines the amount of oil that is displaced through each barrel for each revolution of the drive shaft. As the steering system load changes, the swashplate angle fluctuates between zero and the maximum angle. When the swashplate increases beyond the zero angle, oil is drawn into the pump and oil is forced out of the pump.

When the swashplate angle is zero, the pistons do not move in and out. Therefore, no oil is drawn into the pump or out of the pump. In this condition, the pump is at zero displacement.

The pressure compensator (2) prevents the pump pressure from exceeding 31000 kPa (4496 psi). The flow compensator (3) maintains a constant pressure drop across the main valve. The flow compensator is sensing the required flow that is needed in the system. The required flow is determined by the position of the main valve stem. Pressure and flow compensators (2) and (3) use two control pistons in order to adjust the swashplate angle.

Upstroke piston (11) causes swashplate (18) to upstroke the pump. Spring (22) combines with the pump discharge pressure in order to move the swashplate to the maximum angle. This increases pump output.

Destroke piston (7) causes the swashplate to destroke the pump. Pressure and flow compensator (2) and (3) change the pump displacement by regulating the amount of pump discharge pressure that is acting on the destroke piston.

Pressure and flow compensator (2) and (3) prevents overloads of the pump and the system. The pressure compensator prevents the pressure from rising above 31000 kPa (4496 psi). Pump outlet pressure is maintained at 2100 ± 100 kPa (305 ± 15 psi) above the signal oil pressure by flow compensator (3). This is the margin pressure.

Steering Pump in the Upstroking Position

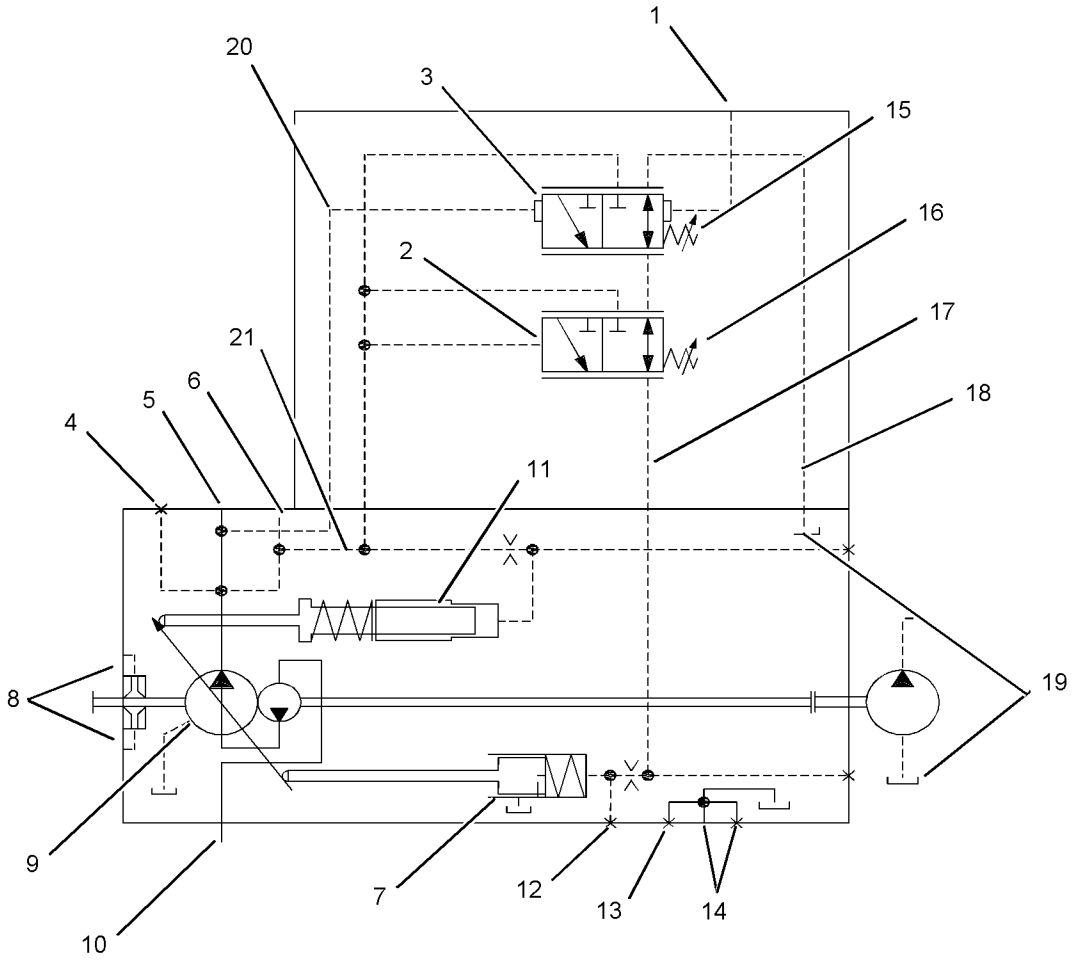


Illustration 14 g01191713

Schematic of the steering pump (Drive-through feature)

(1) Load sensing port from steering control valve
(2) Pressure Compensator
(3) Flow compensator

(4) Port for the discharge pressure
(5) Port for the discharge pressure gauge
(6) Boost pressure port
(7) Destroke piston
(8) Weep holes
(9) Steering pump
(10) Suction port
(11) Upstroke piston
(12) Port for the actuator pressure
(13) Drain port
(14) Case drain ports
(15) Spring
(16) Spring
(17) Oil passage
(18) Oil passage
(19) Hydraulic tank

Upstroking is an increase of pump displacement due to an increased load. When the system requires more flow, signal oil from the steering control valve flows through port (1).

The signal oil pressure combines with the force of spring (15). This causes flow compensator spool (3) to move to the left. When the spool moves left, the spool blocks the flow of pump oil through passage (20).

While flow compensator spool (3) is to the left, the oil in the chamber of destroke piston (7) can flow into passage (17). The oil flows past the cavity of spring (16), past flow compensator spool (3), and through passage (18). The oil then flows back to hydraulic tank (19).

Oil from the steering pump flows through passage (21) and into the chamber of upstroke piston (11). The combined force of the spring in upstroke piston (11) and of the oil in upstroke piston (11) moves the swashplate toward the maximum angle that causes the pump to upstroke.

Destroking

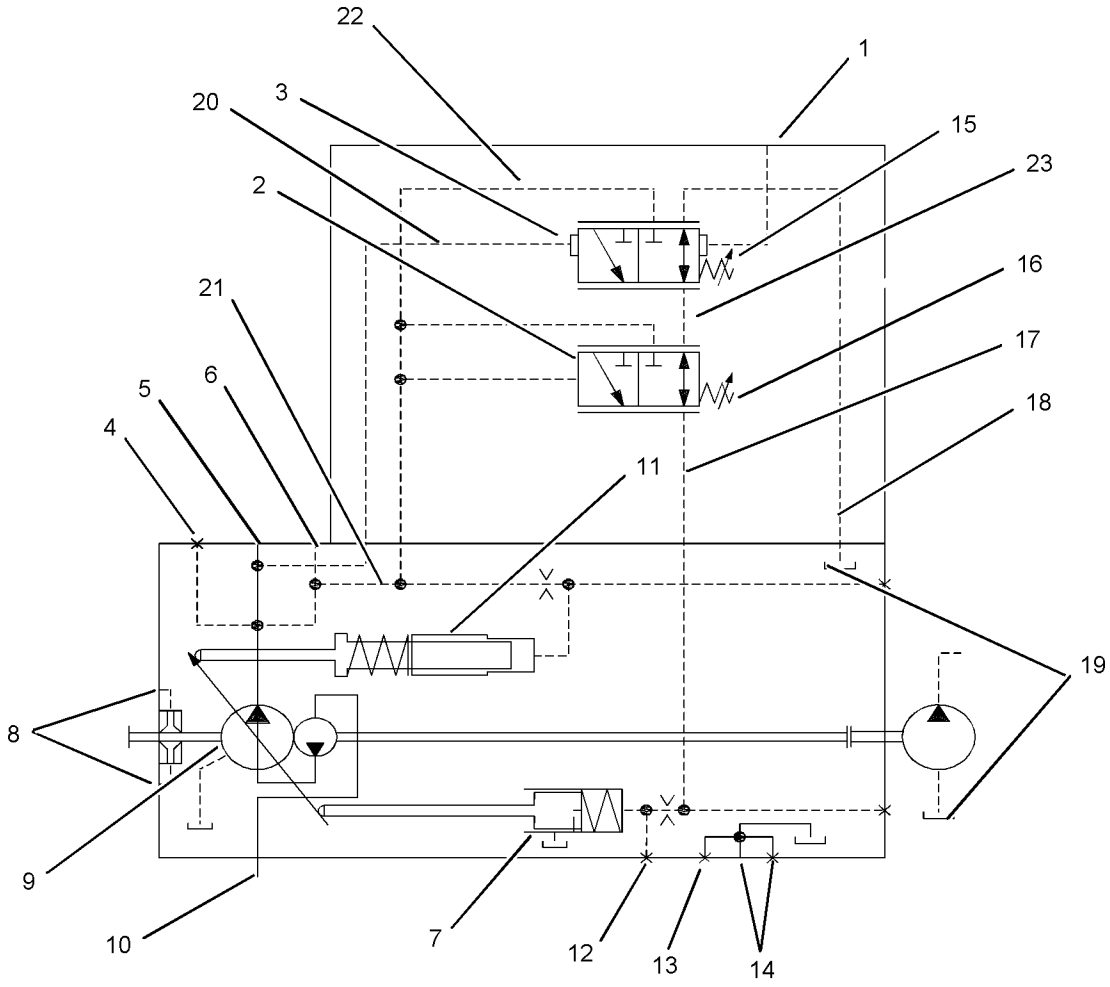


Illustration 15 g01191822

Schematic of the steering pump

(1) Load sensing port from steering control valve
(2) Pressure Compensator
(3) Flow compensator
(4) Port for the discharge pressure gauge
(5) Discharge port
(6) Port for boost pressure
(7) Destroke piston
(8) Weep holes
(9) Steering pump
(10) Suction port
(11) Upstroke piston
(12) Port for Actuator pressure
(13) Drain port
(14) Case drain ports
(15) Spring
(16) Spring
(17) passage
(18) Oil passage
(19) Hydraulic tank
(20) Passage
(21) Oil passage
(22) Passage
(23) Passage

Destroking is a reduction in pressure when pump output decreases. Destroking occurs when the signal oil pressure through line (1) decreases from lower loads. While the steering control valve is in the NEUTRAL position, and the spool is in the centered position blocking the pump to the actuators. The pump pressure increases in order to overcome the flow compensators and the spool will shift to the right. When the pump oil pressure in passage (20) is greater than the force of signal oil pressure and of spring (15), flow compensator spool (3) will move to the right and oil pressure in passage (22) flows past spool (3). The oil then flows through passages (23) and (17). The oil then flows into the chamber of destroke piston (7).

Destroke piston (7) is larger than upstroke piston (11). Because of this difference in size, the oil pressure that is acting against the destroke piston exerts a greater amount of force than the combined forces that are acting against the upstroke piston.

The oil pressure that is acting against the destroke piston (7) overcomes the combined force of the oil and of the spring in the upstroke piston (11). This causes destroke piston (7) to move to the left.

As destroke piston (7) moves to the left, the swashplate moves toward the minimum angle. This causes the pump to destroke. As the angle of the swashplate moves toward the minimum angle, the pump output and the pump pressure decrease.

Steering Pump During High Pressure Stall

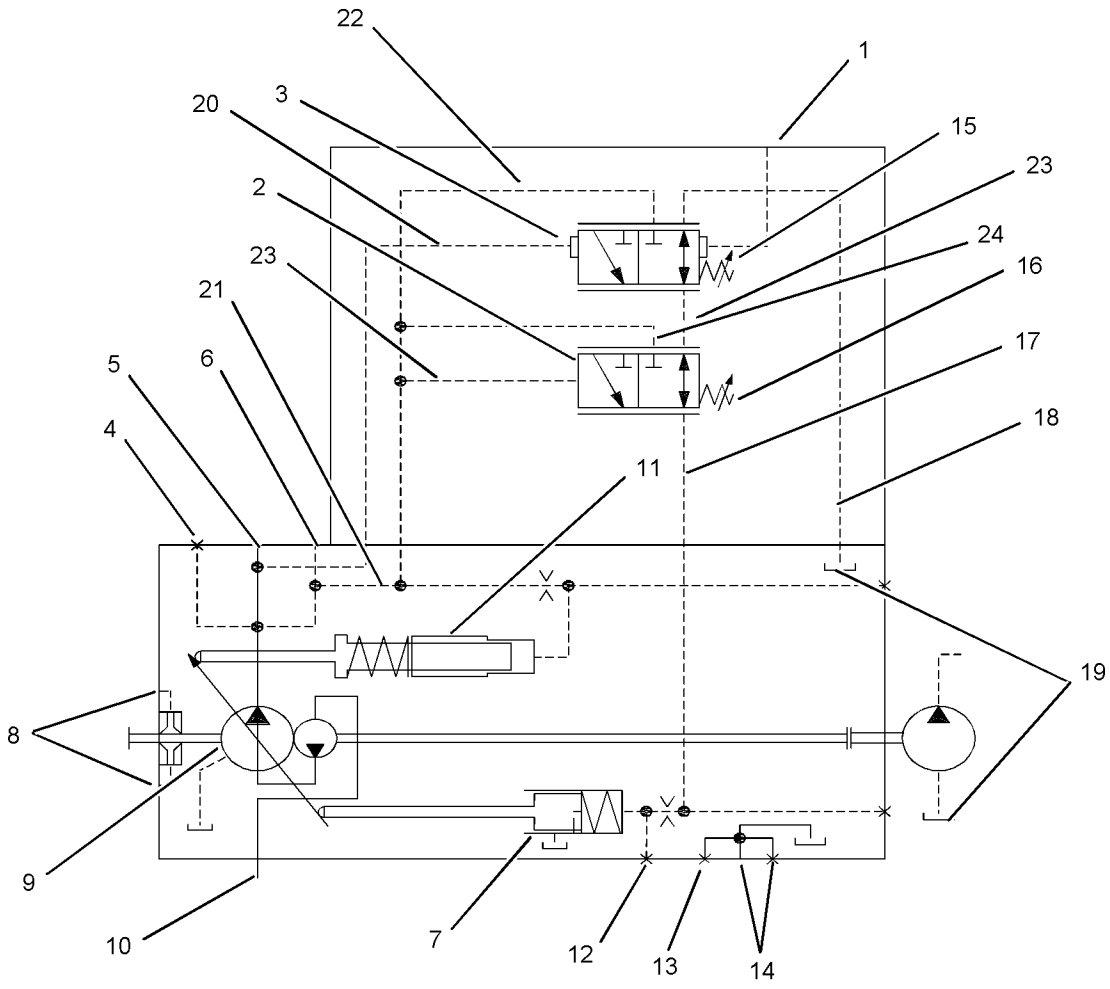


Illustration 16 g01191956

Schematic of the steering pump

(1) Load sensing port from steering control valve
(2) Pressure Compensator
(3) Flow compensator
(4) Discharge pressure gauge
(5) Discharge line
(6) Port for boost pressure
(7) Destroke piston
(8) Weep holes
(9) Steering pump
(10) Suction port
(11) Upstroke piston
(12) Port for Actuator pressure
(13) Drain
(14) Case drain ports
(15) Spring
(16) Spring
(17) passage
(18) Oil passage
(19) Hydraulic tank
(20) Passage
(21) Oil passage
(22) Passage
(23) Passage
(24) Passage

When the hydraulic system stalls under a load in the steering circuit, the oil pressure increases. A stall occurs when pump oil pressure reaches 31000 kPa (4496 psi). The signal oil pressure in line (1) and in the chamber of spring (15) becomes equal to the pump output pressure.

Spring (15) and the signal oil in the spring chamber keep flow compensator spool (3) moved to the left. Pressure oil in passage (23) then acts against pressure compensator spool (2).

As the pump oil pressure in passage (23) reaches 31000 kPa (4496 psi), the pressure overcomes the force of spring (16). This causes the pressure compensator spool (2) to move to the right.

As the spool moves to the right, the spool allows the pump oil to flow through passage (24), past the spool, through passage (17), and into the chamber for destroke piston (7). The oil in the chamber of destroke piston (7) overcomes the force of the spring in upstroke piston (11). This causes destroke piston (7) to move to the left.

As destroke piston (7) moves left , the piston moves the swashplate. The swashplate moves toward the destroked position to a point when the pump output flow is enough to compensate for system leakage and when the pump output flow is enough to maintain the system pressure at 31000 kPa (4496 psi).

When the load that is causing the stall is removed, the pressure decreases below 31000 kPa (4496 psi). The force of spring (16) moves pressure compensator spool (2) left.

When the pressure compensator spool moves to the left, the pressure compensator spool blocks the flow of oil to destroke piston (7). As the pump pressure decreases, the pressure compensator spool moves to the left. This causes the pressure compensator spool to open the chamber of destroke piston (7). The oil then flows to passage (23) and to flow compensator spool (3).

As system pressure reaches margin pressure, and if there is no signal oil pressure, flow compensator spool (3) moves to the METERING position. The swashplate will maintain a slight angle that sufficiently compensates for system leakage. The swashplate will also maintain the lower pressure requirement.

i02381107

Steering Control Valve

SMCS Code: 4307

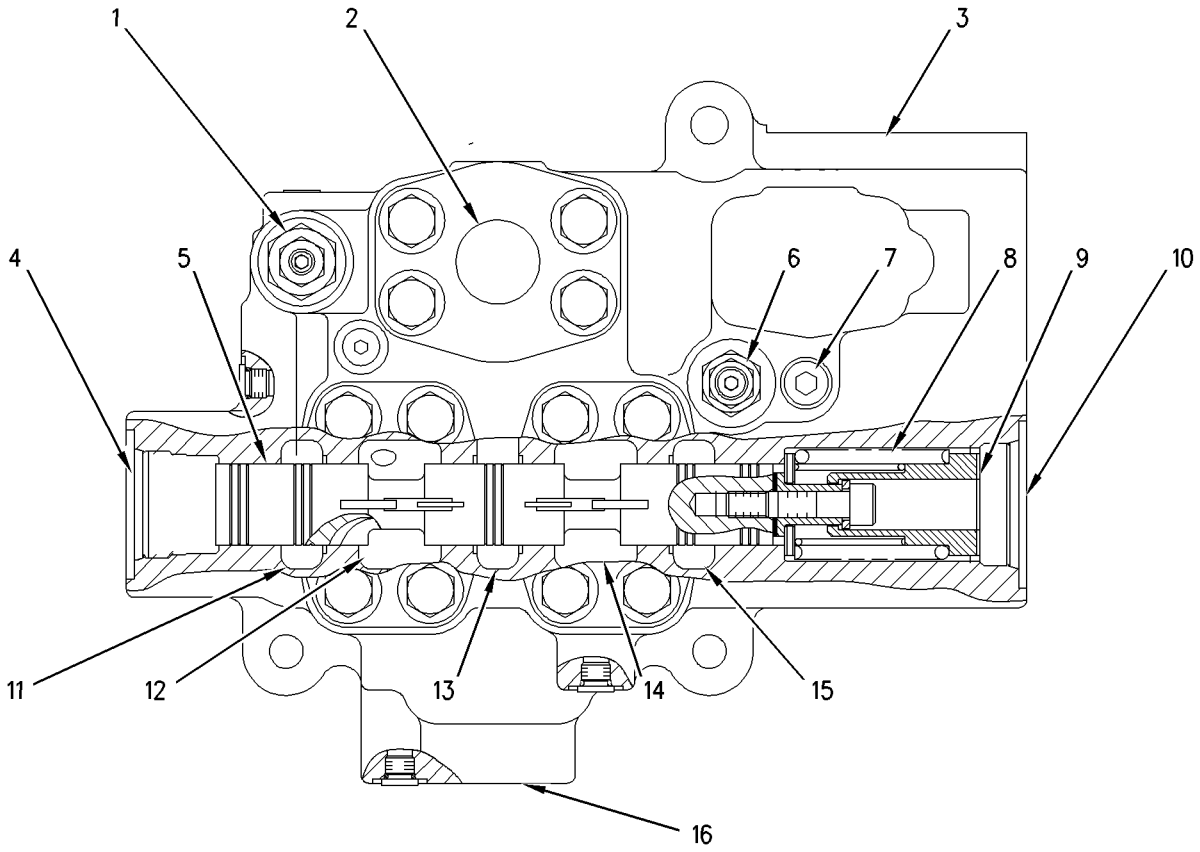


Illustration 17 g00851877

Steering Control Valve in the Neutral Position

(1) Pressure regulating valve. (2) Inlet from pump. (3) Outlet to hydraulic tank. (4) Pilot port. (5) Spool. (6) Cylinder crossover relief valve. (7) Shuttle valve. (8) Springs. (9) Retainer. (10) Pilot port. (11) Return passage. (12) Port for right turn. (13) Oil supply passage. (14) Port for left turn. (15) Return passage. (16) Relief valve.

Note: This valve does not include secondary steering. Secondary steering will be covered later.

While the engine is running, oil flows from the steering hydraulic tank to the steering pump. The oil flows to the steering control valve through inlet port (2).

The flow of pilot oil to the spool is stopped when the STIC is moved to the CENTER position. The flow of pilot oil is also stopped if a neutralizer valve is activated. When no pilot oil is acting on either end of the spool, centering springs (8) return the spool to the neutral position. As the spool returns to neutral, the pilot oil that had been acting on an end of the spool is forced across an orifice and back to the tank.

Oil flow to port (2) is blocked at passage (13), when the spool is in the CENTER position. Oil in the steering cylinder lines is also blocked in ports (12) and (14). The load for the cylinder is sensed by shuttle valve (7). The shuttle valve routes the signal back to the steering pump. This will cause the pump to destroke. During destroke, the pressure compensator will supply only enough oil for leakage.

Note: If you are making a turn and if you release the lever, the machine will continue to turn. Therefore, releasing the lever will not return the machine to the straight forward travel.

If the fan drive pump fails, pilot oil in the steering pilot system will flow from a port near pressure reducing valve (1) and to the pilot control valve. The pressure reducing valve maintains pilot pressure at 1650 ± 150 kPa (239 ± 22 psi).

Left Turn Position

When the operator moves the control lever to turn left, pilot oil will flow from the pilot control valve, through the right neutralizer valve, and through dual check valves into port (10). The pilot oil is forced on retainer (9). The oil pressure pushes the springs (8) and the spool moves to the left.

Oil in passage (13) can now flow past the spool into port (14). The oil in port (14) flows to the head end of the right side steering cylinder and the rod end of the left side cylinder.

Oil from the rod end of the right side steering cylinder and the head end of the left side cylinder flows into port (12). The oil flows from port (12) back to the hydraulic tank.

The machine articulates left and the machine begins making a left turn. When the control lever is released, pilot oil flow to port (10) stops. Oil pressure on the retainer (9) must be removed before the spool can return to the neutral position. Because pilot oil flow is blocked, springs (8) cause the spool to return to the center position. As the spool travels to the right oil in springs (8) chamber will flow through port (10) and returns to the tank.

The spool blocks the flow of steering oil to the steering cylinders when the valve is in the neutral position. This causes the machine to be held in a turning position.

Blocked outlets (12) and (14) oil pressure is sensed by the crossover relief valve in port (6). When the wheels contact a stationary object, the steering cylinders may experience a sudden shock load. Any pressure that is generated in the steering cylinders from the shock load is sensed in passages. The crossover relief valve (6) senses the oil pressure and opens. The relief valve will not allow pressure to rise above the 34500 ± 700 kPa (5000 ± 100 psi) setting.

Right Turn Position

When the machine is turned to the right, the steering control valve operates in a similar manner.

For a right turn, pilot oil enters pilot port (4). Pressure oil from pump inlet port (2) flows through passage (13). The oil then flows past directional spool (5). From directional spool (5), the oil flows out of steering cylinder port (12).

The pressure oil then flows to the rod end of the steering cylinder on the right side of the machine. The oil also flows to the head end of the steering cylinder on the left side of the machine.

The oil then flows to the rod end of the right steering cylinder, and the head end of the left steering cylinder. This causes the machine to articulate to the right.

i02383777

Secondary Steering System

SMCS Code: 4300-SE

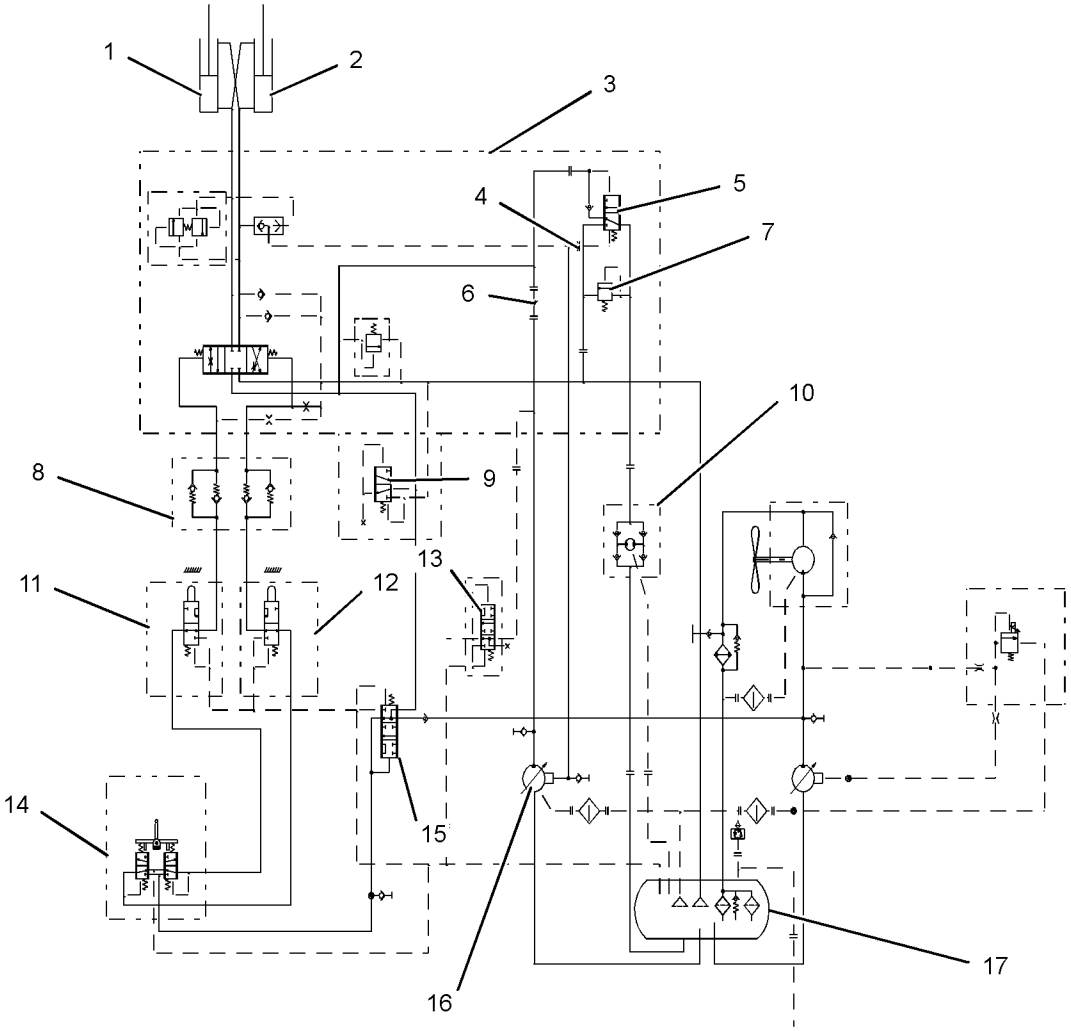


Illustration 18 g01189609

Secondary Steering System Schematic

(1) Left steering cylinder assembly. (2) Right steering cylinder assembly. (3) Steering control valve. (4) Check valve. (5) Diverter valve. (6) Check valve. (7) Relief valve. (8) Dual check valves. (9) Pressure reducing valve. (10) Secondary steering pump. (11) Right neutralizer valve. (12) Left neutralizer valve. (13) Steering oil pressure sensor. (14) Pilot control valve. (15) Pressure control and selector valve. (16) Steering pump. (17) Hydraulic tank.

The secondary steering system supplies the steering oil only if the following conditions exist. The primary steering pump fails, or the engine stops while the machine is still moving.

The following components make up the secondary steering system: Hydraulic oil tank (17) for the steering systems , secondary steering pump (10), secondary steering relief valve (7) and diverter valve (5).

Note: Diverter valve (5) and secondary steering relief valve (7) are part of steering control valve (3).

During normal machine operation, steering pump (16) draws oil from hydraulic tank (17). The pump then sends the oil through check valve (6). Check valve (6) is located in steering control valve (3). The oil then flows to pressure reducing valve (9), and steering cylinders (1) and (2).

As the machine starts to move, oil begins to flow from secondary steering pump (10). Secondary steering pump (10) is a ground driven pump that is attached to the output transfer gears of the transmission. If the machine is moving forward or backward, the pump will provide oil flow.

With secondary steering pump (10) in operation, oil flows into diverter valve (5). If steering pump (16) maintains a steady pressure, that pressure remains greater than the pressure from secondary steering pump (10). This keeps the check valve (4) against the seat. This also keeps the spool in diverter valve (5) in the DOWNWARD position.

With the spool in diverter valve (5) in the DOWNWARD position, the oil from secondary steering pump (10) flows back to hydraulic tank (17).

When steering pump (16) does not maintain adequate system pressure, and if the machine is in motion, a spring on the bottom of the diverter valve spool forces the spool upward. The oil from secondary steering pump (10) now flows through diverter valve (5). The oil then flows through check valve (4). Then oil flows to check valve (6).

Because primary steering pump (16) has stopped working, or because the engine has stopped, the secondary steering oil forces check valve (6) to seat. This stops the flow of oil from secondary steering pump (10) from flowing to steering pump (16).

This forces the pressurized oil to flow to pressure reducing valve (9), and to steering cylinder (1) and steering cylinder (2).

Pressure reducing valve (9) changes the pressure of the secondary steering oil to pilot pressure. The pilot oil then flows through steering pilot valve (14). From steering pilot valve (14), the pilot oil flows through steering neutralizer valve (11) and steering neutralizer valve (12). The pilot oil then flows through the neutralizer check valves (8). Then oil flows to the steering control valve (3).

The pressure oil that flows to steering cylinder (1) and steering cylinder (2) is controlled by the manipulation of steering pilot valve (14).

Selector and pressure control valve (18) senses the pressure from steering pump (16). Loss of steering pressure from steering pump (16) is detected by a pressure sensor, connected to line (13). The pressure sensor sends a signal to the monitoring system. This creates a Warning Category 3 alarm.

A Warning Category 3 alerts the operator that machine shutdown should occur as soon as possible. This helps prevent potential damage to the machine.

A Warning Category 3 causes the action lamp and alert indicator to flash. Warning Category 3 also causes the action alarm to sound. A Warning Category 3 may cause a message to appear in the message area. In some cases, the universal gauge may show a relative value.

Reference: For additional information about Warning Category 3 alerts, refer to the Service Manual moduleOperation And Maintenance Manual for the machine that is being serviced.

Do not operate the machine until the cause has been corrected.

Note: Steering pilot valve (14) will not provide the capacity for manual steering when the engine is stopped. When the engine is stopped, you can only steer the machine under two conditions. The secondary steering system must be installed, and the machine must be in motion.

i01646934

Gear Pump (Secondary Steering)

SMCS Code: 4324-GT; 5073-SST

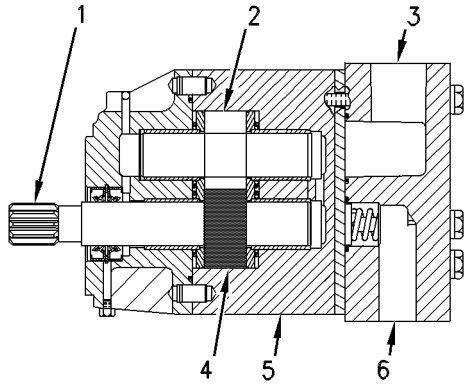


Illustration 19 g00274381

Secondary Steering Pump

(1) Drive shaft. (2) Idler gear. (3) Inlet port. (4) Drive gear. (5) Pump housing. (6) Outlet port.

Secondary steering pump (18) is mounted onto the front of the output transfer gear housing above the output shaft. Diverter valve (16) is mounted to secondary steering pump (18).

If the primary steering pump (13) fails to pump oil or if the engine stops, the diverter valve (16) will allow oil pressure from secondary steering pump (18) to flow to steering control valve (1).

If the primary steering pump (13) fails to pump oil, flow switch (19) alerts the operator of a failure by sending a warning signal to the cab.

i02389469

Steering Control Valve (with Secondary Steering)

SMCS Code: 4307-SST

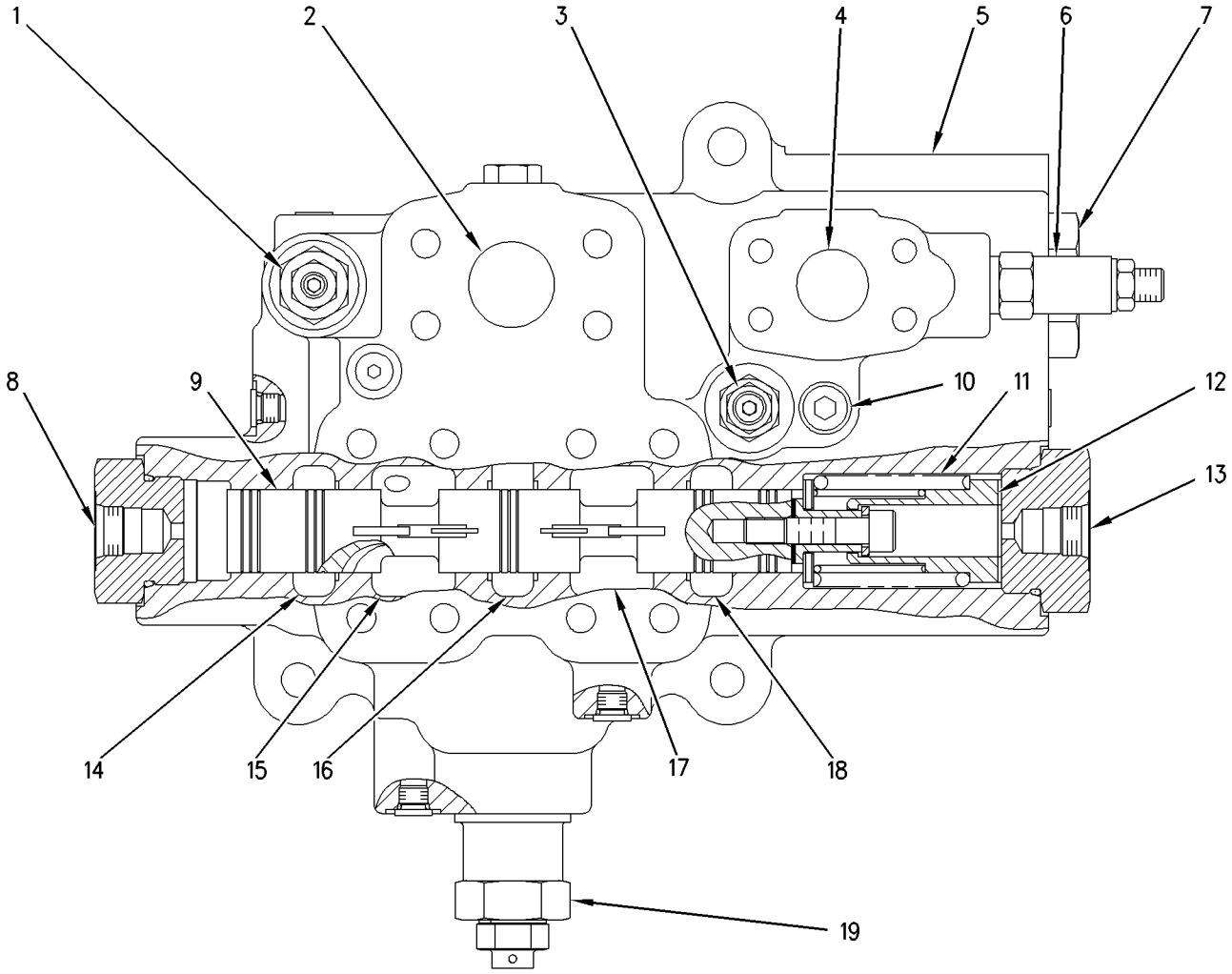


Illustration 20 g00853705

Secondary Steering Control Valve in the PRIMARY Position

(1) Pressure reducing valve. (2) Inlet from the steering pump. (3) Steering cylinder crossover relief valve. (4) Inlet from the secondary steering pump. (5) Outlet to the hydraulic oil tank for the steering system. (6) Secondary steering relief valve. (7) Diverter valve. (8) Pilot port. (9) Spool. (10) Shuttle valve. (11) Springs. (12) Retainer. (13) Pilot oil port. (14) Return oil passage. (15) Port for left turns. (16) Passage of the supply oil. (17) Port for right turns. (18) Return passage. (19) Primary steering relief valve.

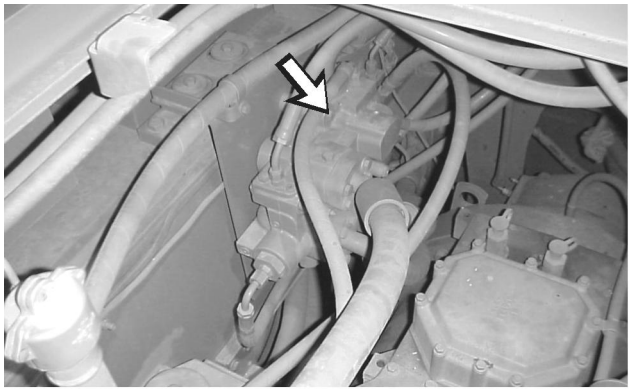


Illustration 21 g00853708
Typical example of the steering control valve

Note: The secondary steering control valve is located on the left inner frame behind the cab.

Standard steering control valves and secondary steering control valves consist of the same basic components. Additionally, standard steering control valves and secondary steering control valves have the same basic functions, unless there is a loss of primary pump flow.

Reference: For additional information about the operation of primary steering control valves, refer to the Service Manual module Systems Operation, “Steering Control Valve” for the machine that is being serviced.

Although the basic components of a standard steering control valve and of a secondary steering control valve are the same, secondary steering control valves contain the following additional components:

- Inlet (4) for the secondary steering pump
- Secondary steering pump relief valve (6)
- Diverter valve (7)
- Load check valve (not shown)

If the primary steering pump fails, diverter valve (7) sends oil from the secondary steering pump. The oil is then pumped into oil passage (16). This will continue to occur when the machine is moving forward or backward.

When the operator moves the STIC steering control lever in order to make a right turn, pilot oil flows from the pilot control valve through the right neutralizer valve. The oil then flows through the quad check valves and to pilot oil port (13). Pilot oil flows past retainer (12). The oil flow acts against spool (9). The force of the oil overcomes springs (11). This causes spool (9) to move to the left.

When spool (9) moves to the left, oil in passage (16) flows past spool (9). The oil then flows into port (17) for right turns. The oil then flows through the lines to the head end of the left steering cylinder. The oil in port (17) then flows through the lines to the rod end of the right steering cylinder.

Secondary steering relief valve (6) limits the secondary steering system pressure to 14000 ± 700 kPa (2050 ± 100 psi).

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RENR8817-01 (en-us)
August 2018

Testing and Adjusting

990H Wheel Loader and , 844H Wheel Dozer
Steering System

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Testing And Adjusting Section

Troubleshooting

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Machine Preparation for Troubleshooting

SMCS Code: 4300-035

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Move away from other operating machines and away from personnel. Park the machine on a smooth, level surface. Lower the work tools to the ground. Stop the engine.
2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.
3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

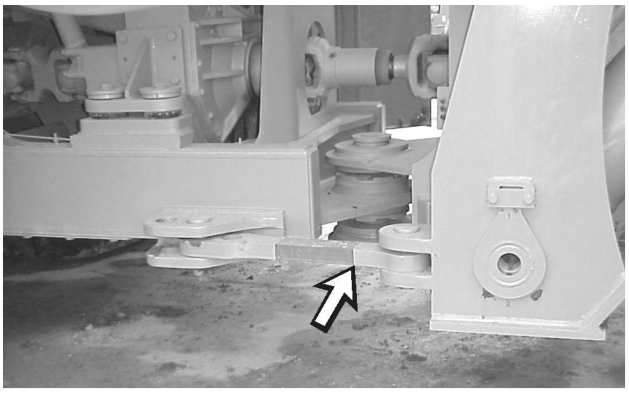


Illustration 1 g00853163
Steering frame lock in the LOCKED position

4. Install the steering frame lock in the LOCKED position so the machine can not articulate.
5. Depress the brake pedal repeatedly in order to relieve any pressure that may be present in the brake hydraulic system. This may require more than ten applications of the service brakes.
6. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the FLOAT position. Place the tilt control lever in the HOLD position.

7. Turn the STIC steering control lever several times in both directions in order to relieve the pressure in the steering system.

8. This machine is equipped with two hydraulic oil tanks. In order to relieve all of the pressure in each of the hydraulic oil tanks, carefully remove the hydraulic tank cap. The hydraulic tank for the implement system and the braking system is located outside the cab on the right side of the machine under the floorplate. The hydraulic tank for the steering system and the hydraulic fan system is located outside the cab on the left side of the machine under the floorplate.

i06890478

Machine Preparation for Troubleshooting

SMCS Code: 4300-035

S/N: BWX1–Up

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Park the machine on a smooth, level surface. Move away from other operating machines and away from personnel. Lower the implements to the ground. Stop the engine.

2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.

3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

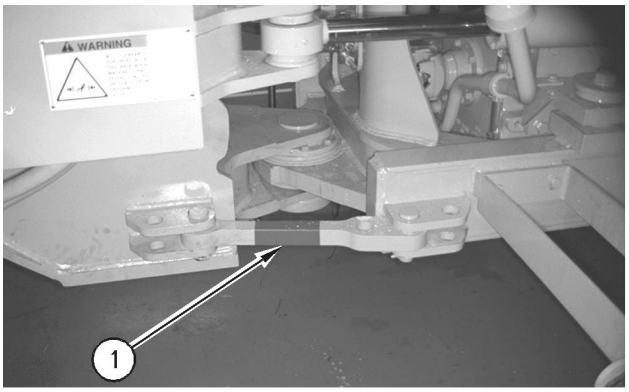


Illustration 2 g00501895
Typical example of a steering frame lock
(1) Steering frame lock in the LOCKED position.

4. Install steering frame lock (1) in the LOCKED position so the machine can not articulate.

5. Depress the brake pedal repeatedly. This will relieve any pressure that may be present in the brake hydraulic system.

Note: If the machine is equipped with electro-hydraulic controls, turn the engine start switch key to the ON position before performing step 6 and step 7. The engine start switch key must then be turned back to the OFF position before proceeding.

6. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the HOLD position. Place the tilt control lever in the HOLD position.

7. Turn the steering wheel several times in both directions in order to relieve the pressure in the steering system.

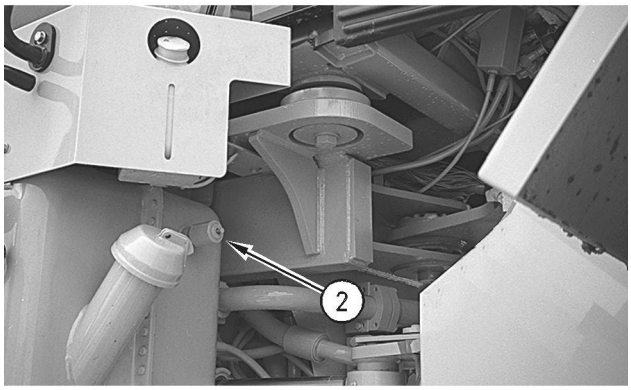


Illustration 3 g00495483

Typical example of a breaker relief valve.

(2) Breaker relief valve

8. In order to relieve all of the pressure in the hydraulic oil tank, press and hold down the plunger on breaker relief valve (2). The breaker relief valve is located on the top of the hydraulic oil tank.

Note: If the machine is not equipped with a hydraulic tank breaker relief valve, the hydraulic tank cap may be removed slowly in order to relieve tank pressure.

i02410231

Visual Inspection

SMCS Code: 4300-035

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the systems is one of the first steps when you are troubleshooting a problem. Before any tests are performed, visually inspect the systems for oil leaks and for damaged parts.

1. When possible, talk to the operator. Ask about the symptoms of the problem: machine performance, noises, smells and frequency of the problem.

2. Prepare the machine for troubleshooting. Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced.

3. Check the display of the monitoring system for the following machine conditions: alert indicators, warnings and service codes.

4. Be aware of the work environment. An extreme work environment can greatly affect the symptoms of a machine.

5. Check the hydraulic oil levels in the sight gauges on both of the tanks. The 844H Wheel Dozer and 990H Wheel Loader have two separate hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. The tank for the hydraulic fan system and the steering system is located on the left side of the cab under the floorplate. The sight gauges can be seen from the ground on either side of the machine.

6. Look for air in the hydraulic tank oil immediately after the engine is stopped. Use a clear container to obtain a sample of the oil. Look for air bubbles in the oil in the container.

7. Remove the hydraulic oil filter and cut the filter open with a filter cutter. Look for particles in the filter elements. A magnet will separate the ferrous particles such as iron and steel from the nonferrous particles such as brass, aluminum and rubber.

8. Check all hydraulic hose and connections. Look for damage, tightness of fasteners, and leaks.

9. Inspect all of the hydraulic cylinders for damage and leaks.

10. Inspect all of the control linkages for components that are bent, broken, or damaged.

i01658073

Steering System Troubleshooting

SMCS Code: 4300-035

Performance tests for the steering system can be used for a diagnosis of poor performance and for finding the source of oil leaks inside the hydraulic system.

This section provides probable causes to a known problem. Since there may be several probable causes, specific inspections or specific instrument tests may be recommended. These inspections and tests will help to identify the cause that is most probable.

The machine turns slowly when the STIC steering control lever is moved.

Probable causes

- The oil is too cold.
- There is a restriction in the pilot lines of the pilot valve.
- The pilot lines to the pilot valve are not connected to the correct ports.
- Steering pump pressure is low.

The machine responds slowly when the machine is steered quickly from a full turn.

Probable cause

- There is not enough clearance between the ball check valve and the plug assembly in the steering neutralizer valve.

The STIC steering control lever attempts to turn the machine when the machine is in a full turn.

Probable causes

- The adjustment of the steering neutralizer valve is not correct.
- The seat for the ball check valve is worn or damaged.
- The relief valve opens before the turn stop moves the neutralizer.

The machine does not turn easily.

Probable cause

- The steering control valve spool does not move freely.

The machine turns too slowly in both directions.

Probable causes

- The springs for the steering control valve spool are not adjusted correctly.
- There is not enough flow from the primary steering pump.
- The steering control valve spool does not move all the way.

The machine turns too slowly in one direction.

Probable causes

- The flow balance adjustment of the steering control valve spool is not correct.
- There is a faulty seal and/or a faulty seat in the shuttle valve.

The machine turns correctly during roading, but the machine turns slowly in both directions when the machine turns against a load.

Probable causes

- Oil is leaking past the relief valve seat or past the seals.
- Oil is leaking past the seat of the shuttle valve.
- The steering control valve spool does not fit correctly in the bore.

The machine does not turn when the STIC steering control lever is moved.

Probable causes

- The steering control valve spool will not move from the NEUTRAL position.
- Oil is leaking past the seat of the pilot relief valve or past the seals.

The machine turns when the STIC steering control lever is not moved.

Probable causes

- The steering control valve spool will not return correctly to the NEUTRAL position.
- The mounting bolts for the steering control valve are too tight.
- The bolts for the end covers of the steering control valve are too tight.
- Manufacturing tolerances for the steering control valve spool in the steering control valve do not permit the steering control valve spool to return to the NEUTRAL position. This can be corrected on some machines by rotating the steering control valve spool in the bore so that the opposite end is inserted first. The spring, the retainer and the shims must be installed on the opposite end of the steering control valve spool. An adjustment of the steering time may be necessary.

The machine turns too fast so that small steering corrections can not be made at fast speeds.

Probable causes

- The adjustment of the steering control valve spool is not correct.
- The steering control valve spool does not move freely.
- Metering orifices on the steering control valve spool are filled with foreign material or the orifices were not drilled correctly.

The pump makes noise and the steering cylinder pistons and cylinder rods do not move evenly.

Probable causes

- There is air in the steering hydraulic circuit.
- The pump has too much wear.
- There is a loose connection of the oil line on the inlet side of the pump.
- The viscosity of the oil is incorrect.
- The relief valve opens at low oil pressure.
- The tank oil level is low.

Testing and Adjusting

i02411423

System Pressure - Release

SMCS Code: 4300-553-PX

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: The 844H Wheel Dozer and 990H Wheel Loader are equipped with two hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. The tank for the hydraulic fan system and the steering system is located on the left side of the cab under the floorplate. If maintenance is performed on any of the hydraulic systems, the hydraulic pressure should be released from both of the hydraulic tanks.

Reference: Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced before performing the following procedure.

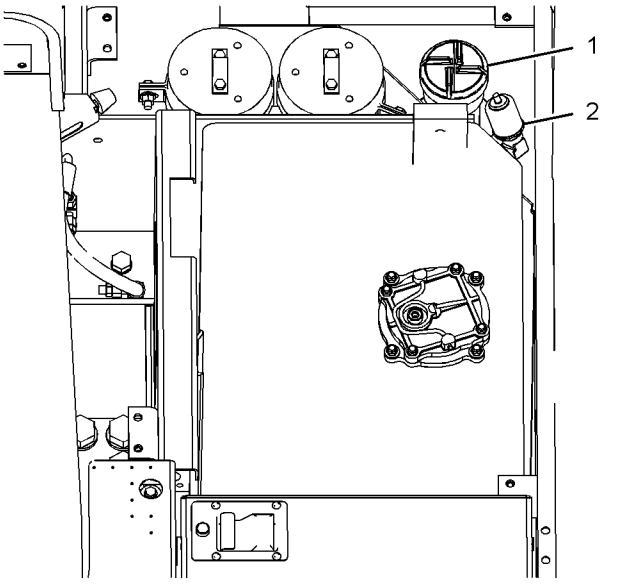


Illustration 4 g01205402

Brake and Implement Hydraulic Tank

(1) Filler cap
(2) Breaker relief valve

To manually purge the pressure that is in the hydraulic tanks, the following procedure should be done.

1. Park the machine on a smooth, level surface. Engage the parking brake. Turn the ignition key to the OFF position.
2. In order to release the pressure in the accumulators, apply the brakes repeatedly.
3. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the HOLD position. Place the tilt control lever in the HOLD position.
4. Move the STIC steering control lever several times through the full range of motion in order to relieve the pressure in the steering system.

5. In order to purge the pressure that is in the hydraulic oil tanks, press the plunger on breaker relief valve (2) on each tank.

i02410011

Hydraulic Oil Contamination - Test

SMCS Code: 4300-008

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine.

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Table 1

Required Tools		
Part Number	**Description**	**Quantity**
169 - 7372	Fluid Sampling Bottle	1
177 - 9343	Fluid Sampling Cap and Probe Gp	1

The hydraulic oil in this system is SAE 10. If the hydraulic oil becomes contaminated, premature component failure could result. Contaminated hydraulic oil can also contribute to overheating.

Use the following procedure in order to sample the hydraulic oil.

1. Start the engine and run the engine at high idle. Allow the oil temperature to reach the normal operating temperature.

2. Actuate all cylinders through a minimum of ten full cycles.

3. Lower the work tools to the ground.

4. Stop the engine.

5. Release the pressure in the hydraulic system.

Reference: For additional information about the release of hydraulic oil pressure, refer to the Service Manual module Testing and Adjusting, “System Pressure - Release” for the machine that is being serviced.

6. Make sure that all of the control levers are in the HOLD position.

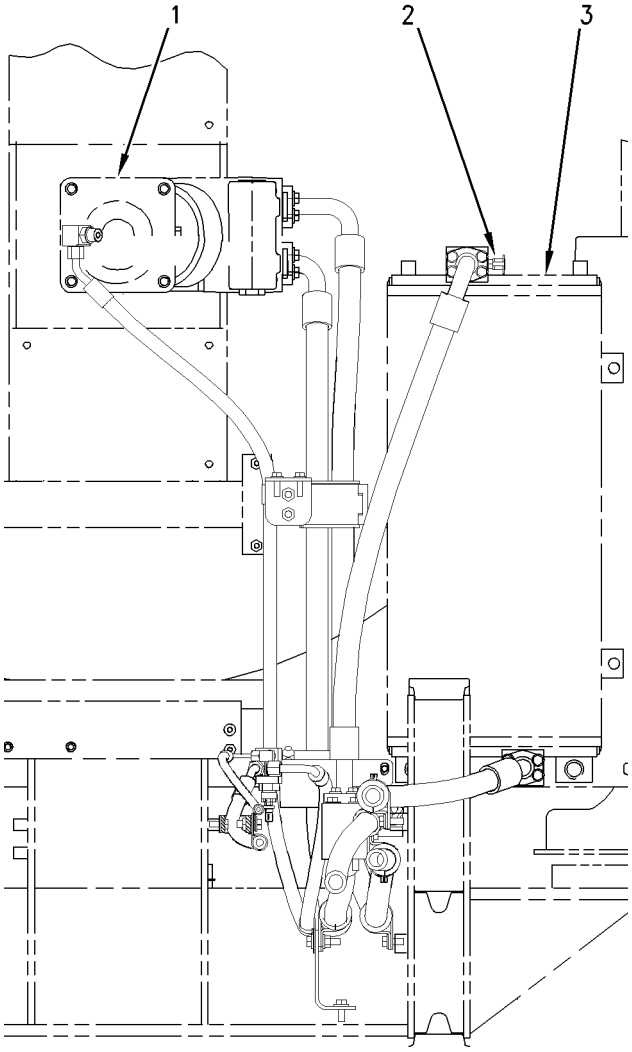


Illustration 5 g00857123

Location of Fluid Sampling Valve for the Steering and Hydraulic Fan System

(1) Fan motor. (2) Fluid sampling port. (3) Hydraulic oil cooler.

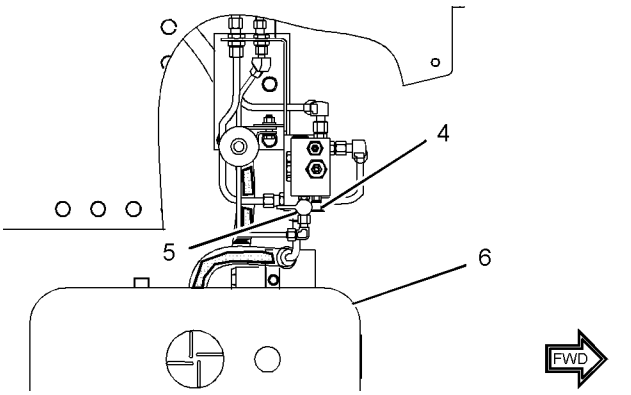


Illustration 6 g01217047

Location of Fluid Sampling Valve for the Brake and Implement System (Top View)

(4) Fluid Sampling Valve. (5) Pressure Tap. (6) Hydraulic Tank.

Note: Fluid sampling valve (4) for the brake and the implement system is under the right side cab platform. Fluid sampling valve (2) for the steering and the hydraulic fan system is at the top of hydraulic oil cooler (3).

7. Purge fluid sampling port (2). Insert an 8T-9208 Probe Assembly into the hydraulic oil sampling port.

Note: Use approximately 150 mm (6 inch) length of tube on the end of the probe. Drain approximately 100 mL (4 fl oz) of oil into a container for disposal. This will clean out the sampling port so that a good oil sample may be obtained.

8. Start the engine and allow the engine to run at low idle.

Note: Do not operate the hydraulic controls.

9. Use a clean tube to draw a 50 mL (2 fl oz) oil sample from the fluid sampling valve. Use an 8T-9190 Fluid Sampling Bottle in order to take the hydraulic oil sample.

10. The recommended level of cleanliness for the hydraulic system is ISO Code 18/15. Refer to Table 2 for the maximum allowable particle count.

Table 2

Hydraulic Oil Contamination		
ISO Code	**Particle Size (Microns)**	**Maximum Number of Particles Per 1 mL Sample**
18	5	2500
15	15	320

Note: The concentration of the particles by size should be monitored over a series of samples. This information can be used in order to spot abnormal wear before a failure occurs. A spectrographic analysis of the samples can be used in order to identify the composition of the particles. The analysis of the oil sample may be used in order to identify the components that are failing.

i02438071

Pump Performance (Steering) - Test

SMCS Code: 4306-032-QP; 5070-032-ZH

The following procedure should be used in order to help determine if there is a problem with the steering pump. Pump performance should be checked if the machine has slow steering times.

Machine Preparation

1. Move the machine to a smooth level surface. Move away from working machines and personnel. Lower the work tool to the ground.

2. Allow only one operator on the machine. Keep all personnel away from the machine or in the view of the operator.

3. Engage the parking brake.

Performance Test

Steering Cycle Time

The steering time is affected by the amount of oil flow that is produced by the steering pump. Check the steering times in order to determine if there is a problem with the steering pump.

1. Perform the machine preparation for testing.

2. Warm the hydraulic oil to normal operating temperature. Raise the work tool slightly off the ground.

3. Maintain the engine speed at high idle.

4. Record the steering time from stop to stop. The steering time should be 3.7 ± .3 seconds.

5. Lower the boom and place the work tool flat on the ground.

6. Reduce engine speed to low idle.

7. Stop the engine.

Compare the test results with the cycle times that are listed. The steering pump should be working properly if the cycle times match the cycle times that are listed.

If the cycle times are not correct one of the following conditions may be present:

- The pressure setting for the backup relief valve is not within specifications.
- The pump is not upstroking.
- The pump may have excessive wear.
- The margin pressure setting for the steering pump is not within specifications.

The main relief pressure should be measured. If the main relief pressure is low, the cycle times should be retested after the main relief pressure has been corrected.

Reference: For more information on testing and adjusting the main relief valve, refer to the Service Manual module Testing and Adjusting, “Relief Valve (Pump Backup) - Test and Adjust” for the machine that is being serviced.

The margin pressure for the pump should be measured. If the margin pressure for the pump is low, the cycle times should be retested after the margin pressure for the pump has been corrected.

Test the pressure of the steering pump in order to make sure that the pump is upstroking.

Reference: For more information on testing and adjusting the steering pump, refer to the Service Manual module Testing and Adjusting, “Piston Pump (Steering) Margin - Test and Adjust” for the machine that is being serviced.

If the cycle time is slow for only one of the steering circuits, the circuit with slow cycle time should be tested for one of the following conditions:

- Low relief valve setting
- Leak in the circuit
- Control spool that is not shifting fully

Flow balance shims may need to be adjusted if the steering times are consistently slow in one direction.

Reference: For more information on testing and adjusting the main relief valve, refer to the Service Manual module Testing and Adjusting, “Steering Time - Check and Adjust” for the machine that is being serviced.

i02410571

Steering System Pressure (High Pressure Stall) - Test and Adjust

SMCS Code: 4306-081-PX; 5070-081-PX; 5086-025-ZH; 5455-025-ZH

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

The maximum pressure in the steering system is limited to 31000 ± 750 kPa (4500 ± 110 psi) by the pump control section (pressure and flow compensator valve) of the steering pump.

Reference: For the correct procedure to relieve any hydraulic oil pressure that may be in the steering system, refer to the Service Manual module for Testing and Adjusting, “System Pressure - Release” for the machine that is being tested.

Table 3

Required Tools		
Part Number	**Description**	**Qty**
1U-5481	Pressure Gauge Group	1
1U-5482	Pressure Adapter Group	1

1. Position the machine so that the machine is in the STRAIGHT AHEAD position.

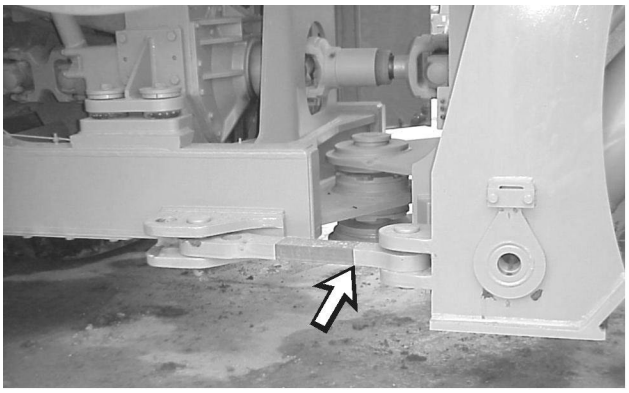


Illustration 7 g00853163

Steering frame lock is in the LOCKED position.

2. Move steering frame lock into the LOCKED position.
3. Engage the parking brake. Move the transmission direction control switch to the NEUTRAL position.

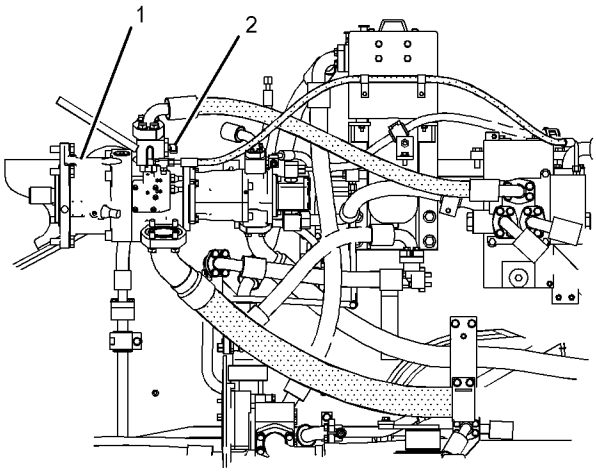


Illustration 8 g01204900

(1) Steering pump. (2) Pressure tap.

4. Attach the correct hose assembly from the 1U-5482 Pressure Adapter Group to pressure tap (2). Attach the opposite end of the hose assembly to a 0 to 40000 kPa (0 to 5800 psi) pressure gauge in the 1U-5481 Pressure Gauge Group. Pressure tap (2) is located on the discharge line of steering pump (1). The steering pump is located on the left side of the machine under the access panel behind the cab.

5. Start the engine. Operate the engine at high idle. The oil is at normal operating temperature when the hydraulic oil temperature gauge is between the first mark and the second mark.

6. After the oil has reached normal operating temperature, lower the work tool until the work tool is slightly off the ground. Run the engine at high idle.

Note: During the following step, do not keep the steering pump at stall condition for more than ten seconds. If necessary, release the STIC steering control lever and wait for 30 seconds before you repeat the step.

7. Move the STIC steering control lever against the steering frame lock. Continue to move the STIC steering control lever against the steering frame lock in order to obtain a reliable pressure reading.

8. Record the pressure reading on the pressure gauge. The reading should be 31000 ± 750 kPa (4500 ± 110 psi).

9. Stop the engine. Lower the work tool to the ground.

10. Remove the hose assembly and the pressure gauge from pressure tap (2).

Note: If the pressure reading is not correct, the pressure compensation valve may need adjustment. The pressure compensation valve is located in the steering pump. The steering pump is located on the left side of the machine under the access panel behind the cab.

Adjustment of the Pressure Compensator Valve

NOTICE
When the compensator is rebuilt, make sure that the pressure compensator adjustment is backed out to a low pressure setting before the engine is started. Otherwise, severe pump and system damage can result.

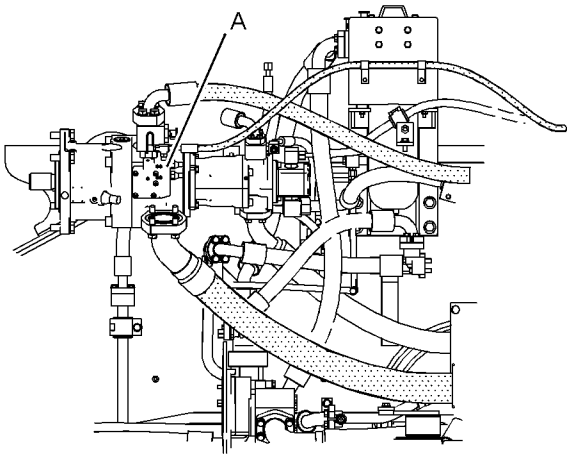


Illustration 9 g01218605

(A) Pressure and Flow Compensator valves

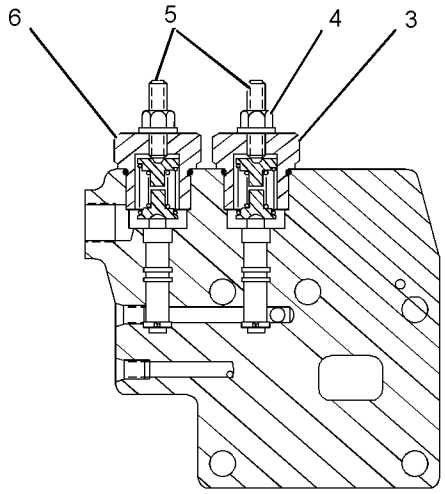


Illustration 10 g01218624

(3) Pressure compensator valve. (4) Locknut. (5) Adjustment screw. (6) Flow compensator.

1. Reduce the engine speed to low idle. Stop the engine. The steering pump is located behind the operator's cab. The pressure compensator is located under the steering pump.

2. Loosen locknut (4). Turn adjustment screw (5) clockwise in order to increase the pressure setting. Turn adjustment screw (5) counterclockwise in order to decrease the pressure setting. Perform the high pressure stall test again. Readjust the pressure compensator valve, if necessary.

3. Tighten locknut (4) after you have turned adjustment screw (5).

4. Lower the work tool to the ground. Stop the engine.

5. Remove the hose assembly and the pressure gauge from pressure tap (1).

i02424496

Piston Pump (Steering) Margin Pressure - Test and Adjust

SMCS Code: 4306-081-PX; 5070-081-PX; 5086-025-ZH; 5455-025-ZH

⚠ WARNING

Personal injury or death can result if two persons are not used in the following procedure.

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Reference: For the correct procedure to relieve any hydraulic oil pressure that may be in the steering system, refer to the Service Manual module for Testing and Adjusting, “System Pressure - Release” for the machine that is being tested.

Table 4

Required Tools		
Part Number	**Description**	**Qty**
1U-5796	Pressure Gauge Group	1

(continued)

(Table 4, contd)

8T-8902	Swivel Tee	1
6V-3965	Nipple Assembly	1
6V-8397	O-Ring Seal	1
3J-1907	O-Ring Seal	1
9S-4190	Plug	1
2M-9780	O-Ring Seal	1
6V-0852(1)	Dust Cap	1

(1) Optional



Illustration 11 g00856963

Steering Frame Lock in the LOCKED position

1. Move the steering frame lock into the LOCKED position.

2. Stop the engine. Move the STIC steering control lever to the right. Then move the STIC steering control lever to the left. This releases steering pilot oil pressure.

3. Slowly, loosen the hydraulic oil fill cap. This will relieve any pressure.

Note: Pressure may be trapped in the steering cylinders. To relieve any pressure, perform the following step.

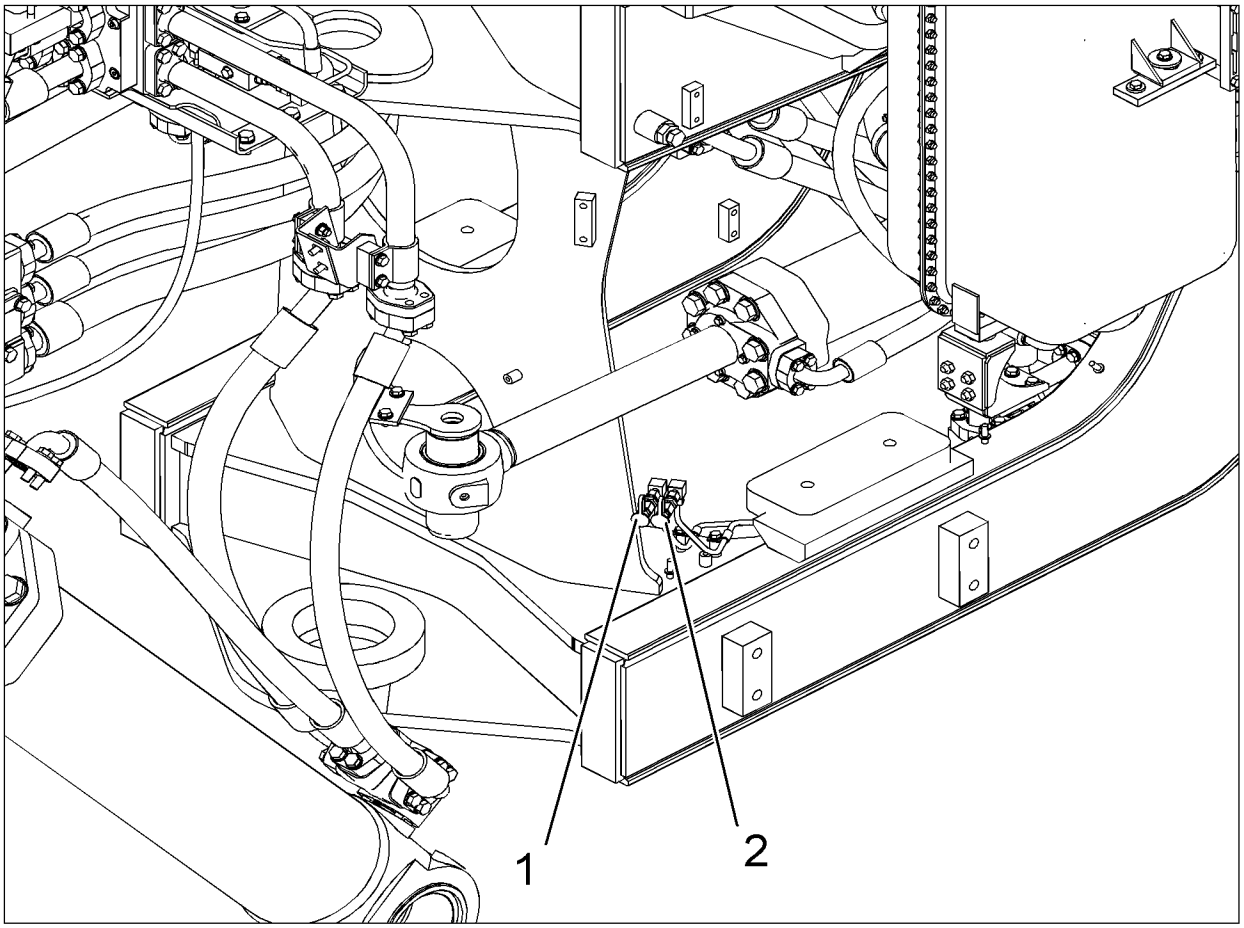


Illustration 12 g01211805

(1) Pressure tap for right turn. (2) Pressure tap for left turn.

4. Attach one end of a drain hose to the pressure tap for left turn (1) and the other end to the hydraulic tank. Attach one end of a drain hose to the pressure tap for right turn (2) and the other end to hydraulic oil tank. The pressure taps are located on the left side of the machine.

5. Move the STIC control to the left and right. Continue this action until there is no movement.

6. After all the steering pressure has been relieved, remove the drain assemblies.

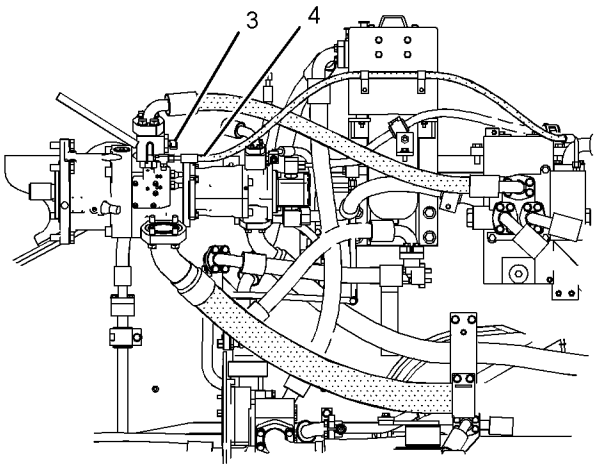


Illustration 13 g01211869

(3) Pressure tap. (4) Pump signal line.

7. Connect the high pressure port of the 1U-5796 Pressure Differential Tool Gp to the quick connect port at the pump discharge pressure tap (3). Install a 40000 kPa (5801 psi) pressure gauge at the high pressure port of the 1U-5796 Pressure Differential Tool Gp. Connect the Pressure Differential Tool Gp on the low pressure port at the pressure tap for the load sensing line.

Note: Two separate 6V-7830 Pressure Gauge can be used in place of the pressure differential gauge. These gauges are tetragauges. The tetragauges are capable of reading pressures from 40000 kPa (5801 psi). Connect one tetragauge to the pressure tap. Connect the other tetragauge to the pressure tap.

8. Start the engine. Run the engine at high idle.

9. Move the STIC control halfway to the RIGHT position. Check the pressure differential gauge. The gauge should stabilize at 2100 ± 100 kPa (305 ± 15 psi) for the margin pressure for the steering pump.

Note: If you are using tetragauges, the steering pump pressure should be 2400 ± 100 kPa (348± 15 psi) higher than the pressure in the load sensing line. This is the margin pressure. These pressures must be read during the articulation of the machine.

10. Stop the engine. Adjust the flow compensator valve if the valve pressure was not correct. Remove the cap (2). Loosen locknut (3). Adjust setscrew (4) in order to adjust the setting of the margin pressure for the steering pump. Turn the setscrew clockwise in order to increase the margin pressure. Turn the setscrew counterclockwise in order to decrease the margin pressure for the steering pump.

Note: If the margin pressure is set above the specification, the performance of the steering will become too responsive and jerky. Poor modulation will result if the margin pressure is set below the specification. Steering performance will become sluggish and less responsive.

11. Move the STIC control halfway to the RIGHT position. Check the differential pressure gauge. The gauge should indicate 2100 ± 100 kPa (305 ± 15 psi).

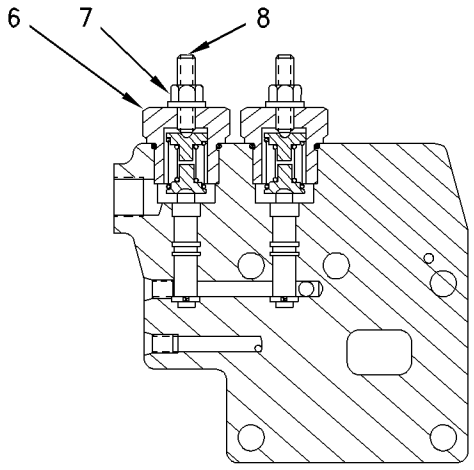


Illustration 14 g00857697

Location of Flow Compensator Valve

(6) Flow compensator valve. (7) Locknut. (8) Adjustment screw.

12. Flow compensator valve (6) must be adjusted if the differential pressure gauge did not indicate 2100 ± 100 kPa (305 ± 15 psi).

If the reading was too high, loosen locknut (7), and turn adjustment screw (8) counterclockwise in order to decrease the margin pressure. If the reading was too low, loosen locknut (7), and turn adjustment screw (8) clockwise in order to increase the margin pressure.

Note: One turn of adjustment screw (8) will change margin pressure approximately 7405 kPa (1075 psi).

13. Tighten locknut (7).

14. Stop the engine. Move the STIC control to the left and right. Continue this action until there is no movement.

15. Slowly, loosen the hydraulic oil fill cap. This will relieve any tank pressure.

Note: Pressure may be trapped in the steering cylinders. To relieve any pressure, perform the following step.

16. Attach one end of a drain hose to the pressure tap for left turn (1) and the other end to the hydraulic tank. Attach one end of a drain hose to the pressure tap for right turn (2) and the other end to hydraulic oil tank.

17. Move the STIC control to the left and right. Continue this action until there is no movement.

18. Remove the drain hoses after all steering pressure has been relieved.

19. Remove the differential pressure gauge.

20. The tee that was installed in Step 7 should be protected by installing a 6V-0852 Dust Cap if the tee is not removed.

21. Remove the 9S-4190 Plug, and 2M-9780 O-Ring Seal that was installed in Step 8.

22. Install crossover relief valve (5) on the steering control valve. Torque for the crossover relief valve 60 ± 7 N·m (45 ± 5 lb ft)

i02425269

Relief Valve (Pump Backup) - Test and Adjust

SMCS Code: 4322-025; 4322-081

S/N: BWX1–Up

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine.

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Table 5

Required Tools		
Part Number	**Description**	**Qty**
1U-5481	Pressure Gauge Group	1
1U-5482	Pressure Adapter Group	1
110-6349	Fitting Assembly	1

Reference: For the correct procedure to relieve any hydraulic oil pressure that may be in the steering system, refer to the Service Manual module for Testing and Adjusting, “System Pressure - Release” for the machine that is being tested.
The backup relief valve for the steering system is located on the steering control valve. The backup relief valve controls the pressure in the steering system in case the pressure compensator of the steering pump fails.

The backup relief valve for the steering system is set to a higher pressure than the maximum system pressure (pump stall pressure). Therefore, the backup relief valve only operates if the pressure compensator of the steering pump fails to regulate the pump pressure to 34500 ± 700 kPa (5004 ± 102 psi).

Use the following procedure to check the pressure setting for the backup relief valve.

1. Position the machine so that the machine is in the STRAIGHT AHEAD position.



Illustration 15 g00856963

Steering Frame Lock in the LOCKED position

2. Move steering frame lock into the LOCKED position.

3. Engage the parking brake. Move the transmission direction control switch to the NEUTRAL position.

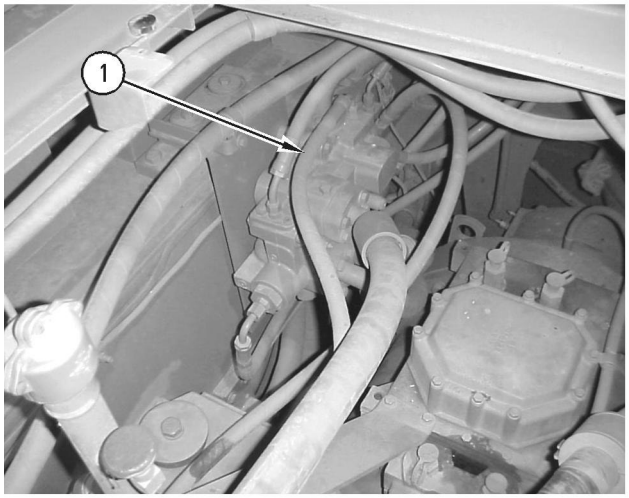


Illustration 16 g00850690

Steering Control Valve (1) is located on the left side of the machine under the access panel behind the cab.

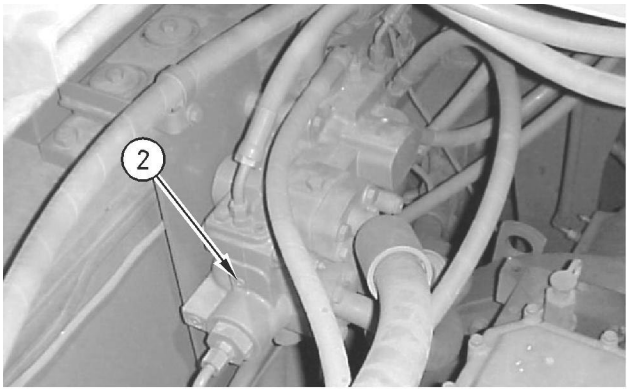


Illustration 17 g00855663

(2) 9S-8002 Plug.

4. Remove 9S-8002 Plug (2) on the steering control valve. Replace the plug with 110-6349 Fitting As. Attach the correct hose assembly from the 1U-5482 Pressure Adapter Group to the pressure tap. Attach the opposite end of the hose assembly to a 0 to 40000 kPa (0 to 5800 psi) pressure gauge in the 1U-5481 Pressure Gauge Group.

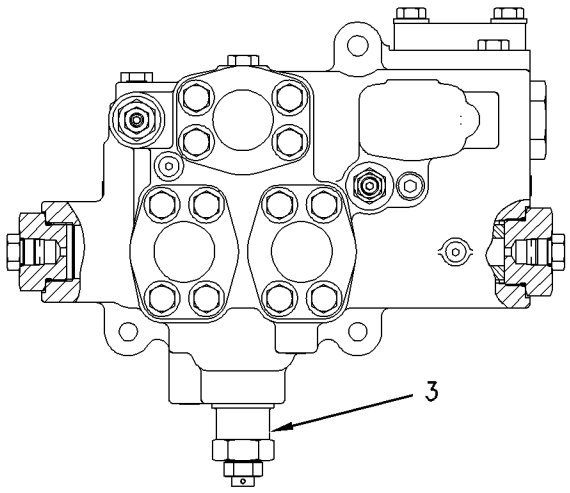


Illustration 18 g00856203

(3) Backup relief valve.

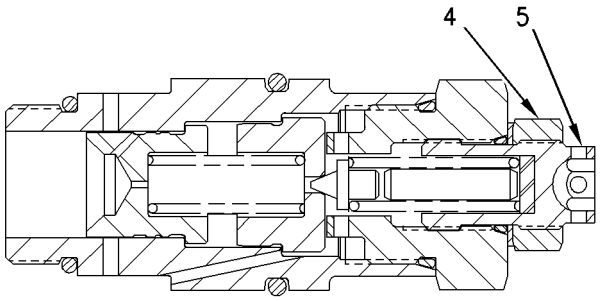


Illustration 19 g00856244

Backup Relief Valve

(4) Locknut. (5) Adjustment screw.

5. Backup relief valve (3) is located on the bottom of the steering control valve. Loosen locknut (4) on steering backup relief valve (3). Turn adjustment screw (5) counterclockwise by two full turns. This will lower the pressure of the backup relief valve below the pressure of the pressure compensator valve of the steering pump. Therefore, the backup relief valve will open before the steering pump reaches a stall condition.

6. Start the engine. Operate the engine at high idle. The oil is at normal operating temperature when the hydraulic oil temperature gauge is between the first mark and the second mark.

7. After the oil has reached normal operating temperature, run the engine at high idle.

Note: During the following step, do not keep the steering pump at stall condition for more than ten seconds. If necessary, release the STIC steering control lever and wait for 30 seconds before you repeat the step.

8. Move the STIC steering control lever against the steering frame lock. Continue to move the STIC steering control lever against the steering frame lock in order to obtain a reliable pressure reading.

9. Record the pressure reading on the pressure gauge. The reading should be lower than 34500 ± 700 kPa (5000 ± 100 psi). Turn adjustment screw (5) slowly in the clockwise direction while you observe the pressure gauge. The reading for the cut off pressure for the steering pump pressure should increase to 31000 ± 750 kPa (4500 ± 109 psi). Then, the pressure should stop rising. Stop turning the adjustment screw when the pressure stops rising.

Note: The pressure stops rising because the steering pump has reached a stall condition. This reduces pump output.

10. When the pump stall pressure is reached, continue to turn adjustment screw (5) clockwise by one full turn. Tighten locknut (4) to a torque of 50 ± 7 N·m (37 ± 5 lb ft).

11. Stop the engine.

12. Relieve the hydraulic pressure.

Reference: For the correct procedure to relieve any hydraulic oil pressure that may be in the steering system, refer to the Service Manual module for Testing and Adjusting, “System Pressure - Release” for the machine that is being tested.

13. Remove the hose assembly and the pressure gauge from the pressure tap.

14. Install 9S-8002 Plug (2).

i02412069

Relief Valve (Steering Cylinder Crossover) - Test and Adjust

SMCS Code: 4322-025; 4322-081

This procedure will check the pressure setting for the crossover relief valve.

Table 6

Tools	
Pt. No.	**Description**
8T-5320	Hydraulic Test Group
1U-5481	Pressure Gauge Group

⚠ WARNING

Personal injury or death can result if two persons are not used in the following procedure.

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine.

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

Before proceeding to the test procedure that follows, complete the procedure:

- Machine Preparation for Troubleshooting

Reference: Refer to the Service Manual moduleTesting and Adjusting, RENR6255, “Machine Preparation for Troubleshooting” for the machine that is being serviced.



Illustration 20 g00856963

Steering Frame Lock is in the LOCKED position.

1. Install the steering frame lock in order to keep the machine from turning.

2. Engage the parking brake. Move the transmission direction selector to the NEUTRAL position.

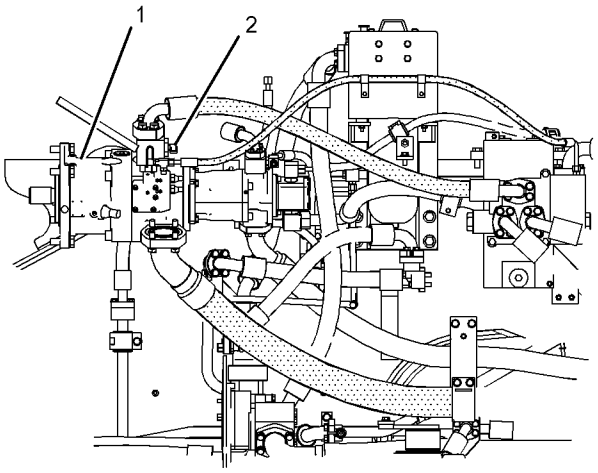


Illustration 21 g01204900

(1) Steering pump. (2) Pressure tap.

3. Install a 0 to 40000 kPa (0 to 5800 psi) pressure tap (2).

4. Start the engine. Operate the engine at high idle. The oil is at normal operating temperature when the hydraulic oil temperature indicator is between the first mark and the second mark.

5. After the oil has reached normal operating temperature, lower the bucket to the ground. Stop the engine.

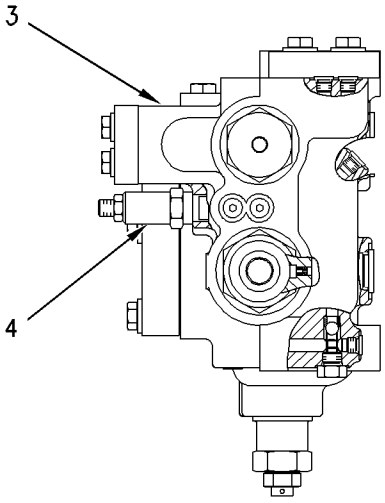


Illustration 22 g00858208

(3) Steering control valve. (4) Steering cylinder crossover relief valve.

Note: Steering control valve (3) is located behind the operator's station. Access is gained by opening an access door that is behind the cab.

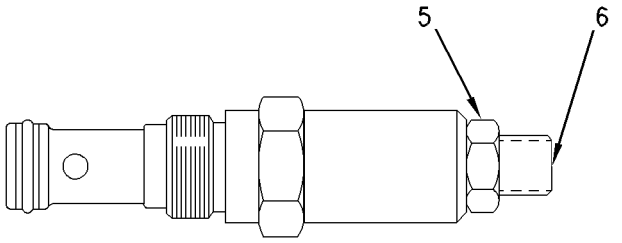


Illustration 23 g00860313

(5) Locknut. (6) Adjustment screw.

Note: Relief valve (4) is located on the steering control valve.

6. Loosen locknut (5) on steering crossover relief valve (4). Turn adjustment screw (6) counterclockwise by two full turns. This will lower the setting of the steering crossover relief valve to a setting that is lower than the cutoff pressure of the steering pump.

7. Start the engine. Raise the bucket and any attachments slightly off the ground. Run the engine at high idle.

Note: During the following step, do not keep the steering pump at stall condition for more than ten seconds. If necessary, release the steering wheel and wait for 30 seconds before you repeat the step.

8. Turn against the steering frame lock. Sustain the FULLY TURNED position in order to obtain a reliable pressure reading.

9. Record the pressure reading on the pressure gauge. The reading should be lower than 34500 ± 700 kPa (5004 ± 102 psi). Turn adjustment screw (6) slowly in the clockwise direction while you observe the pressure gauge. The reading for the cut off pressure for the steering pump pressure should increase to 31000 ± 750 kPa (4500 ± 109 psi). Then, the pressure should stop rising. Stop turning adjustment screw (6) when the pressure stops rising.

Note: The pressure stops rising because the steering pump has reached a stall condition.

10. When the pump stall pressure is reached, continue to turn adjustment screw (6) clockwise by an additional 3/4 turn. Tighten locknut (5) to a torque of 13 ± 2 N·m (10 ± 1 lb ft).

11. Lower the work tool to the ground. Stop the engine.

i01666184

Relief Valve (Secondary Steering) - Test and Adjust

SMCS Code: 4322-081-SST; 4322-025-SST

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Reference: Refer to Testing and Adjusting, “System Pressure - Release” for the correct procedures for relieving hydraulic oil pressure.



Illustration 24 g00856963

Steering Frame Lock in the LOCKED position

1. Move the steering frame lock into the locked position.

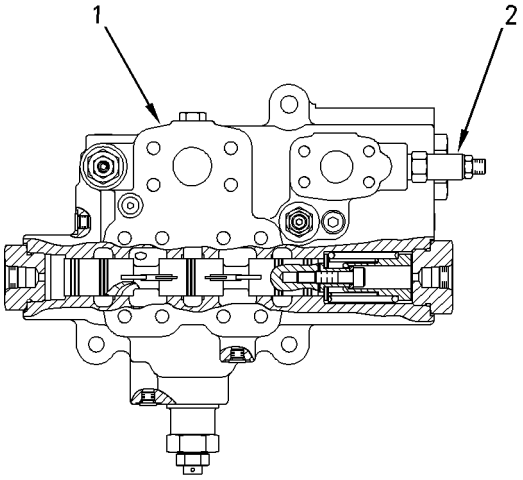


Illustration 25 g00857289

Steering control valve (1). Secondary steering relief valve (2).

2. Steering control valve (1) is located on the left side of the machine, behind the cab, and under the platform. Secondary steering relief valve (2) is located on the steering control valve.

3. Remove the relief valve for the secondary steering system. The relief valve should be bench tested.

4. The correct pressure of the relief valve is 17300 ± 700 kPa (2510 ± 100 psi).

If the pressure was not correct, the relief valve needs to be adjusted. Proceed to step 5 for the adjustment procedure.

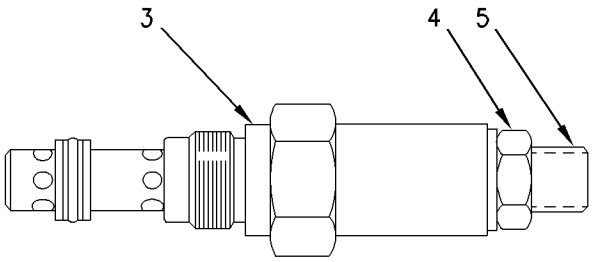


Illustration 26 g00857310

Relief valve (3). Locknut (4). Adjustment screw (5).

5. Loosen locknut (4) that is located on relief valve (3). Turn adjustment screw (5) clockwise in order to increase the pressure of the relief valve. Turn adjustment screw (5) counterclockwise in order to decrease the pressure of the relief valve.

6. Install the relief valve for the secondary steering system when the correct pressure setting is reached. Tighten the relief valve to 50 ± 7 N·m (37 ± 5 lb ft).

i07091170

STIC Control (Steering Deadband) - Adjust

SMCS Code: 3033-025-ZH

The steering deadband refers to the amount of physical movement of the STIC Control that can occur before the hydraulic system is actuated.

The following procedure can be performed to adjust the steering deadband of the STIC Control to the preference of the operator. This procedure is not necessary unless the current deadband in the STIC Control is inconvenient for the current type of operation.

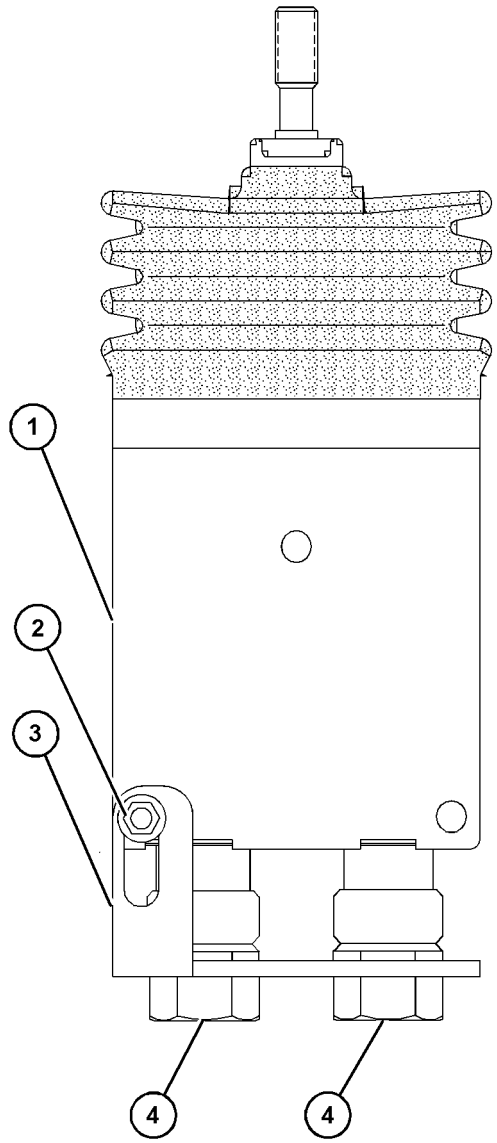


Illustration 27 g06222348

Pilot valve (STIC steering)

(1) STIC control
(2) Bolt
(3) Bracket
(4) Capsule

Correct adjustment of bracket (3) ensures the proper torquing of capsules (4).

1. Loosen the fittings at the end of capsules (4).

2. Loosen bolt (2) that is holding bracket (3).

3. Slide bracket (3) upward past the hex surface.

4. Adjust capsules (4) to the preference of the operator.

5. Slide bracket (3) over the hex surface on both capsules.

6. Tighten bolt (2) to hold bracket (3) in place.

7. Tighten the fittings at the end of capsules (4).

8. Test the steering deadband of the pilot valve.

9. If the adjustments are not satisfactory, repeat Step 1 through Step 8 until the steering deadband is satisfactory.

i01666214

Steering Neutralizer Valve - Check and Adjust

SMCS Code: 4330-535; 4330-025

1. Move the machine to a location that is smooth and level. The location should also be dry and free of debris.



Illustration 28 g00858455

Steering frame lock is in the STORED position.

2. Move the steering frame lock to the STORED position.

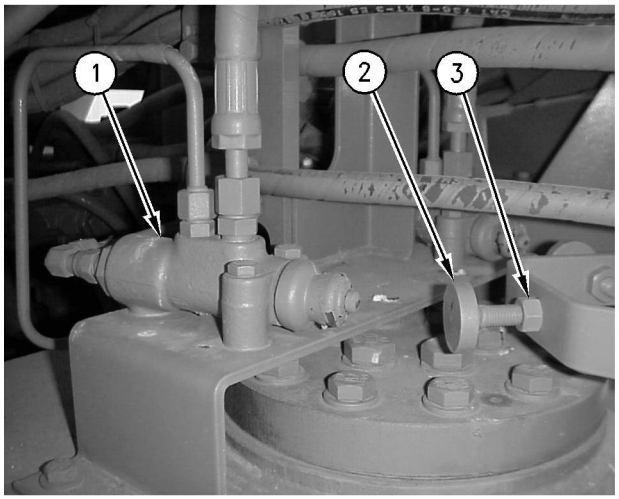


Illustration 29 g00858468

(1) Steering neutralizer valve. (2) Turn stop. (3) Locknut.

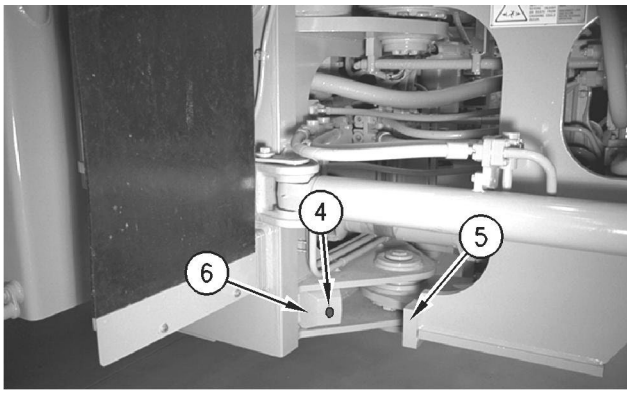


Illustration 30 g00721587

Typical example (showing model 988G Wheel Loader) of the putty ball location.

(4) Putty rolled into a ball. (5) Non-engine end frame. (6) Engine end frame.

3. Place the ball of putty on the right engine end frame (6). The diameter of the ball of putty (4) should be approximately 44.5 mm (1.75 inch). The ball of putty will be squeezed between non-engine end frame (5) and engine end frame (6).

4. Move the transmission direction and speed control lever to the NEUTRAL position. Start the engine. Raise the work tool to a height of approximately 300 mm (11.8 inches).

5. Disengage the parking brake.

6. Operate the engine at high idle. Turn the machine all the way to the right.

7. Steer the machine so that the machine is facing straight ahead. Engage the parking brake. Lower the work tool to the ground. Stop the engine.

8. Measure the thickness of the ball of putty (4). The putty should be pressed to a thickness of 35 mm (1.375 inch).

9. Adjust turn stop (2), as needed. Loosen locknut (3). Turn the turn stop clockwise in order to lower the thickness of the ball of putty. Turn the turn stop counterclockwise in order to raise the thickness of the putty. Tighten locknut (3) in order to lock turn stop (2).

Note: Adjust the turn stop in small increments. Turn the turn stop for 1/2 of a turn or less and recheck the thickness of the putty.

10. If necessary, repeat Steps 3 through 9 until the dimension is correct.

11. Repeat this procedure for the left turn steering stop.

i02412556

Steering Time - Check and Adjust

SMCS Code: 3033-531-D7

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: To check the steering time, park the machine on a dry, hard, level surface.

With the engine at high idle, the steering time for a full turn from stop to stop should be 3.7 ± 0.3 seconds. With the engine at low idle, the steering time for a full turn from stop to stop should be 7.4 ± 0.6 seconds.

When the service brakes are not applied, the difference between the steering time for a right turn and the steering time for a left turn must not be more than 0.3 second. When the service brakes are applied, the steering time must not increase by more than 0.2 second.

If the difference between the steering time for a full right turn and the steering time for a full left turn is more than 0.3 second, use the following procedure to adjust the steering time:

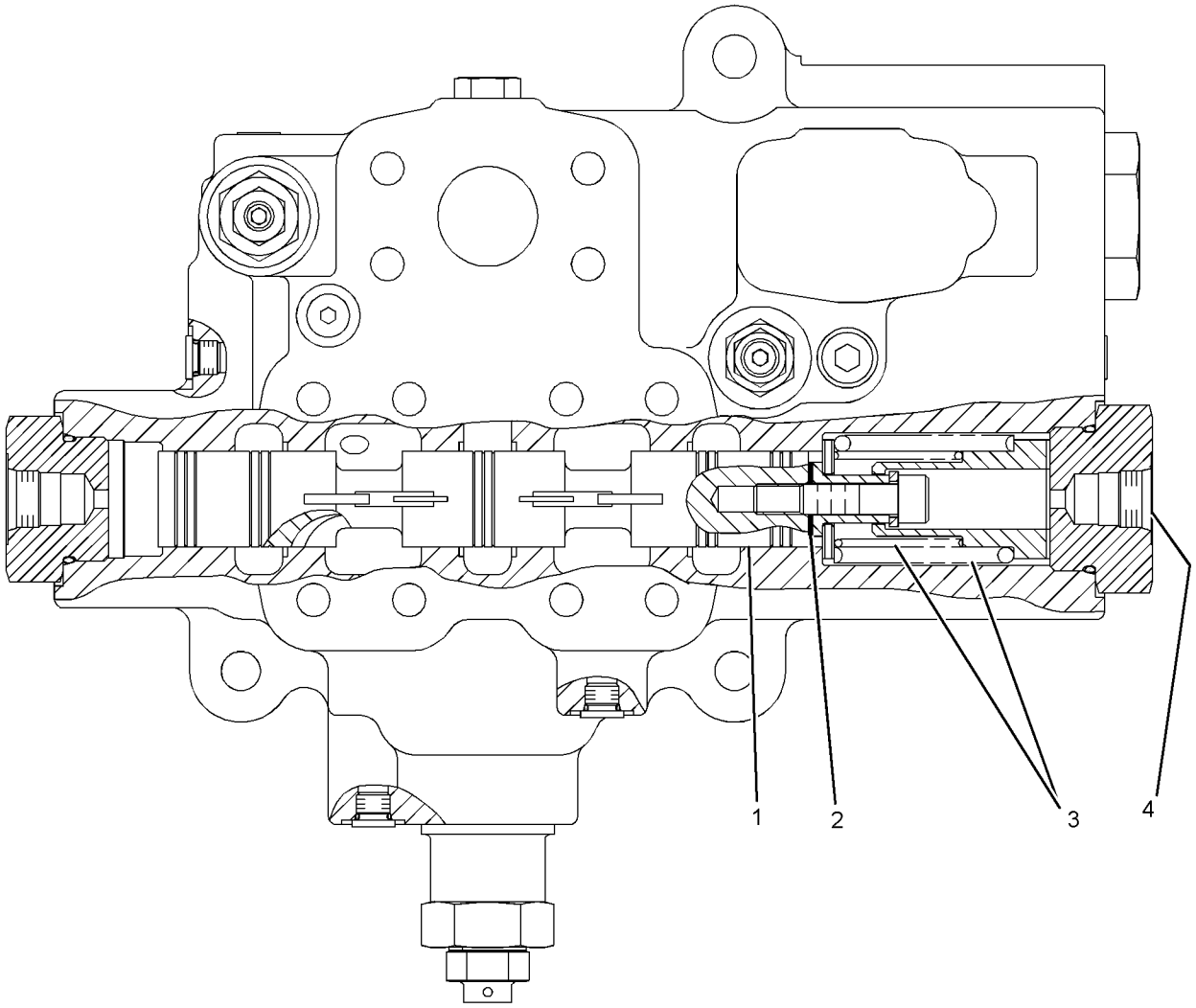


Illustration 31 g01220102

Steering Control Valve

(1) Control valve spool. (2) Flow balance shims. (3) Springs. (4) Pilot oil port.

Note: The standard steering control valve is shown above. However, the secondary steering control valve is similar.

1. Remove the fittings from pilot oil port (4) of the steering control valve.

2. To achieve a faster right turn and a slower left turn, add flow balance shims (2). If flow balance shims (2) are removed, the result is the opposite.

3. The thickness of each 4J-8224 Shim is 0.25 mm (.010 inch). The thickness of each 5J-4776 Shim is 0.12 mm (0.005 inch). Two shims (one shim of each thickness) will change the steering times at high idle by approximately 0.1 second.

4. Install the fittings and the line to pilot oil port (4).

i01663891

Articulated Hitch - Adjust

SMCS Code: 7057-025-BD

Procedure to Assemble the Upper Hitch Bearings

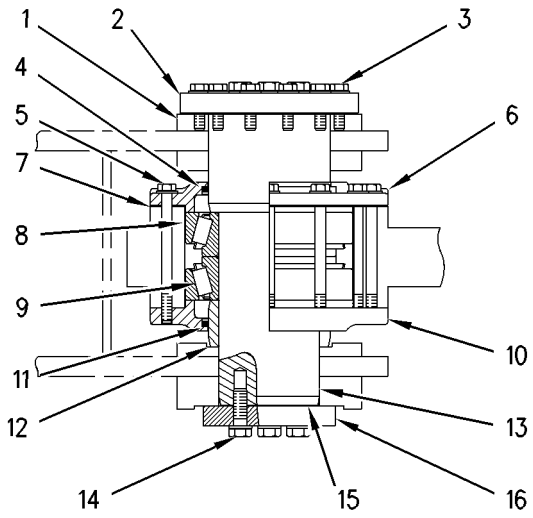


Illustration 32 g00859068

Upper Hitch Assembly

(1) Shim. (2) Retainer plate. (3) Bolt and washer. (4) Seal. (5) Bolt and washer. (6) Cap. (7) Shim. (8) Cup. (9) Cone. (10) Cap. (11) Seal. (12) Space. (13) Pin. (14) Bolt and washer. (15) Shim. (16) Retainer plate.

1. Apply 5P-3931 Anti-Seize Compound on the bearing bores in the frame.

2. Lubricate the sealing lips on seals (4) and (11) with 5P-0960 Molybdenum Grease. Position seals (4) and (11), and press the seals into bearing caps (6) and (10).

3. Cool bearing cups (8) to a temperature of −62° ± 10°C (−80° ± 18°F).

4. Position lower bearing cap (10), and retain lower bearing cap (10) in place. Use a second technician in order to retain lower bearing cap (10) in place.

5. Install lower bearing cup (8) into the bore of the housing. Drive the bearing cup downward in order to ensure contact with lower bearing cap (10).

6. Lubricate bearing cones (9) with oil and install the bearing cones.

7. Install upper bearing cup (8). Drive the bearing cup downward in order to ensure light contact pressure on the bearing cones.

8. Install shim (7), upper bearing cap (6), and three bolts (5). Install the bolts so that the bolts are 120° away from each other. Tighten the bolts by an equal amount.

9. Adjust the rolling torque in order to rotate the bearing cones. As required, use shims (7) to attain the correct amount of rolling torque. The rolling torque should be not less than 14.7 N·m (130 lb in). The rolling torque should not be greater than 32.8 N·m (290 lb in).

10. Install 12 bolts (5). Tighten the bolts to a torque of 300 ± 40 N·m (220 ± 30 lb ft).

Procedure to Install the Upper Hitch Pin

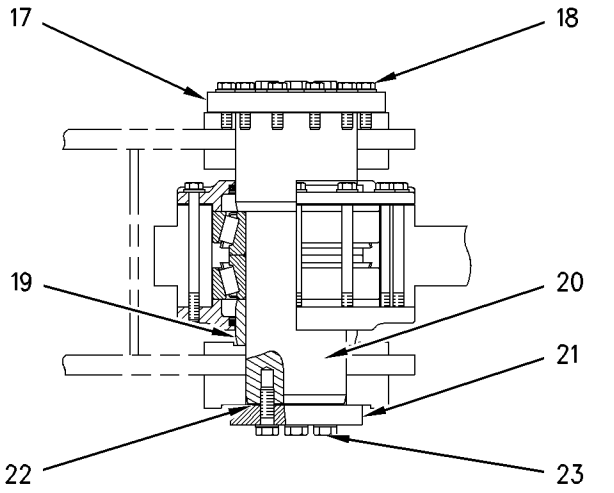


Illustration 33 g00859332

Upper Hitch Assembly

(17) Retainer plate. (18) Bolt and washer. (19) Spacer. (20) Pin. (21) Retainer plate. (22) Shim. (23) Bolt and washer.

1. Install spacer (19) into lower bearing cap.

2. Use two eyebolts in order to connect retainer plate (17) to pin (20). Use two bolts (18) to align plate (17). Cool upper hitch pin (20) to −62° ± 10°C (−80° ± 18°F). Align the bores in the upper hitch. Then insert the pin into the bores. Permit hitch pin to warm to ambient temperature.

3. Use three equally spaced bolts (23) and attach lower retainer plate (21) to hitch pin (20). Tighten the bolts.

4. Measure the gap between the bottom of pin (20) and retainer plate (21).

5. Remove plate (21). Then reassemble retainer plate (21) with a measured amount of shims (22). Tighten twelve bolts (19). Tighten six bolts (23) to 530 ± 70 N·m (390 ± 50 lb ft).

Procedure to Assemble the Lower Hitch Bearings

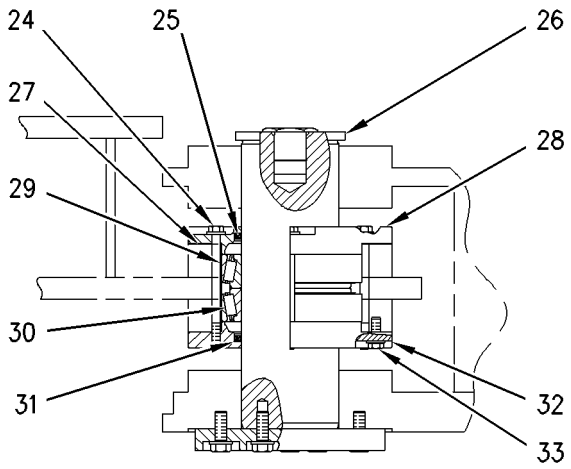


Illustration 34 g00859442

Lower Hitch Assembly

(24) Bolt and washer. (25) Seal. (26) Pin. (27) Shim. (28) Cap. (29) Cup. (30) Cone. (31) Seal. (32) Cap. (33) Bolt and washer.

1. Apply 5P-3931 Anti-Seize Compound on the bearing bores in the frame.

2. Lubricate the sealing lips on seals (25) and (31) with 5P-0960 Molybdenum Grease. Position seals (25) and (31), and press the seals into bearing caps (28) and (32).

3. Cool bearing cups (29) to a temperature of −62° ± 10°C (−80° ± 18°F).

4. Position lower bearing cap (32), and retain lower bearing cap (32) in place. Use a second technician in order to retain lower bearing cap (32) in place.

5. Install lower bearing cup (29) into the bore of the housing. Drive the bearing cup downward in order to ensure contact with lower bearing cap (32).

6. Lubricate bearing cones (30) with oil and install the bearing cones.

7. Install upper bearing cup (29). Drive the bearing cup downward in order to ensure light contact pressure on the bearing cones (30).

8. Install shim (27), upper bearing cap (28), and three bolts (24). Install the bolts so that the bolts are 120° away from each other. Tighten the bolts by an equal amount.

9. Adjust the rolling torque in order to rotate the bearing cones. As required, use shims (27) to attain the correct amount of rolling torque. The rolling torque should be not less than 2.26 N·m (20 lb in). The rolling torque should not be greater than 7.91 N·m (70 lb in).

10. Install six bolts (24). Then tighten the bolts.

Procedure to Install the Lower Hitch Pin

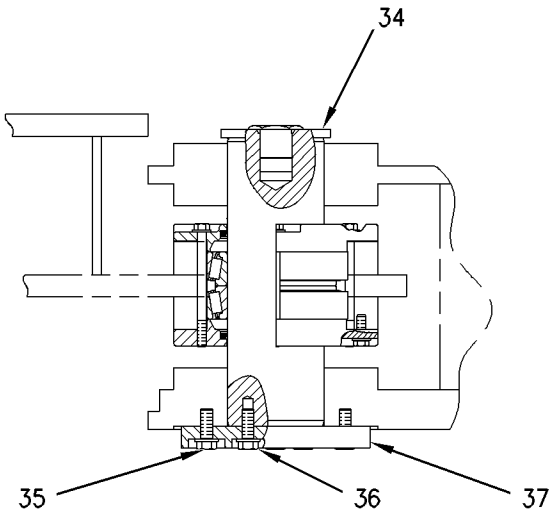


Illustration 35 g00859521

Lower Hitch Assembly

(34) Pin. (35) Bolt, washer, and spacer. (36) Bolt and washer. (37) Retainer plate.

1. Cool lower hitch pin (34) to −62° ± 10°C (−80° ± 18°F). Drop pin (34) into the bores of the hitch.

2. Attach retainer plate (37) to hitch pin (34) with four bolts (36). Use four bolts (35) to attach assembly to the frame. Tighten the bolts.

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RENR8818-01
January 2015

Specifications

990H Wheel Loader, and 844H Wheel Dozer
Braking System

BTW 1-Up (Machine)
BWX 1-Up (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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i02441164

Hydraulic Tank and Filter (Implement, Brake)

SMCS Code: 5056-II; 5056-BRK

Part No.: 237-4228

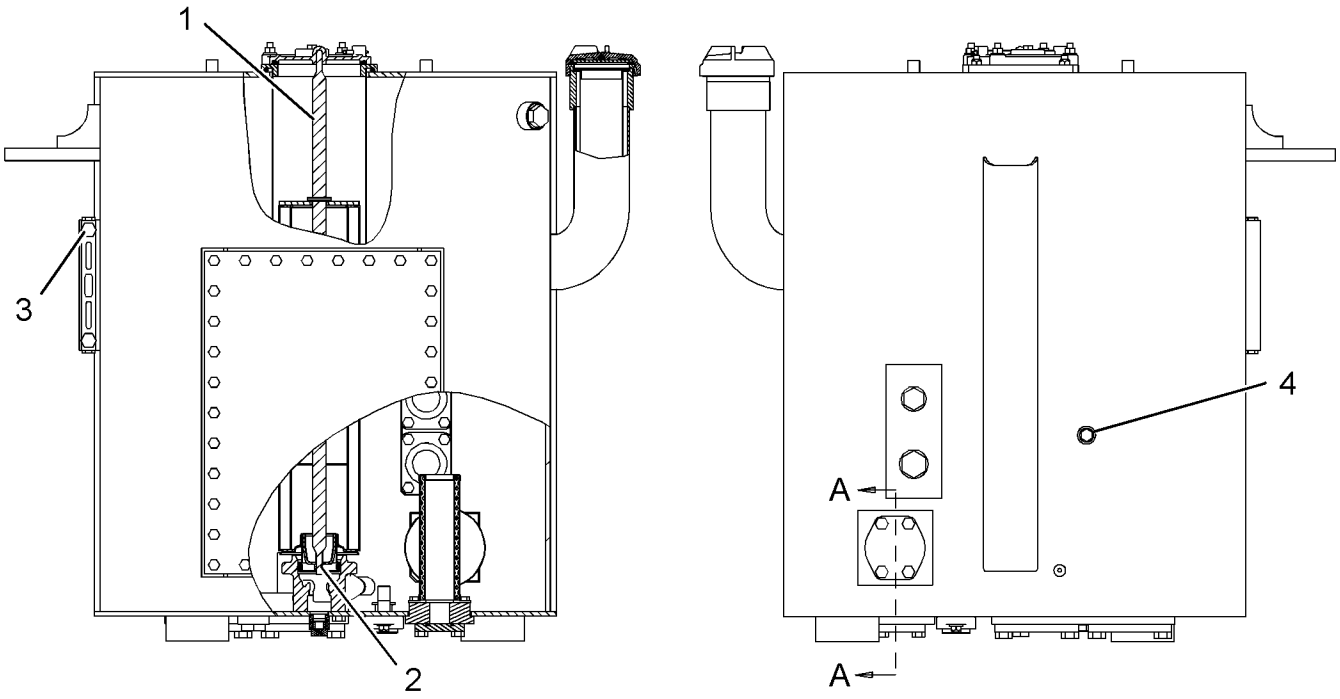


Illustration 1 g01181084

Front view and rear view

(1) Torque for the stud.....35 ± 5 N·m (26 ± 4 lb ft)

(2) Torque for the nut .....20 ± 1.5 N·m (15 ± 1 lb ft)

(3) Torque for the gauge bolts.....7 ± 1 N·m (60 ± 9 lb in)

(4) Use air in order to pressure test the tank. ..... 150 ± 35 kPa (22 ± 5 psi)

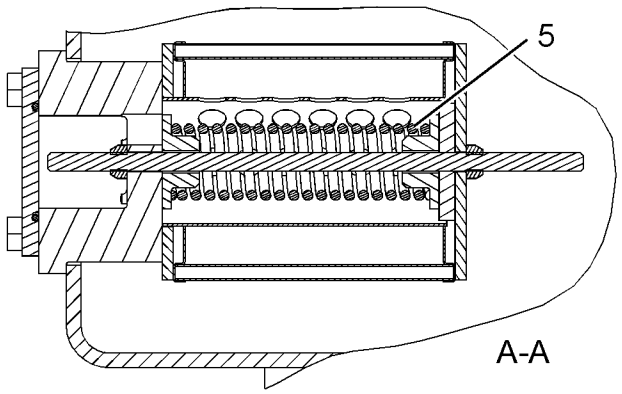


Illustration 2 g01181085

Section A-A

(5) 2M-6911 Spring

Length under test force ..... 137 mm (5.4 inch)
Test force.....1046 ± 45 N (235 ± 10 lb)
Free length after test ..... 228.6 mm (9 inch)
Outside diameter..... 49.3 mm (1.94 inch)

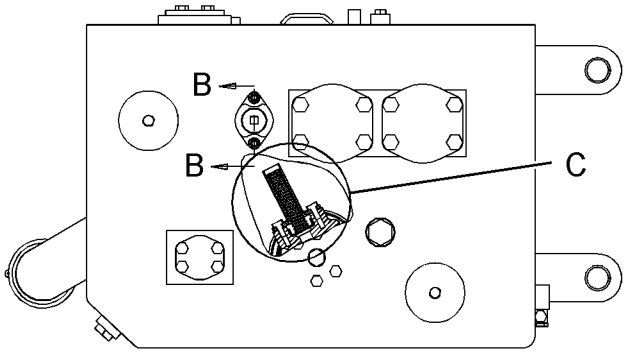


Illustration 3 g01181086

Bottom view

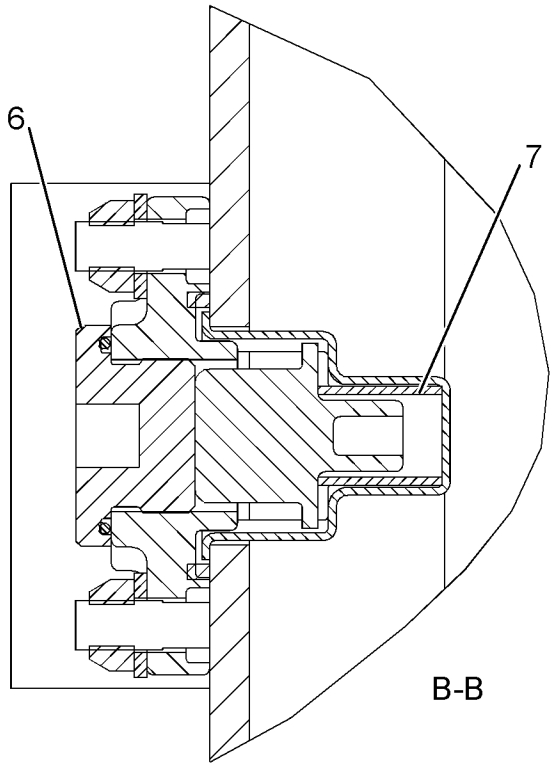


Illustration 4 g01181087

Section B-B

(6) Torque for the plug.....68 ± 7 N·m (50 ± 5 lb ft)

(7) 7B-3039 Spring

Length under test force ..... 26.19 mm (1.03 inch)
Test force.....15.55 ± 1.25 N (3.50 ± 0.3 lb)
Free length after test ..... 36.5 mm (1.44 inch)
Outside diameter..... 19.8 mm (0.78 inch)

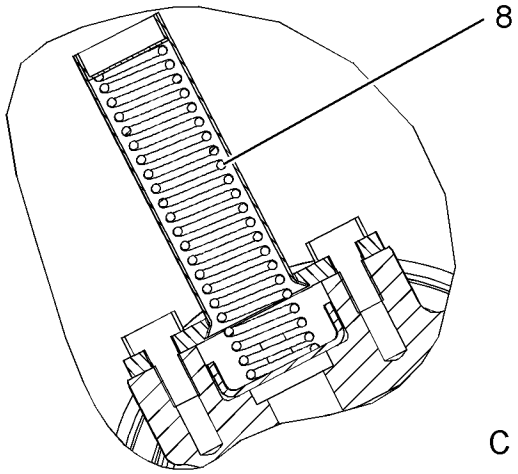


Illustration 5 g01181088

Section C

(8) 1L-4349 Spring

Length under test force ..... 106.0 mm (4.17 inch)
Test force..... 83.9 ± 6.7 N (19 ± 1.5 lb)
Free length after test ..... 139.7 mm (5.5 inch)
Outside diameter..... 24.41 mm (0.96 inch)

i02416689

Temperature Sensor (Implement, Brake Oil)

SMCS Code: 509T

Part No.: 134-2252

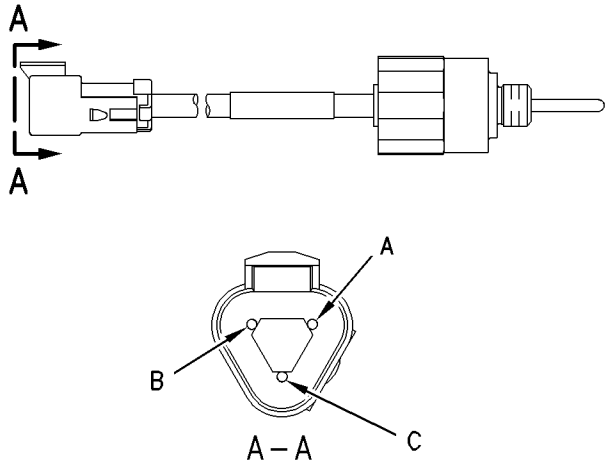


Illustration 6 g00887817

Table 1

Wiring Table		
Pin	**Function**	**Wire Color**
A	+ Battery	Orange
B	Ground	Black
C	Signal	White

Operating temperature ..... −40 to 120° C (−40 to 250° F)

Maximum current from the source ..... 7.4 mA

Operating supply voltage ..... 7.5 to 8.5 volts

Torque for the sensor..... 20 ± 3 N·m (15 ± 2 lb ft)

i02416348

Breaker Relief Valve

SMCS Code: 5118

Part No.: 220-0812
S/N: BTW1–Up

Part No.: 133-1963, 220-0812
S/N: BWX1–Up

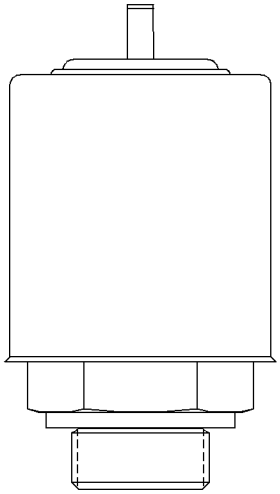


Illustration 7 g01207784

Breaker Relief Valve

133-1963

Vacuum relief cracking pressure ..... 0.0 to 2.00 kPa (0.0 to 0.30 psi)

Pressure relief cracking pressure..... 130 ± 20 kPa (19 ± 3 psi)

Temperature Range..... −40 to 121 °C (−40 to 250 °F)

Burst pressure ..... 620 kPa (90 psi)

220-0812

Vacuum relief cracking pressure ..... 0.0 to 2.00 kPa (0.0 to 0.30 psi)

Pressure relief cracking pressure..... 35 ± 7 kPa (5 ± 1 psi)

Burst pressure ..... 620 kPa (90 psi)

Temperature Range..... −40 to 121 °C (−40 to 250 °F)

i02365961

Gear Pump (Pilot, Brake)

SMCS Code: 4014-GT; 5073-P&B

Part No.: 230-0914

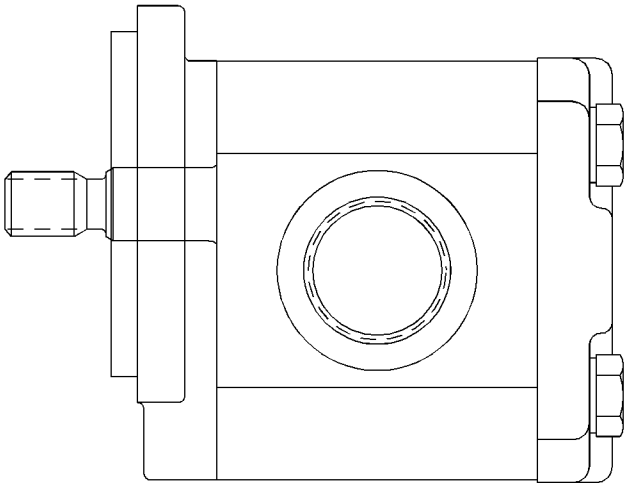


Illustration 8 g01181451

The rotation of the shaft is counterclockwise when the pump is viewed from the shaft end.

For testing purposes, use SAE 10 oil at 65°C (150°F) .

Test at full speed:

Output .....46 L/min (12 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed .....2040 rpm
Engine speed .....2000 rpm

Output .....44 L/min (11.5 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed .....2040 rpm
Engine speed .....2000 rpm

Test at half speed:

Output .....23 L/min (6 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed .....1020 rpm
Engine speed .....1000 rpm

Output .....22 L/min (5.8 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed .....1020 rpm
Engine speed .....1000 rpm

i02437913

Brake Accumulator

SMCS Code: 4263

Part No.: 219-2949, 219-8066

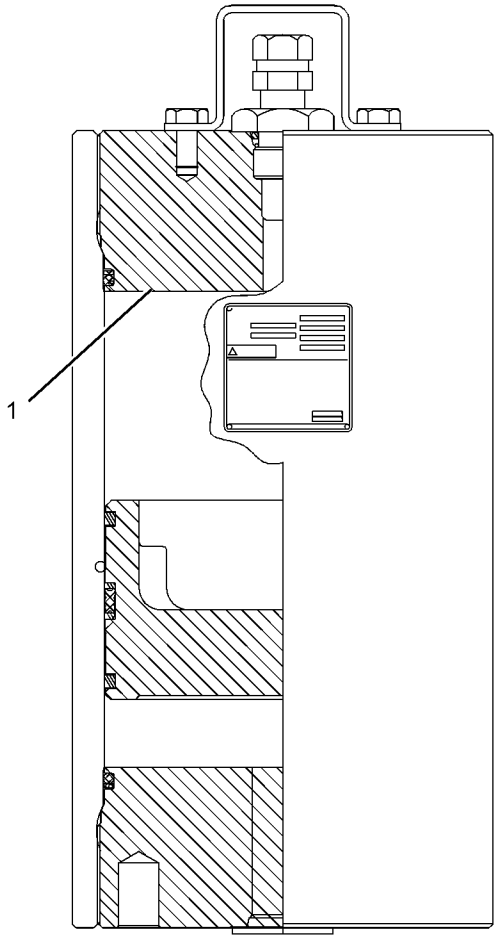


Illustration 9 g01218165

219-2949 Brake Accumulator (CHARGED)

Dry nitrogen precharge pressure at 70° F .....5520 ± 276 kPa (800 ± 40 psi)

The internal volume of the gas chamber ....5.7 L (6 qt)

Maximum operating pressure....20700 kPa (3000 psi)

Maximum operating temperature .....80 °C (176 °F)

Minimum operating temperature.....−40 °C (−40 °F)

(1) The torque for the head.....300 N·m (220 lb ft)

Note: The service replacement for the brake accumulator is 219-8066 Brake Accumulator (UNCHARGED).

i02419588

Combination Valve (Pilot, Brake)

SMCS Code: 5064-P&B

Part No.: 6E-6293, 9T-9551

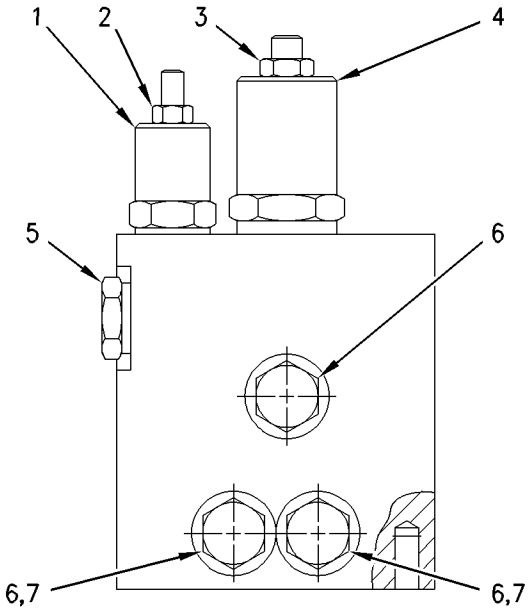


Illustration 10 g00845811

Cut-in pressure ..... 11800 kPa (1725 psi)

Cutout pressure ..... 14500 kPa (2125 psi)

(1) Torque for the 6E - 6293 Relief Valve ..... 61 ± 6 N·m (45 ± 4 lb ft)

(2) The torque for the locking nut..... 13 ± 2 N·m (115 ± 17 lb in)

(3) The torque for the locking nut..... 12 N·m (105 lb in)

(4) The torque for the unloading valve..... 88 N·m (65 lb ft)

(5) The torque for the shuttle valve..... 61 N·m (45 lb ft)

(6) The torque for the check valve..... 48 N·m (35 lb ft)

(7) Torque for the plug..... 14 N·m (10 lb ft)

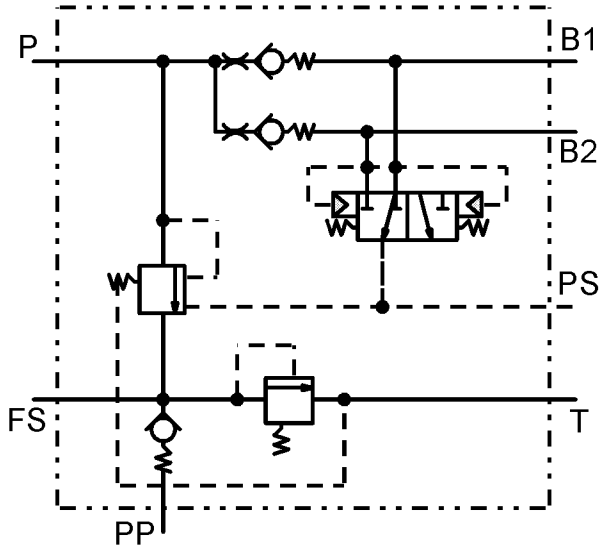


Illustration 11 g01209132

Schematic for Combination Valve

The table below identifies the ports in the combination valve.

Table 2

Ports	
FS	Fluid Sampling
PS	Press. Switch
PP	Pilot Supply
B1	Brake Accumulator 1
B2	Brake Accumulator 2
P	Pump
T	Tank

6E - 6293 Relief Valve (PILOT)

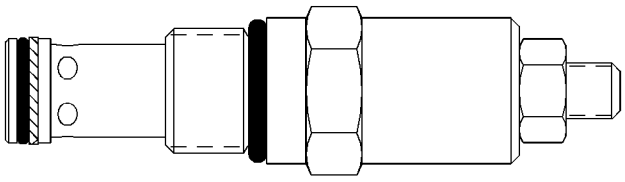


Illustration 12 g01209111

6E - 6293 Relief Valve

Pressure setting at 19 ± 2 L/min (5 ± 0.5 US gpm) at 49° ± 3°C (120° ± 5°F) ..... 2520 ± 70 kPa (365 ± 10 psi)

i04934575

Relief Valve (Brake System Backup)

SMCS Code: 5069-BRK

Part No.: 234-0351

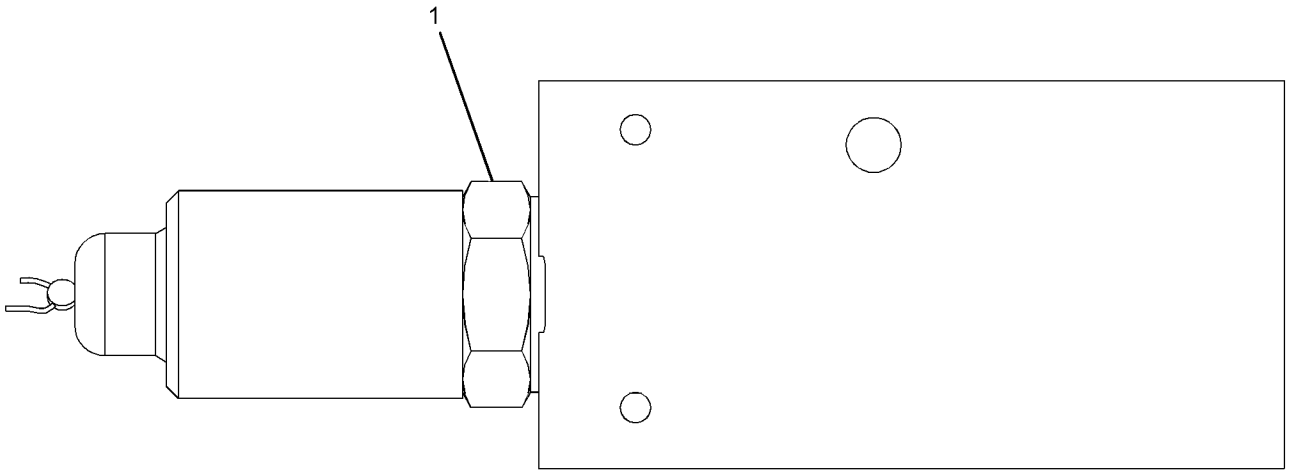


Illustration 13 g03106847

Table 3

Specification for 234-0351 Relief Valve Gp			
Item	**Qty**	**Part**	**Specification Description**
1	1	234-0352 Relief Valve Gp	Lubricate the bore lightly with the lubricant that is being sealed.
			Torque to 50 to 60 N·m (37 to 44 lb ft).

i02421808

Foot Brake Control

SMCS Code: 4269-FU

Part No.: 205-9236, 250-9458, 251-4629

Foot Brake Base (Left Hand Pedal)

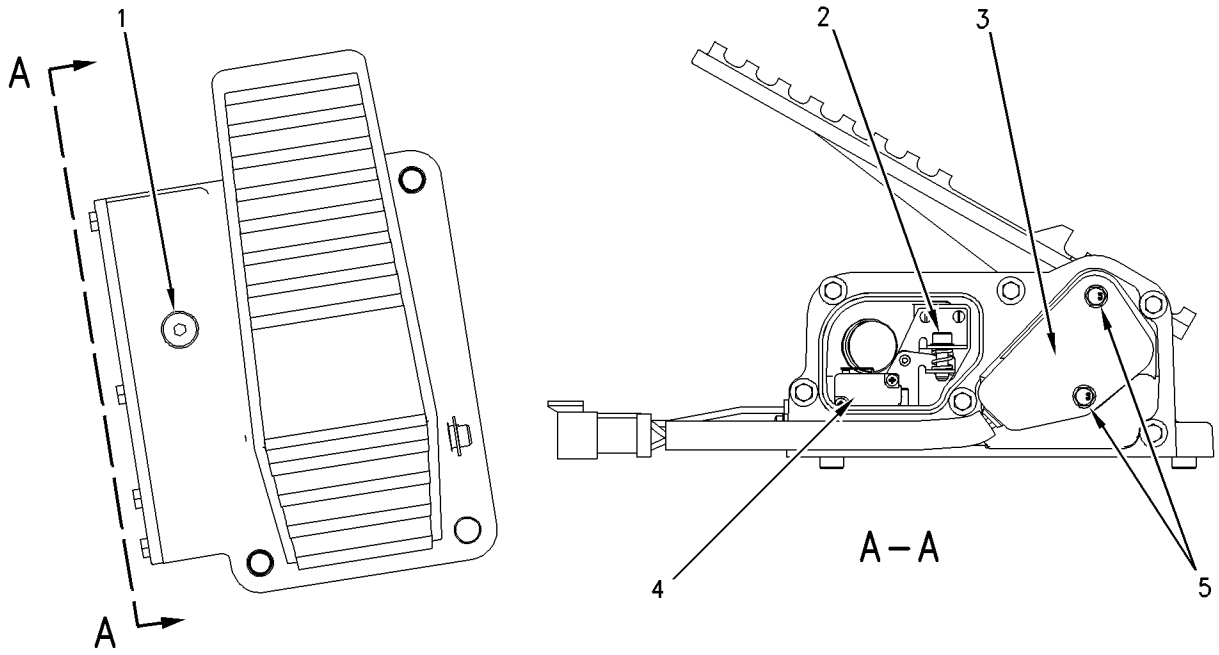


Illustration 14 g00928054

205-9236 Foot Brake Base (Left Hand Pedal)

(1) Plug. (2) Adjustment screw (stop light). (3) Position sensor. (4) Limit switch (stop light). (5) Mounting bolts.

(1) Torque for the plug.....7.6 ± 0.25 N·m (67 ± 2 lb in)

(5) Apply 4C-4030 Thread Lock Compound to the bolts prior to assembly. Torque for the two bolts .....2.25 ± 0.25 N·m (20 ± 2 lb in)

Foot Brake Base (Right Hand Pedal)

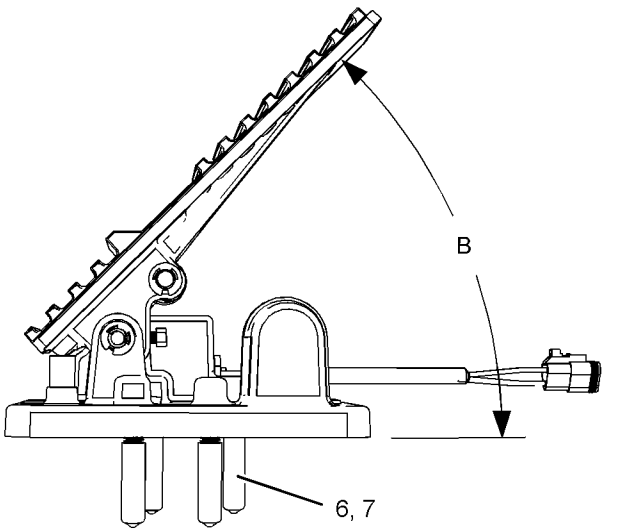


Illustration 15 g01148850

251-4629 Foot Brake Base (Right Hand Pedal)

(6) Apply 7M-7456 Bearing Mount Compound to the studs before assembling to the base of the cab (if equipped).

(7) Torque for the four studs .....17 ± 3 N·m (13 ± 2 lb ft)

(B) Angle of the foot brake pedal in the RELEASED position .....43 ± 1°

i04492190

Limit Switch (Stop Light)

SMCS Code: 4269-ZS

Part No.: 105-6117

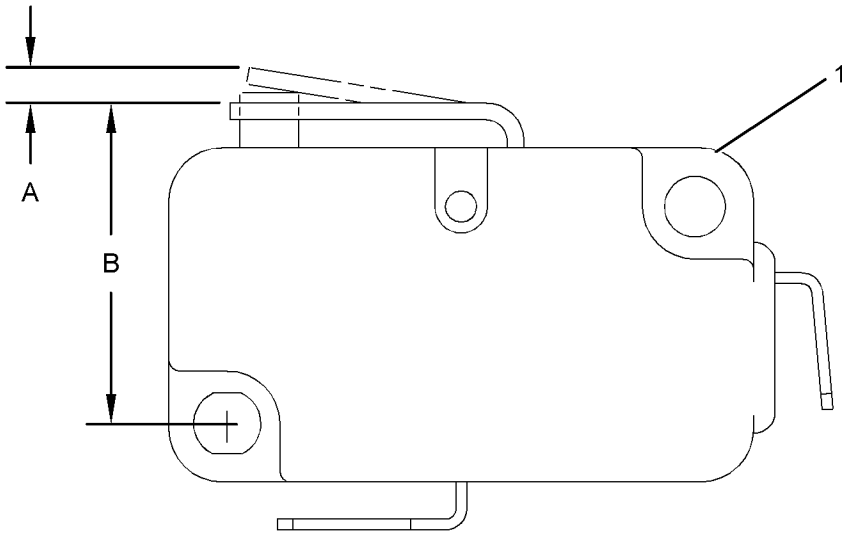


Illustration 16 g02673637

Reference: For additional information about adjusting the stop light limit switch, refer to the Service Manual module for Testing and Adjusting, “Limit Switch (Stop Light) - Adjust” for the machine that is being serviced.

Table 4

Specification for 105-6117 Limit Switch As (STOP LIGHT)			
Item	**Qty**	**Part**	**Specification Description**
A	-	-	Maximum pretravel is 1.52 mm (0.060 inch).
B	-	-	Operating dimension is 15.24 ± 0.51 mm (0.600 ± 0.020 inch).
1	1	105-6117 Limit Switch As	Maximum actuating force is 1.16 N (0.261 lb).
			The contacts “COM” and “N.C.” are normally closed.

i02894868

Position Sensor (Torque Converter Impeller Clutch) (Left Brake Pedal)

SMCS Code: 4269-PSN

Part No.: 214-4863

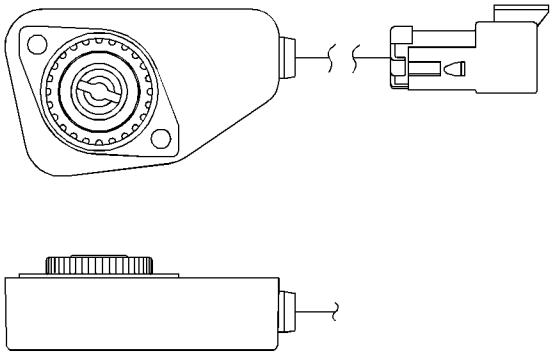


Illustration 17 g01440949

Tighten the two bolts (not shown) that hold the position sensor group to the brake control group to 2.25 ± 0.25 N·m (20 ± 2 lb in).

Operating temperature ... −40 to 85 °C (−40 to 185 °F)

Duty cycle ..... 4 to 97 %

Operating voltage (battery circuit) .....9 to 32 VDC

Operating voltage (regulated circuit) ....8.0 ± 0.4 VDC

Nominal supply current for sensor in a battery circuit ..... 17 mA

Nominal supply current for 8 volt sensor at low duty cycle output ..... 22 mA

Nominal output frequency ..... 500 Hz

Maximum current draw ..... 30 mA

High output voltage range at rated current for sensor in battery circuit ..... 3.5 to 10.0 VDC

High output voltage range at rated current for 8 volt sensor ..... 4.0 to 8.4 VDC

Maximum low output voltage at rated sink current ... 1 VDC

i02084341

Limit Switch (Throttle Lock Deactivation) (Right Brake Pedal)

SMCS Code: 4269-ZS

Part No.: 127-4988

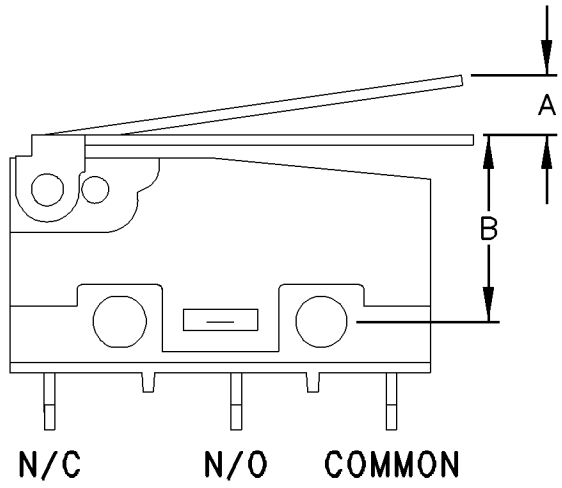


Illustration 18 g00870647

(A) Maximum pretravel ..... 2.8 mm (0.11 inch)

(B) Operating dimension..... 8.8 ± 0.8 mm (0.35 ± 0.03 inch)

Actuating force..... 1.4 N (0.32 lb)

Operating temperature range ..... −25° to 85°C (−14° to 185°F)

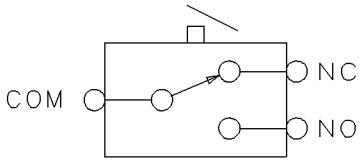


Illustration 19 g00870650

Note: The contacts “COMMON” and “N.C.” are normally closed.

i02891647

Brake Control Valve (Service)

SMCS Code: 4265

Part No.: 269-3289

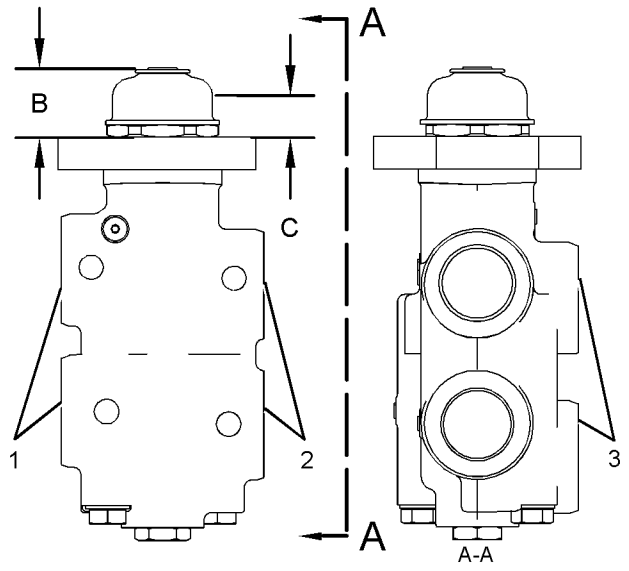


Illustration 20 g01440127

(1) Return ports to the hydraulic oil tank
(2) Supply ports from the brake accumulator charging valve
(3) Supply ports to the service brake

(B) Height of brake control valve group after installation.....31.8 mm (1.25 inch)

(C) Height of the brake control valve group with the service brake in the FULLY APPLIED position .....22.4 mm (0.88 inch)

Note: The output pressure of the upper port will be approximately 100 kPa (15 psi) higher than the output pressure of the lower port.

Service brake pressure.....4310 ± 350 kPa (626 ± 50 psi)

i03624255

Brake Control Valve (Parking)

SMCS Code: 4282

Part No.: 106-1774

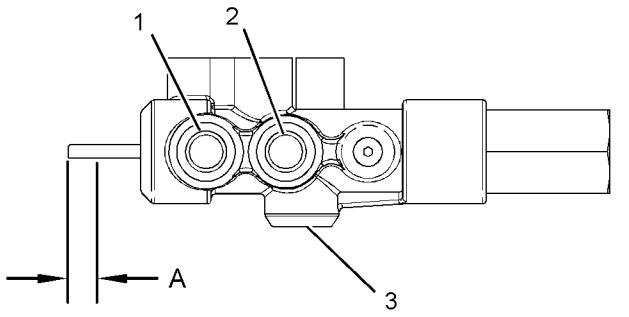


Illustration 21 g01440251

(1) Hydraulic oil return port
(2) Supply port for the brake actuator
(3) Supply port for the brake accumulator charging valve

(A) Travel of the rod .....8.6 mm (0.34 inch)

Maximum pressure difference between port (1) and port (3) for the automatic application of the parking brake.....2400 kPa (350 psi)

Note: The parking brake can be manually engaged and disengaged when the pressure in the system is above 10300 kPa (1495 psi). However, if the system pressure is below 10300 kPa (1495 psi), actuation force increases.

Note: The rod may be extended to the shown position when the tank pressure is above 690 kPa (100 psi).

i01318726

Pressure Switch (Parking Brake Oil)

SMCS Code: 1435-PX; 4284-ZS

Part No.: 174-4312

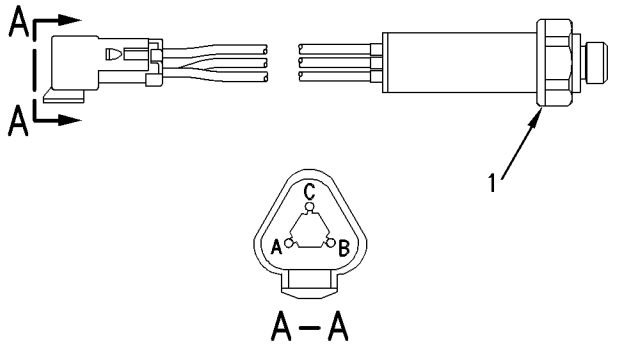


Illustration 22 g00292351

(1) Torque for the 174-4312 Pressure Switch ..... 48 ± 5 N·m (35 ± 4 lb ft)

(1) Torque for the 3E-6452 Pressure Switch ..... 40 ± 5 N·m (30 ± 4 lb ft)

Maximum actuation pressure at −40 to +120°C (−40 to +248°F) ..... 8300 kPa (1200 psi)

Deactuation pressure at −40 to +120°C (−40 to +248°F) ..... 6900 ± 345 kPa (1000 ± 50 psi)

Current draw at 28 VDC ..... 1.5 amperes

Contacts (A) and (C) are normally closed below the deactuation pressure of the pressure switch.

Contacts (A) and (B) are normally open below the deactuation pressure of the pressure switch.

i02889486

Limit Switch (Parking Brake)

SMCS Code: 4284-ZS

Part No.: 171-7085

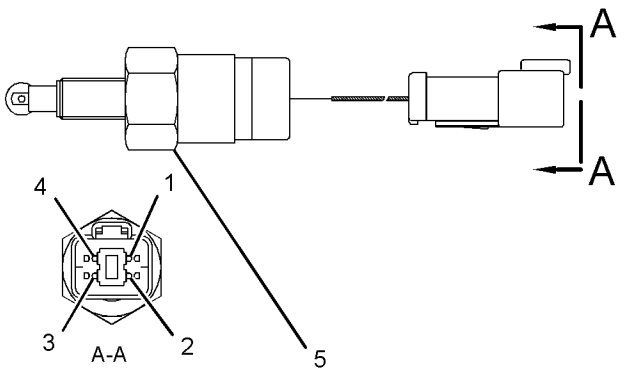


Illustration 23 g01438740

(5) Installation torque for the limit switch assembly ..... 9.5 N·m (85 lb in)

Actuating force ..... 45.5 ± 9.0 N (10.2 ± 2.0 lb)

Maximum force for overtravel ..... 89 N (20 lb)

Maximum voltage drop that is permitted across closed contacts

New contacts ..... 0.3 volts
Worn contacts ..... 0.5 volts

Operating temperature ..... −40 to 100 °C (−40 to 212 °F)

Contacts (1) and (2) are normally open.

Contacts (3) and (4) are normally closed.

i02420370

Service Brakes

SMCS Code: 4251

Part No.: 241-8930

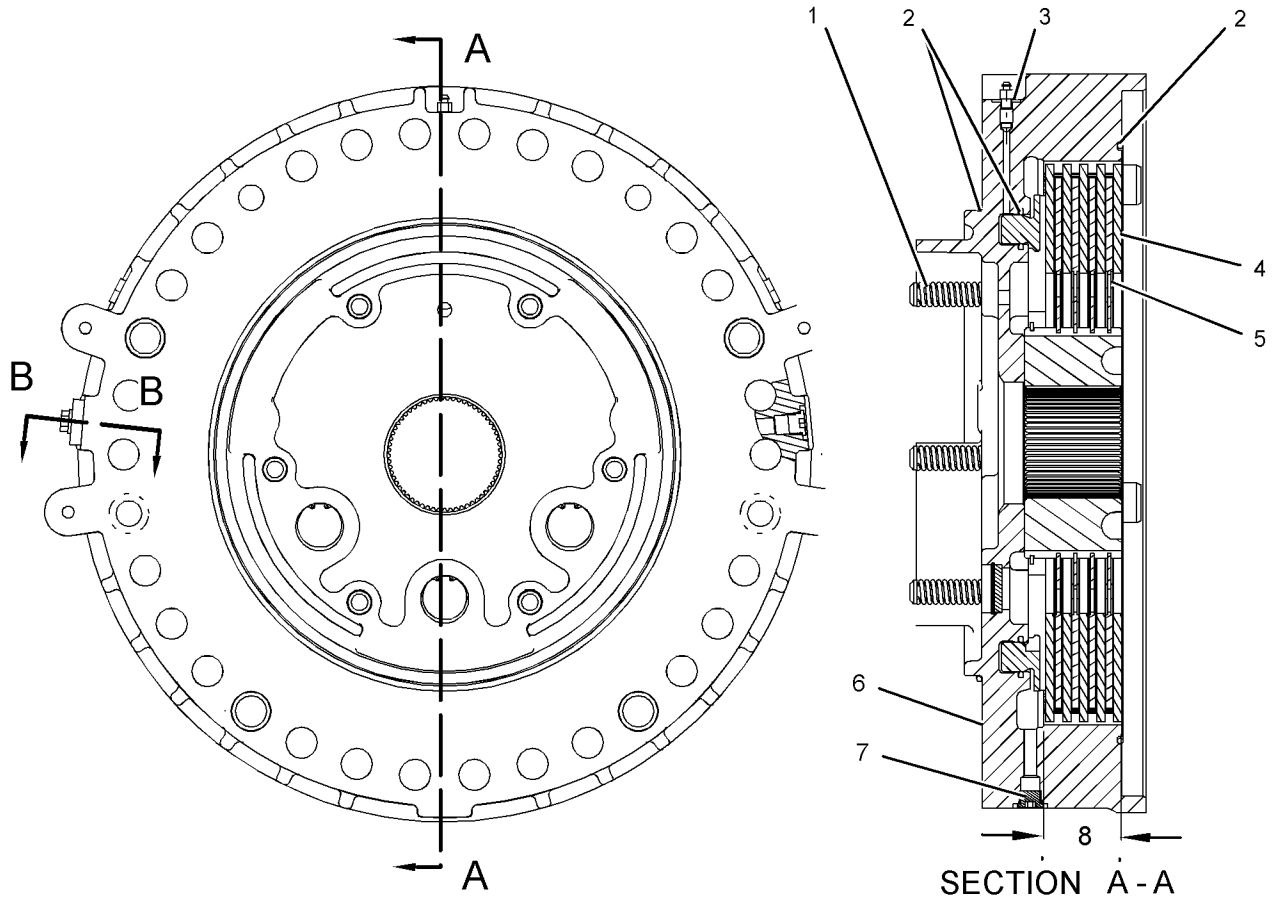


Illustration 24 g01209364

Service Brake

(1) Brake retracting spring
(3) Purge screw
(4) Outer plate
(5) Friction disc
(6) Brake anchor
(7) Plug

(1) 8V-3609 Brake Retracting Spring

Quantity ..... four
Length under test force ..... 86.4 mm (3.40 inch)
Test force ..... 715 N (161 lb)
Free length after test ..... 107.7 mm (4.24 inch)
Outside diameter ..... 20.42 mm (0.804 inch)

(2) Lubricate seals with the lubricant that is being sealed.

(3) Torque for the purge screw ..... 11 ± 4 N·m (8 ± 3 lb ft)

(4) 9U-1739 Outer Plate

Thickness of new outer plate ..... 7.30 ± 0.10 mm (0.287 ± 0.004 inch)
Minimum thickness of worn plate ..... 6.22 mm (0.245 inch)

(5) Thickness of a 9U-1738 Friction Disc

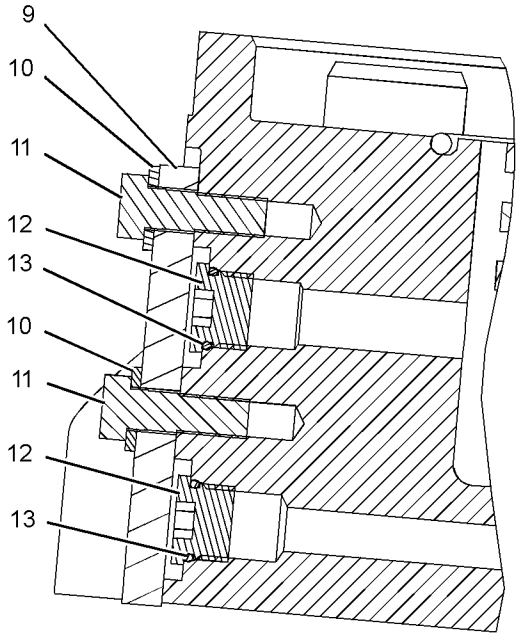
New disc ..... 6.10 ± 0.13 mm (0.240 ± 0.005 inch)
Worn disc (minimum thickness) ..... 4.88 mm (0.192 inch)

(6) Use 4C-4079 Brake and Electrical Cleaner (aerosol container) or 9U-6346 Component Cleaner (pump) to clean the brake anchor. Dry the brake anchor with a clean cloth. Apply 9S-3265 Compound to the mating surface of the brake anchor or to the thrust washer. Assemble the thrust washer and the brake anchor together.

(7) Torque for the plug ..... 70 ± 7 N·m (52 ± 5 lb ft)

(8) Brake Disc Pack

Thickness of five new outer plates and four new friction discs ..... 60.90 ± 1.02 mm (2.398 ± 0.040 inch)
Minimum worn thickness ..... 56.50 mm (2.224 inch)



SECTION B - B

Illustration 25 g01209852

(9) Plate
(10) Washer
(11) Bolt
(12) Plug
(13) O-ring seal

Assemble plate (9), bolts (11), washers (10), plug (12), and seals (13) as shown in Illustration 2 for use on the fixed axle, right side final drive. Use this configuration for the oscillating axle on the left side of the final drive.

For the fixed axle on the left side of the final drive and the oscillating axle on the right side of the final drive, install the assembly on the opposite port.

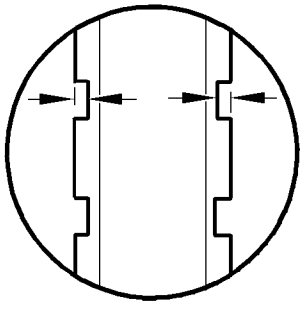


Illustration 26 g00478267

Measuring the depth of the grooves on the service brake disc

Note: In order to check a friction disc for wear, measure the disc thickness and measure the groove depth in the friction material. The minimum groove

depth in a friction disc must be at least 0.32 mm (0.013 inch).

At assembly, dip the friction discs in lubricant that is used in the final drive.

Reference: For additional information on measuring the thickness of a disc and groove, refer to the Service Manual module for Testing and Adjusting, “Service Brake Discs - Check” for the machine that is being serviced.

i02291199

Parking Brake Control

SMCS Code: 4284

Part No.: 242-1902

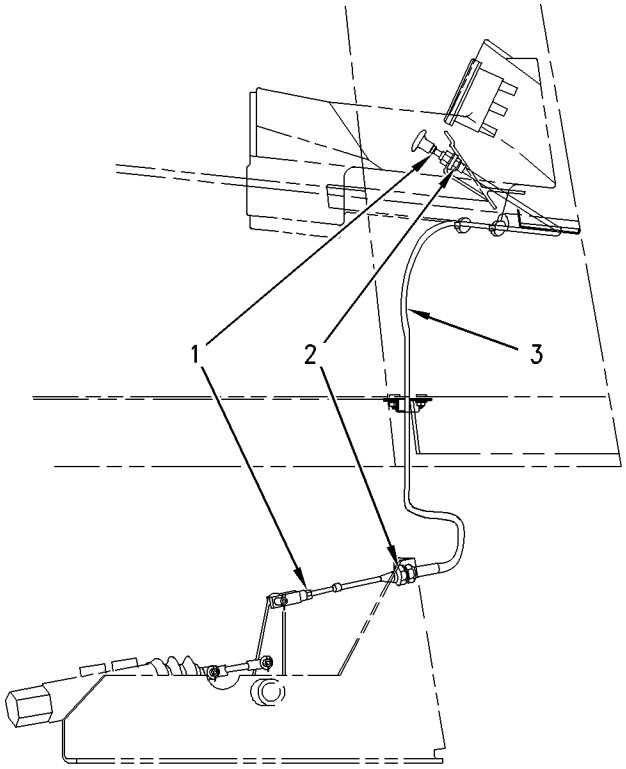


Illustration 27 g00848015

(1) The torque of the locking nuts on the ends of the cable assembly.....8 ± 3 N·m (6 ± 2 lb ft)

(2) Installation torque of the four bulkhead nuts .....38 ± 7 N·m (28 ± 5 lb ft)

(3) Overall length of the 251-4738 Cable Assembly ..... 2762 ± 6 mm (108.7 ± 0.2 inch)

i02113142

Parking Brake

SMCS Code: 4267

Part No.: 170-4618
S/N: BTW1–177

Part No.: 170-4618
S/N: BWX1–434

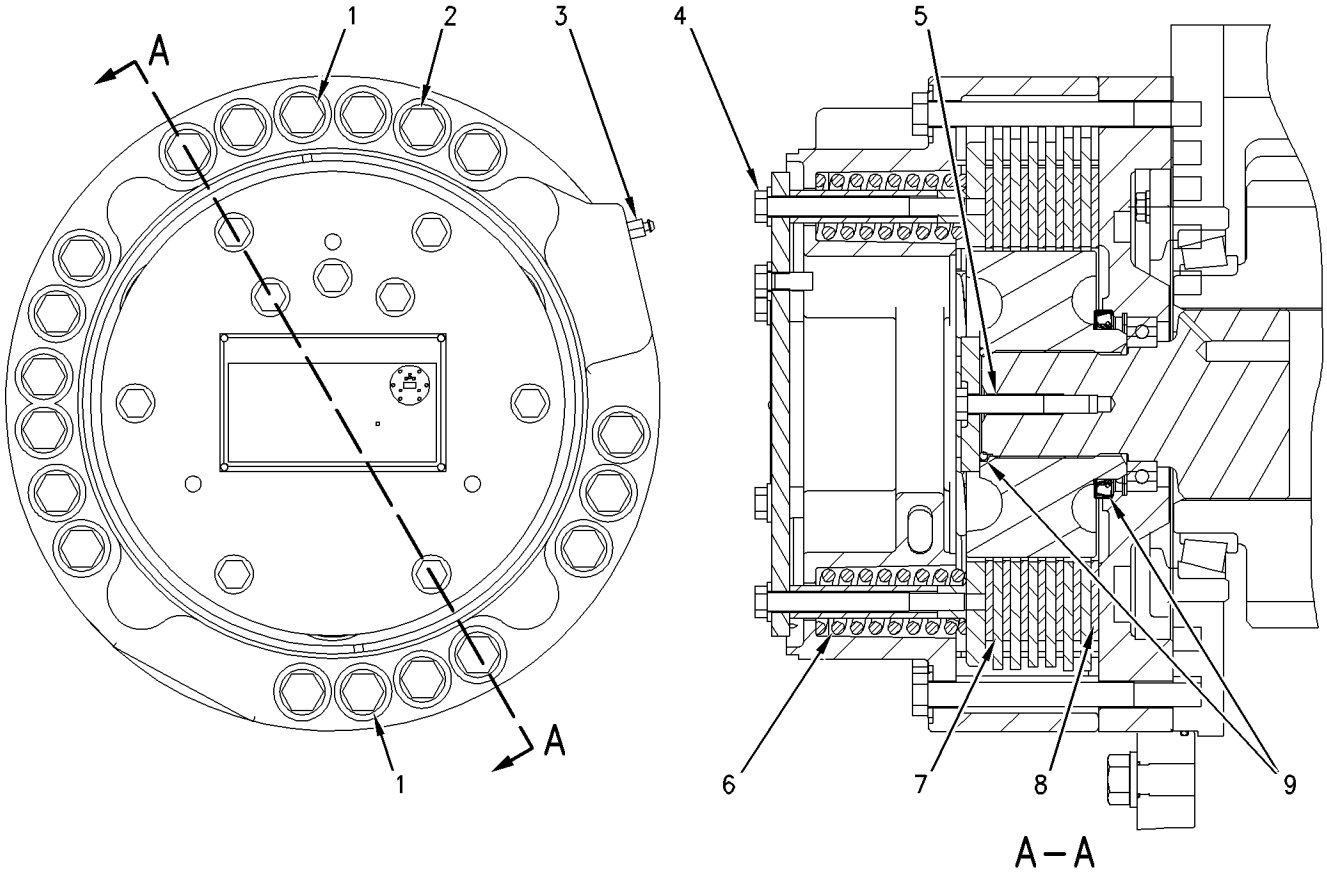


Illustration 28 g00848305

The maximum slope for the parking brake to hold ..... 30 degrees

(1) The two bolts that are located next to the notches in the housing are used to assemble the package.
Torque for the two bolts ..... 270 ± 40 N·m (200 ± 30 lb ft)

(2) The torque for the seventeen bolts ..... 270 ± 40 N·m (200 ± 30 lb ft)

(3) The torque for the purge screw ..... 11 ± 4 N·m (97 ± 35 lb in)

(4) The torque for the six retaining plate bolts ..... 105 ± 20 N·m (77 ± 15 lb ft)

(5) The tightening torque for the bolt ..... 105 ± 20 N·m (77 ± 15 lb ft)

(6) Nine 169-4670 Springs

Length under test force ..... 99.2 mm (3.9 inch)
Test force ..... 3885 ± 190 N (875 ± 43 lb)
Free length after test ..... 125 mm (4.9)
Outside diameter ..... 43 mm (1.7 inch)

(7) The thickness of one of six new 172-0844 Clutch Plates ..... 6.66 ± 0.08 mm (.262 ± .003 inch)

(8) 1V-8279 Brake Disc

The thickness of one of seven new discs ..... 4.95 ± 0.08 mm (.195 ± .003 inch)
The recommended replacement thickness of a worn disc ..... 4.50 mm (.177 inch)

(9) Lubricate all seals with a minimal amount of the lubricant that is being sealed prior to installation.

i06044964

Parking Brake

SMCS Code: 4267

Part No.: 294-7730
S/N: BTW178–Up

Part No.: 294-7703
S/N: BWX435–Up

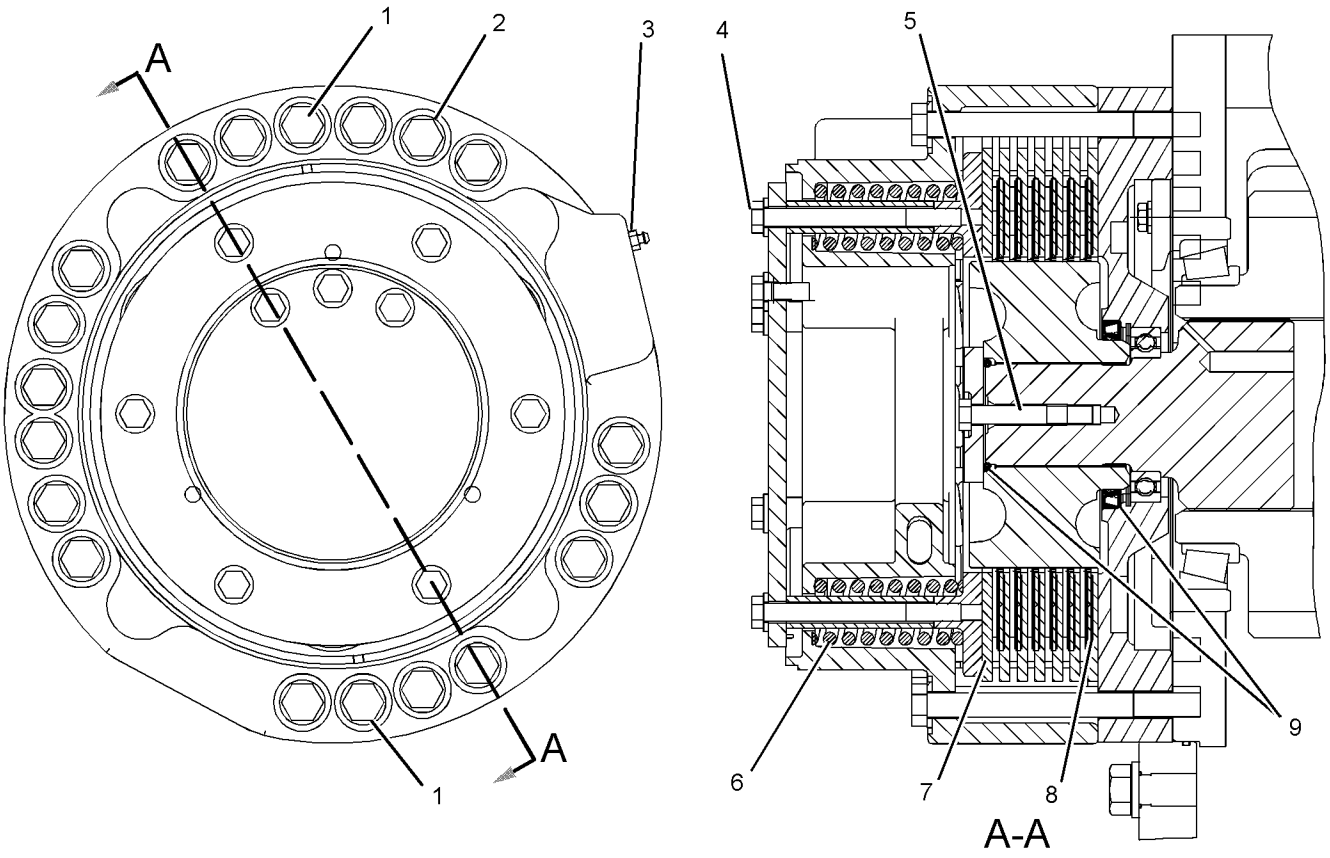


Illustration 29 g03787573

The maximum slope for the parking brake to hold ..... 30 degrees

(1) The two bolts that are located next to the notches in the housing are used to assemble the package.
Torque for the two bolts ..... 270 ± 40 N·m (200 ± 30 lb ft)

(2) The torque for the seventeen bolts ..... 270 ± 40 N·m (200 ± 30 lb ft)

(3) The torque for the purge screw ..... 11 ± 4 N·m (97 ± 35 lb in)

(4) The torque for the six retaining plate bolts ..... 105 ± 20 N·m (77 ± 15 lb ft)

(5) The tightening torque for the bolt ..... 105 ± 20 N·m (77 ± 15 lb ft)

(6) Nine 169-4670 Springs

Length under test force ..... 99.2 mm (3.9 inch)
Test force ..... 3885 ± 190 N (875 ± 43 lb)
Free length after test ..... 125 mm (4.9)
Outside diameter ..... 43 mm (1.7 inch)

(7) The thickness of one of seven new 172-0844 Clutch Plates ..... 6.66 ± 0.08 mm (.262 ± .003 inch)

(8) 1V-8279 Brake Disc

The thickness of one of six new discs ..... 4.95 ± 0.08 mm (.195 ± .003 inch)
The recommended replacement thickness of a worn disc ..... 4.50 mm (.177 inch)

(9) Lubricate all seals with a minimal amount of the lubricant that is being sealed prior to installation.

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RENR8819-01 (en-us)
August 2018

Systems Operation

990H Wheel Loader and , 844H Wheel Dozer
Braking System

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

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General Information

SMCS Code: 4250

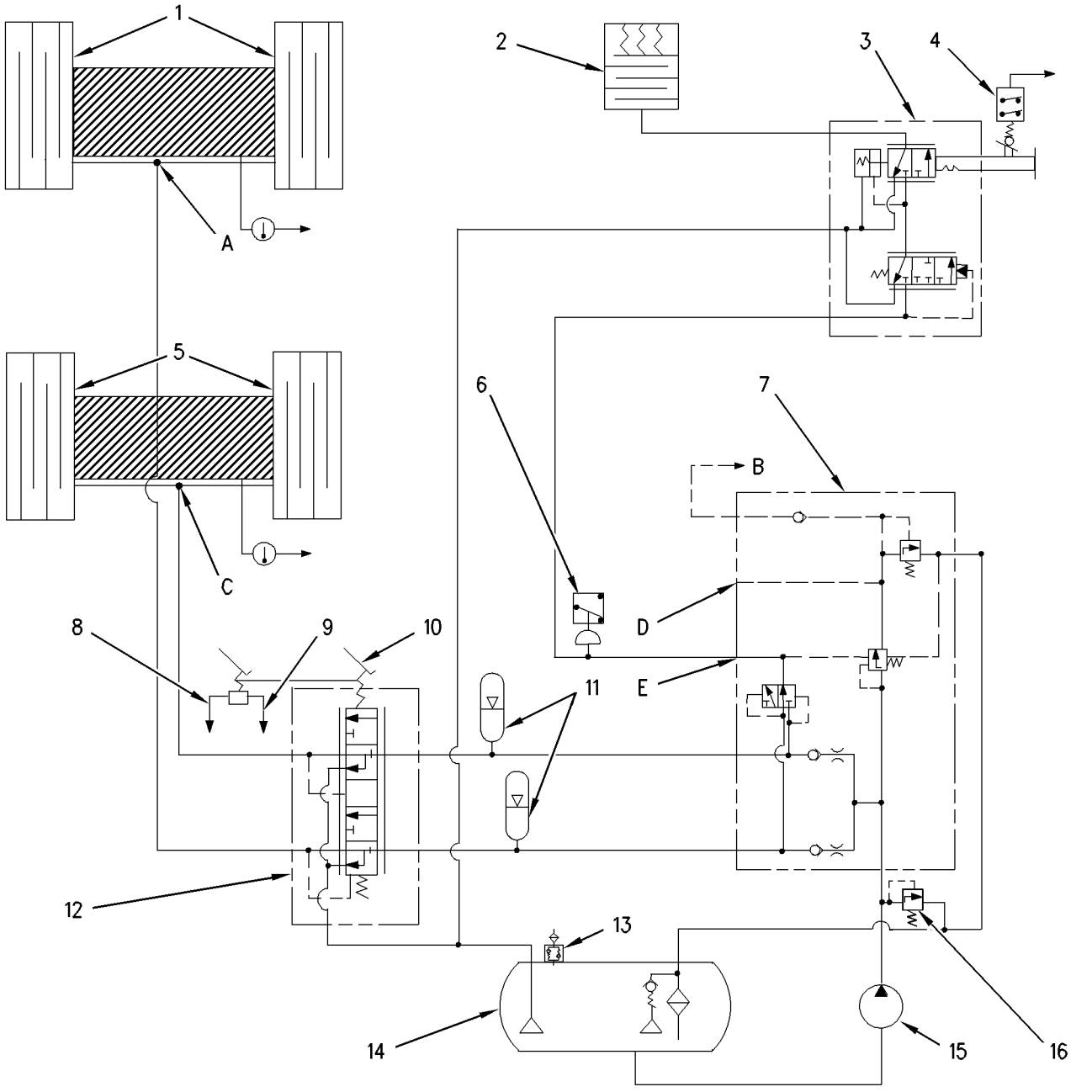


Illustration 1 g00861098

(1) Front service brakes
(2) Parking brake
(3) Brake control valve (Parking)
(4) Limit switch (Parking brake)
(5) Rear service brakes
(6) Pressure switch (Parking brake oil)
(7) Combination Valve
(8) Limit switch (Stop light)
(9) Left pedal position sensor
(10) Foot brake control
(11) Brake accumulator
(12) Brake control valve (Service)

(13) Breaker relief valve
(14) Hydraulic tank and filter (Implement and braking)
(15) Gear pump (Pilot and braking)
(16) Relief valve (Braking system)
(A) Pressure test point
(B) Implement system pilot control valve
(C) Pressure test point
(D) Fluid sampling port
(E) Pressure test point for the accumulator

The 844H Wheel Dozer and the 990H Wheel Loader have two separate hydraulic systems. One system supplies pressure to the hydraulic fan and the steering systems. The other system supplies pressure to the braking and implement systems. The braking and implement systems share the same hydraulic oil tank. Pressure for the brake system and the implement system is supplied from two different pumps.

Oil is supplied to the brake system by gear pump (15). The pump also supplies pressure to the implement pilot system. If the oil pressure is 21000 ± 500 kPa (3046 ± 72.5 psi), system relief valve (16) will divert the flow of oil to the hydraulic tank. The oil is diverted into a front brake circuit and a rear brake circuit by combination valve (7). The oil is also supplied to service brake control valve (12) and parking brake control valve (3).

Nitrogen charged accumulators (11) in the service brake circuits will fill with the oil until the pressure of 14662 kPa (2127 psi) is reached. Pressure oil will then be diverted from the accumulators to the implement pilot system.

Check valves in combination valve (7) prevent the oil from flowing back through the valve. A flow control valve in the combination valve will control the maximum oil pressure to the accumulators if the charging valve spool does not work correctly.

Service brake control valve (12) is in the circuit between the accumulator and the service brakes. When either brake pedal is pushed, oil from the accumulator flows to the service brake at each wheel through service brake control valve (12). The heat from the friction of the brakes is removed by the oil in the final drive housing. After the brakes have been applied several times, there is a smaller volume of oil in the accumulator which allows the pressure to drop. When the pressure drops to 11902 kPa (1726 psi), combination valve (7) diverts oil from pump (15) to accumulators (11) until the pressure again rises to cutoff pressure.

The application of pressure to either foot brake pedal (10) will apply pressure to the service brakes. The application of any pressure to the right foot brake pedal will also disengage the throttle lock. The application of light pressure to the left foot brake pedal will limit the drive train torque by limiting the impeller clutch pressure. Limiting impeller clutch pressure will provide more engine power for use in the hydraulic system. Additional pressure on the left pedal will also actuate the service brake at each wheel.

Parking brake (2) is engaged by the force of the springs. Oil pressure disengages the parking brake. When the brake system pressure is low, the parking brake will be engaged. To manually disengage the parking brake, follow the directions that are on the retaining plate on the brake housing.

The parking brake circuit will receive pump flow from the service brake circuit with the lowest pressure through a shuttle valve within combination valve (7). When parking brake control valve (3) is moved to the RELEASE position, the system pressure will disengage the parking brake.

Parking brake limit switch (4) will indicate whether the parking brake is engaged or disengaged. The following conditions will cause the alert indicator light on the Caterpillar Monitoring System to flash:

- The engine is running.
- The parking brake is engaged.
- The transmission is in neutral.

The alert indicator will go out when the parking brake is disengaged.

The following conditions will turn on the action light on the Caterpillar Monitoring System:

- The engine is started.
- The parking brake is engaged.
- The transmission is IN GEAR.

The action alarm will also sound a steady tone. Under these conditions, the machine should be stopped immediately.

i02425059

Monitoring System (Brake Functions)

SMCS Code: 7451; 7490

Caterpillar Monitoring System

This machine is equipped with the Caterpillar Monitoring System EMS-III. The Caterpillar Monitoring System includes the following components: an action alarm, an action lamp, a monitoring panel with ten alert indicators for the numerous machine systems, a tachometer and a gauge display. The system continuously monitors the numerous machine systems. The alert indicators show any abnormal condition of the machine.

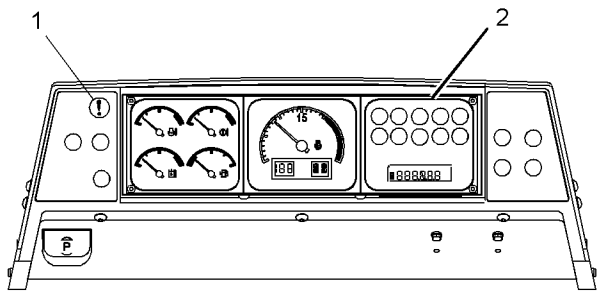


Illustration 2 g01212116

(1) Action lamp
(2) Monitoring System Display

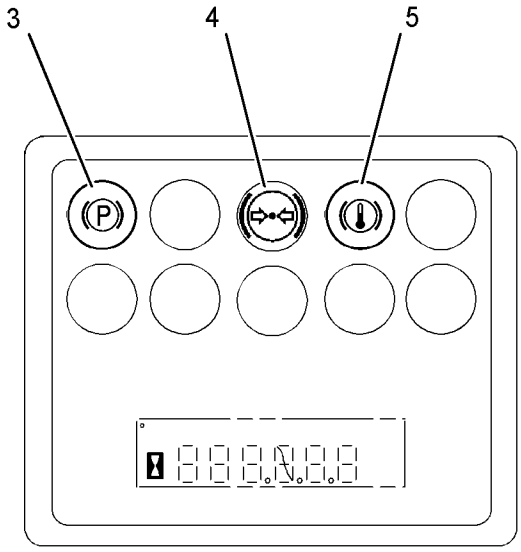


Illustration 3 g01212462

Monitoring System Display

(3) Parking brake indicator
(4) Brake pressure indicator
(5) Brake oil temperature warning indicator

When an abnormal condition exists, alert indicator (1) FLASHES. Also, an indicator lamp in the monitoring system display (2) will illuminate. The action alarm will sound during 2S and 3 warnings.

Warning Levels

The Caterpillar Monitoring System provides four warning categories. The categories are based on the severity of the problem. The categories dictate the required response of the operator.

Table 1

WARNING LEVELS	
Warning Category	**Description**
1	Corresponding alert indicator illuminates (constant).
2	Action lamp flashes, corresponding alert indicator illuminates (constant).
2S	Action alarm sounds (constant), the action lamp flashes, the corresponding alert indicator illuminates (constant).
3	Action alarm sounds (pulsing), the action lamp flashes, the corresponding alert indicator illuminates (constant).

Warning Category 1

For the brake system, when a Warning Category 1 occurs, the monitoring system activates parking brake indicator (3). Parking brake indicator will illuminate when the operator starts the engine.

A Warning Category 1 will occur in the following situation:

- The parking brake is in the ENGAGED position, and the transmission is in the NEUTRAL position. The engine may be ON or OFF.

Parking brake indicator (3) for the parking brake will turn OFF when the parking brake is moved to the DISENGAGED position.

Warning Category 2

For the brake system, when a Warning Category 2 occurs, the monitoring system activates the alert indicator and the action lamp will flash.

A Warning Category 2 will occur in the following situation:

- The parking brake is ENGAGED. The engine is OFF. The transmission is in FORWARD or REVERSE.
- The brake oil temperature is greater than 100 °C (212 °F) with either engine ON or OFF.
- The brake accumulator pressure is LOW with engine OFF.

A Warning Category 2 needs operator response to the problem.

Warning Category 2-S

A Warning Category 2-S activates the alert indicator and the action lamp will flash . The action alarm also makes a constant sound. The Warning Category 2-S is a severe condition. The operator should immediately change operating procedures in order to prevent damage to the machine. When the correct measures have been taken, the alarm will stop. A Warning Category 2-S is logged.

A Warning Category S-2 will occur when the following situation arises:

- The operator selects a FORWARD or REVERSE position while the engine is running and the parking brake is engaged.

Warning Category 3

For the brake system, when a Warning Category 3 occurs, the monitoring system causes one or more alert indicators to turn ON. The monitoring system activates the alert indicator and the action lamp will flash. The action alarm also makes a pulsating sound.

A Warning Category 3 will occur when the following situation arises:

- There is a loss of brake accumulator oil pressure with the engine ON.

When a Warning Category 3 occurs during machine operation, stop the machine immediately and engage the parking brake. Stop the engine. Investigate the cause of the warning before returning the machine to service.

Monitoring Brake Functions

Table 2

Parameter	Warning Criteria	Warning Level Category	
		Engine OFF	Engine ON
Parking Brake ENGAGED	Machine in NEUTRAL	1	1
	Machine in FORWARD or REVERSE	2	2S
Axle temperature (High)	Differential oil reaches 100 °C (212 °F).	2	2
Brake Pressure (Low)	Brake accumulator pressure (Low)	2	3

Note: When the temperature of the differential oil drops below 95 °C (203 °F), the action lamp and the brake oil temperature warning indicator will turn OFF.

Reference: For more information about the Caterpillar Monitoring System, refer to Service Manual, SENR1394, “Caterpillar Monitoring System” for the machine that is being serviced.

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Gear Pump (Pilot, Brake)

SMCS Code: 4014-GT; 5073-P&B

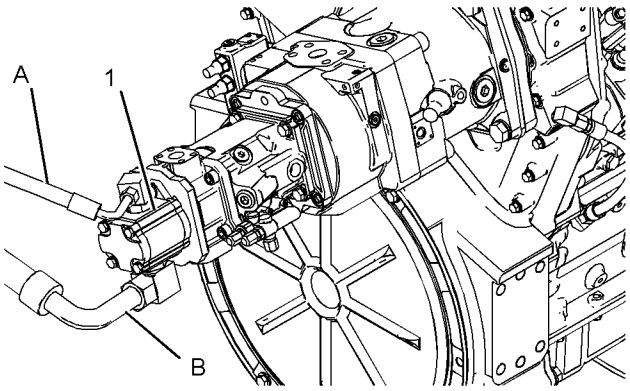


Illustration 4 g01215871

Gear pump (left side view)

(A) Outlet (high pressure)
(B) Inlet (low pressure)
(1) Pilot/brake pump

Pilot/brake pump (1) is a fixed displacement external gear pump. The pump supplies pressure to the hydraulic brake system and pilot pressure for the implement system. When the pump is viewed from the drive end, the pump shaft rotates in a counterclockwise direction.

Pilot/brake pump (1) is mounted on the upper center of the torque converter between the steering pump and the implement pump. The pumps are located behind the cab under the floorplate.

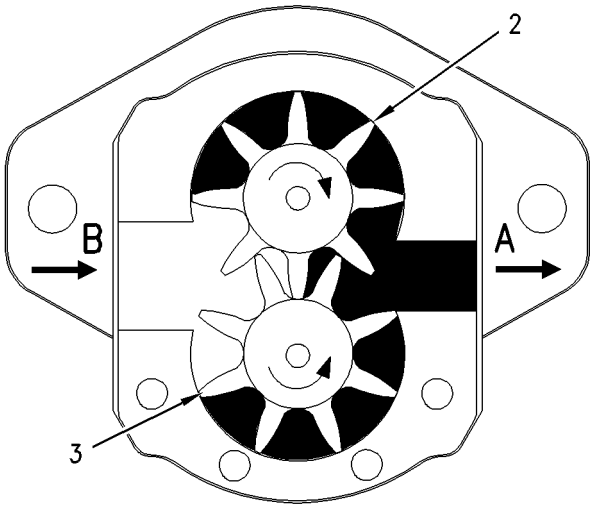


Illustration 5 g00850745

Operation of Typical Fixed Displacement External Gear Pump

(2) Drive gear
(3) Idler gear
(A) Outlet (High pressure)
(B) Inlet (Low pressure)

A gear pump carries oil from inlet port (B) to outlet port (A) in the spaces between the gear teeth.

The drive shaft turns drive gear (2). The drive gear forces idler gear (3) to rotate. When the gear teeth separate, a partial vacuum is formed. Oil fills the spaces between the teeth in inlet port (B). The gears carry oil around the circumference of the pump to outlet port (A). A seal is formed by the gear teeth against the pump housing. Oil is forced out of the spaces between the gear teeth as the gear teeth mesh together at outlet port (A). Oil will not return to inlet port (B) because the meshing of the gears will fill the spaces between the gear teeth.

The volume of oil that is supplied by the pump is controlled by the rate of rotation of the shaft.

i01646708

Brake Accumulator

SMCS Code: 4263

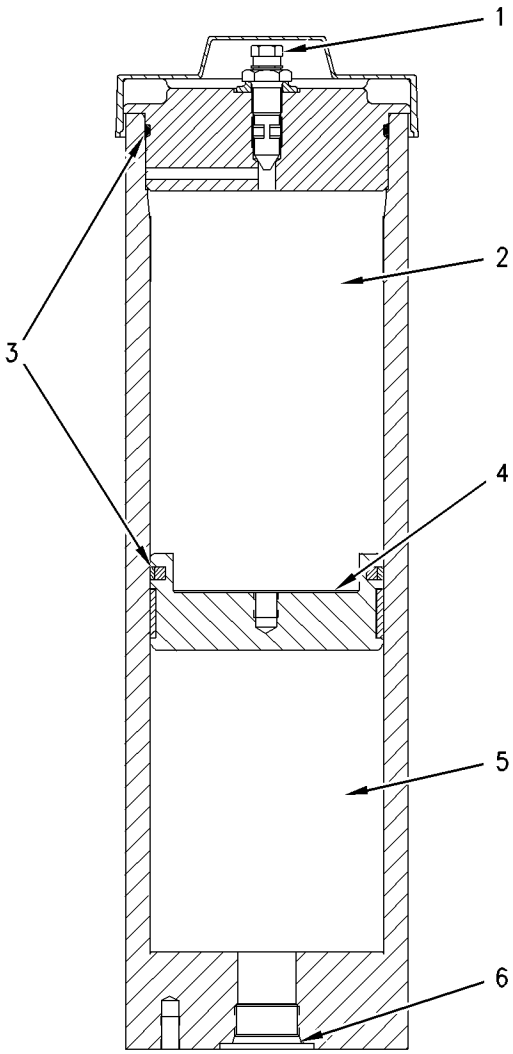


Illustration 6 g00851010

Brake Accumulator

(1) Nitrogen charging valve
(2) Nitrogen gas charge
(3) Seal kit
(4) Piston
(5) Pressure oil chamber
(6) Pressure port

Accumulators provide a way to store the pressure oil in the hydraulic circuit. The accumulator will supply the pressure oil to the circuit on demand.

In the brake system, there is an accumulator on both the front and rear service brake circuits. The accumulators provide pressure for the service brakes, the parking brake, and the implement pilot system.

Piston (4) moves up and down inside the bore of each accumulator. Nitrogen gas (2) has a charge of approximately 5520 kPa (800 psi). Each accumulator is charged with nitrogen through charging valve (1).

Oil enters pressure oil chamber (5) from the brake pump. The oil reaches the pressure oil chamber through outlet port (6). The oil pushes piston (4) upward. The compressed gas provides the resistance that maintains pressure of the oil.

When the pressure in the accumulator reaches approximately 13000 ± 1000 kPa (1875 ± 145 psi), the supply of oil is stopped. When either brake pedal is pushed, oil from pressure oil chamber (5) flows out of pressure port (6) to the service brake control valve. This applies the service brakes. When the pressure in the accumulator decreases to approximately 11500 ± 600 kPa (1675 ± 85 psi), the combination valve will allow pump flow into the accumulator to repeat the cycle.

A shuttle valve within the combination valve provides constant pressure from either accumulator for disengagement of the parking brake.

i02424504

Combination Valve (Pilot, Brake)

SMCS Code: 5064-P&B

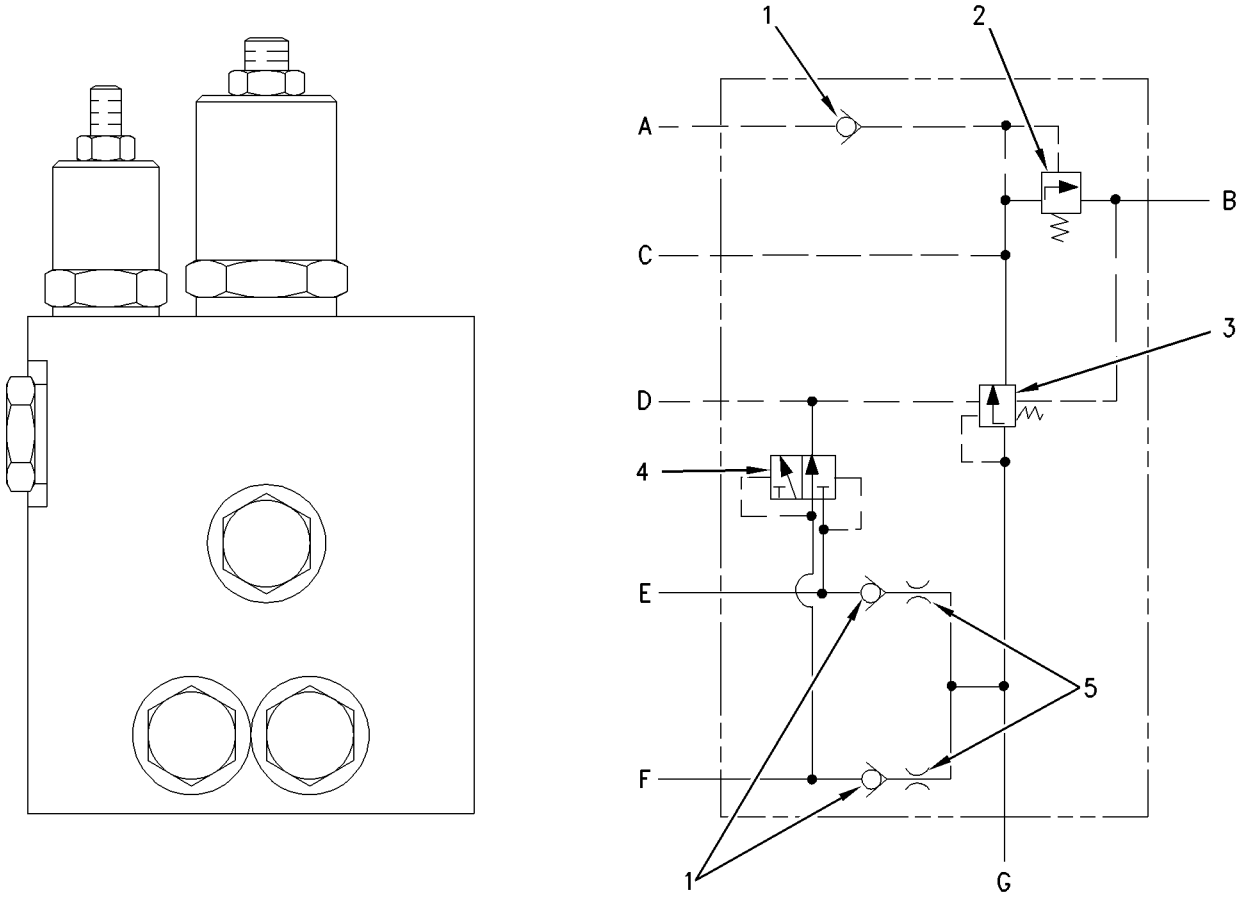


Illustration 7 g00851245

(1) Check valve
(2) Pilot relief valve
(3) Unloading valve
(4) Shuttle valve
(5) Fixed restrictor
(A) Implement pilot port
(B) Tank return port
(C) Fluid sampling port
(D) Parking brake port
(E) Accumulator and rear service brake port
(F) Accumulator and front service brake port
(G) Pump pressure port

The combination valve controls the flow of the oil from the pump to either the brake system or the implement pilot system. The pump oil is diverted, based on the pressure requirements of the systems.

When the machine is started, the combination valve diverts the oil to the service brake circuits and accumulators first. The pump oil flows through fixed restrictors (5) and check valves (1) to the accumulators for the front (F) and rear (E) service brake circuits. Fixed restrictors (5) allow the accumulators to fill at a uniform rate. The check valves prevent accumulator pressure from flowing out of the brake circuits.

Once the accumulators are filled to cutoff pressure, the line pressure from either service brake circuit will shift shuttle valve (4). The shuttle valve will direct the pump flow to parking brake circuit (D). This ensures that the service brakes will function before the parking brake can be disengaged.

When the parking brake circuit reaches the required pressure, the line pressure will shift unloading valve (3). The unloading valve will direct pump flow to the fluid sampling port (C) and through check valve (1) to implement pilot port (A). The implement pilot pressure enables control functions of the implements.

Once the implement pilot system reaches the required pressure, the line pressure that is coming from the unloading valve will force pilot relief valve (2) to shift. The pilot relief valve will divert the pump flow back to hydraulic tank return port (B).

As the service brakes are applied, the line pressure in the circuits will decrease. The decrease in pressure will allow shuttle valve (4) to close. The closing of the shuttle valve will direct the pump flow back into the service brake circuits and accumulators. The cycle will continue to repeat.

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Relief Valve (Brake System Backup)

SMCS Code: 5069-BRK

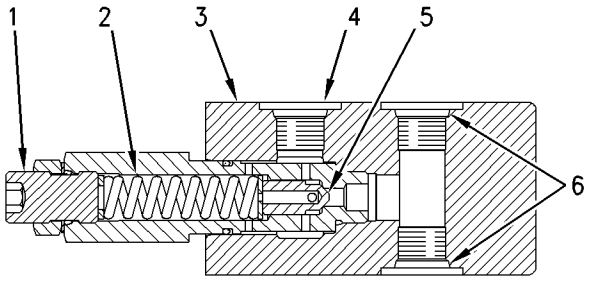


Illustration 8 g00851529

Brake Relief Valve

(1) Retainer assembly
(2) Spring
(3) Manifold
(4) Tank return port
(5) Valve
(6) Pressure port

The brake relief valve is a normally closed valve that is connected between the pump pressure line and the hydraulic tank. The brake relief valve prevents excessive pressure in the hydraulic brake and implement pilot systems.

The brake relief valve is set to open at 22750 ± 400 kPa (3300 ± 58 psi). To adjust the pressure setting, turn retainer assembly (1) clockwise or counterclockwise.

The pressure oil from the pump enters manifold (3) at pressure port (6). The oil will exert pressure on the closed valve (5) which is held closed by spring (2). The spring will hold the valve closed when the oil pressure is below 22750 ± 400 kPa (3300 ± 58 psi). If the oil pressure approaches 22750 kPa (3300 psi), the force of the oil will overcome the force of the spring which will open the valve. The oil will be diverted to the hydraulic tank through tank port (4). This controls the amount of pressure that flows to the rest of the system. The force of the spring will close the valve when the oil pressure decreases below the pressure setting.

i02424415

Brake Control Valve (Service)

SMCS Code: 4265

269-3289 Brake Control Valve (Service)

The service brake control valve is located on the front right side, and under the operator's platform.

A mechanical link connects the two brake pedals to each other. When a brake pedal is depressed, a lever and cam assembly actuates the service brake control valve. The control valve is a fully split modulating valve with two independent output pressures.

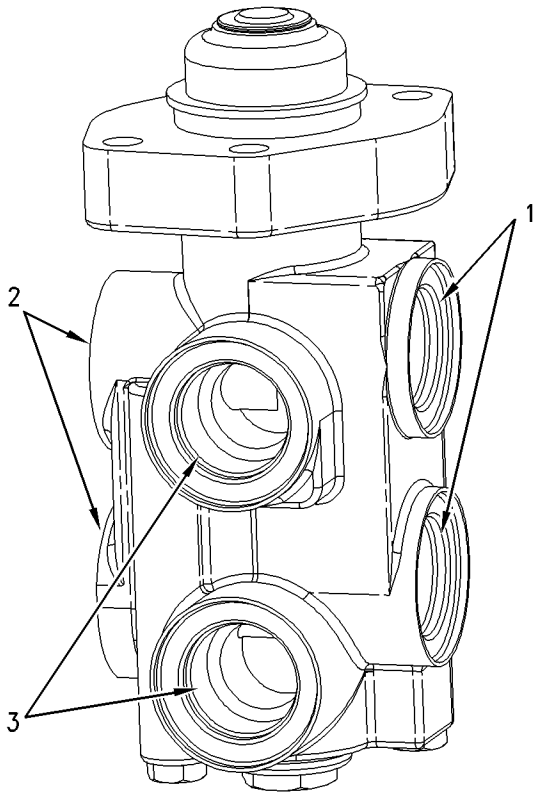


Illustration 9 g00829933

Service Brake Control Valve for the 844H Wheel Tractor and the 990H Wheel Loader

(1) Return ports to the hydraulic tank. (2) Supply ports from the brake accumulator charging valve. (3) Supply ports to the service brakes.

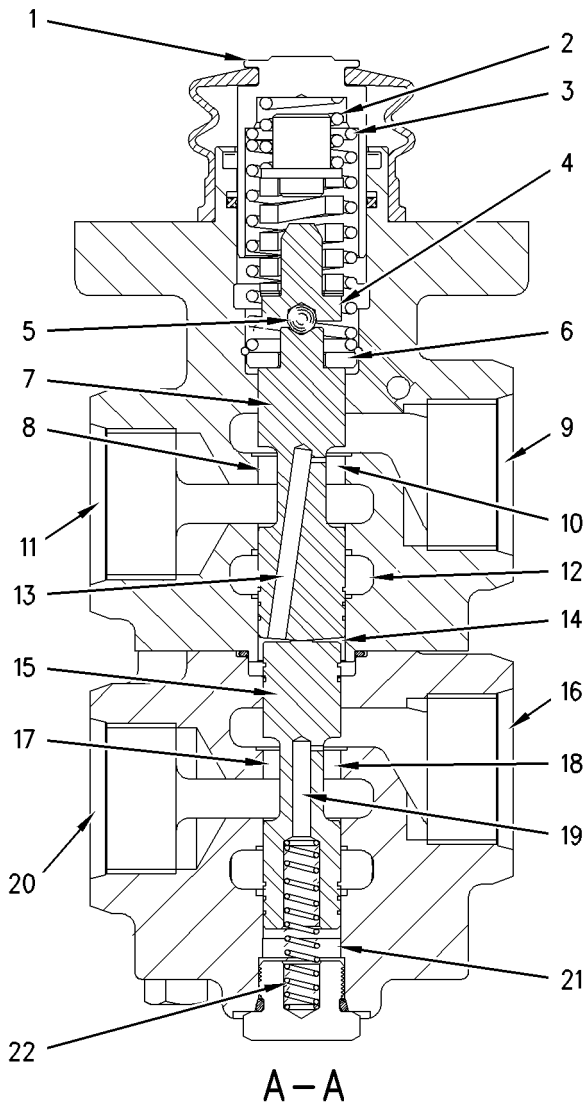


Illustration 10 g00695822

View A-A of the Service Brake Control Valve for the 844H Wheel Tractor and the 990HWheel Loader

(1) Piston. (2) Spring. (3) Spring. (4) Retainer. (5) Ball. (6) Spacer. (7) Upper valve spool. (8) Outlet to rear service brakes. (9) Outlet to hydraulic oil tank. (10) Passage. (11) Supply from accumulator for the rear service brakes. (12) Drain port to tank. (13) Upper valve spool passage. (14) Cavity. (15) Lower valve spool. (16) Plug. (17) Outlet to front service brakes. (18) Passage. (19) Lower valve spool passage. (20) Supply from accumulator for the front service brakes. (21) Cavity. (22) Spring.

The service brake control valve modulates the flow of pressurized oil. The flow of pressurized oil is modulated between the brake accumulators and the service brakes. The position of either brake pedal causes a specific pressure at the service brakes. As the position of the pedal changes, the pressure at the service brakes also changes.

Applying one of the brake pedals will cause a roller arm in the foot brake control to push on piston (1). Piston (1) applies a force on springs (2) and (3). The force of springs (2) and (3) moves retainer (4) and ball (5). Movement of retainer (4) and ball (5) causes upper valve spool (7) to move away from the seat in spacer (6).

The movement of upper valve spool (7) causes the movement of lower valve spool (15) and the compression of spring (22). When valve spools (7) and (15) move, oil flow through passages (10), (12), and (18) to the hydraulic oil tank is blocked.

This allows pressurized oil from accumulator ports (11) and (20) to flow through passages (10), (13), (18), and (19). The oil then flows through passages (8) and (17) in order to apply the service brakes. At the same time, pressurized oil flows into cavities (14) and (21), and through passages (13) and (19). The oil pressure at the service brakes has the same pressure as the oil in cavities (14) and (21).

Oil pressure in cavity (21) and the force of spring (22) act to balance lower valve spool (15) against the force of the pressure in cavity (14). In the same manner, pressure in cavity (14) creates a force against the bottom of upper valve spool (7). The upper valve spool is balanced by the force of spring (2) at the top of spool (7).

The force of springs (2) and (3) is balanced by the force that is applied to the pedal. Upward movement of valve spools (7) and (15) causes accumulator ports (11) and (20) to be covered. The level of pressure in the independent valve sections creates a force of feedback. This allows the operator to modulate the pressure to the service brakes.

Valve spools (7) and (15) balance between the ports for the hydraulic oil tank and the ports for the service brakes. This is done in order to maintain the brake pressure until the position of the pedal changes. The change in the pedal position means that more brake pressure or less brake pressure is necessary.

If piston (1) is moved downward in order to apply more compression on spring (2), valve spools (7) and (15) will move. The valve spools move in order to allow more pressure oil to flow to outlets (8) and (17) to the service brakes. This results in a higher oil pressure in cavities (14) and (21). A higher oil pressure is necessary in order to maintain the balance of valve spools (7) and (15).

i01649200

Torque Converter Impeller Clutch Operation

SMCS Code: 3134-CL

The left brake pedal controls the amount of brake oil pressure that is used to apply the service brakes. The left brake pedal also controls the amount of pressure that actuates the impeller clutch. The impeller clutch is positioned between the engine and the torque converter.

By using the left brake pedal to limit the impeller clutch pressure, the operator may divert engine power to the implement hydraulic circuit without putting the transmission in neutral.

As the operator depresses the pedal, the impeller clutch pressure drops quickly to a working pressure. The pressure is then modulated to a reduced pressure. This sequence occurs during the next eleven degrees of pedal travel. Depressing the left brake pedal past this point applies the service brakes.

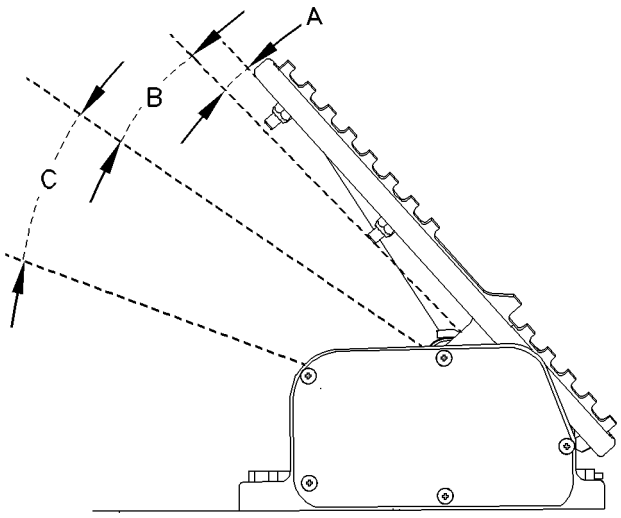


Illustration 11 g00851910

Left Brake Pedal

(A) Range for impeller clutch maximum pressure
(B) Range for impeller clutch control
(C) Range for service brake application

Range (A) indicates the first two degrees of pedal movement. In this range, the impeller clutch pressure is reduced to the maximum working pressure level. Range (A) is the approximate pressure range for preventing slippage of the impeller clutch.

Range (B) indicates the next eleven degrees of pedal movement. In this range, the impeller clutch pressure is reduced proportionally. More pedal travel will equal less impeller clutch pressure. Range (B) will modulate the impeller clutch pressure from the maximum working pressure to the minimum impeller clutch pressure.

Range (C) occurs approximately within the next thirteen degrees of pedal travel. In this range, the pedal will engage the service brakes proportionally.

Reference: For more information about the torque converter impeller clutch, refer to the Service Manual module Systems Operation, “Torque Converter” for the machine that is being serviced.

i02427018

Brake Control Valve (Parking)

SMCS Code: 4282

The parking brake control valve controls the flow of pressure oil to the parking brake and from the parking brake.

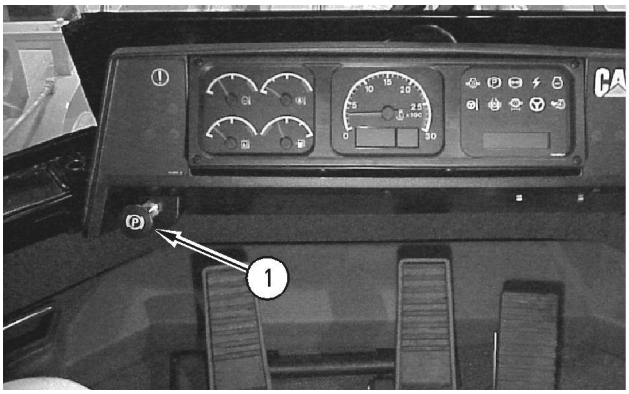


Illustration 12 g00851807

(1)Parking brake control knob

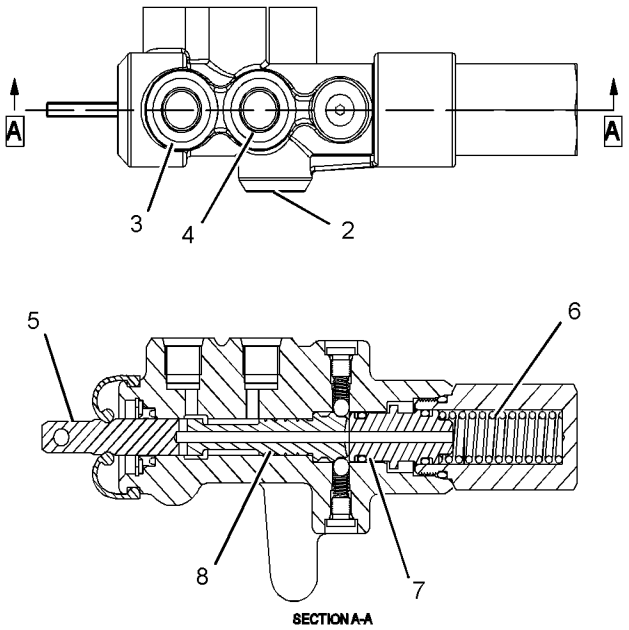


Illustration 13 g01213096

Parking Brake Control Valve

Engaged Position

(2) Pressure port from the brake accumulators. (3) Tank port.(4) Parking brake port.(5) Stem for the parking brake control valve. (6) Spring. (7) Retainer. (8) Spool.

When parking brake control knob (1) is pushed in, the parking brake is in the disengaged position. Spool (7) and retainer (8) move to the right. This movement compresses spring (6) and pressure oil is allowed to flow into the pressure port from accumulators (2). The pressure oil also flows into a cavity in the parking brake.

When the pressure of the oil in the cavity is high enough to compress the springs in the parking brake, the brake disengages. This oil pressure keeps the parking brake disengaged.

To engage the parking brake, pull out on parking brake control knob (1). When stem (5) is pulled out, the flow of oil from the accumulators to the parking brake stops. Moving stem (5) causes spool (8) to move to the left. This stops the supply of oil from the accumulators. The oil is then allowed to drain back to the hydraulic oil tank.

This causes a decrease in the oil pressure for the brake system. When the oil pressure is decreased, the force of the springs in the parking brake is greater than the pressure of the oil in the cavity of the parking brake. This allows the springs in the parking brake to engage the parking brake.

If there is a decrease of hydraulic oil pressure in the service brake circuit during machine operation, the parking brake control valve will automatically engage the parking brake. If the machine is in either first speed forward or first speed reverse, the transmission will also shift into the NEUTRAL position.

i02424219

Service Brakes

SMCS Code: 4251

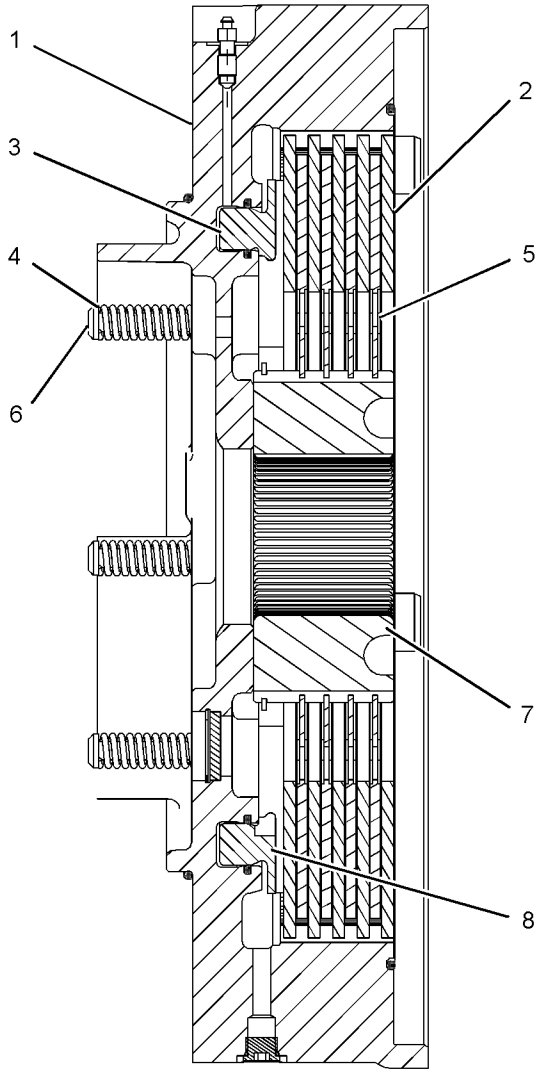


Illustration 14 g01211272

Components of the Service Brake

(1) Brake anchor. (2) Plates (five). (3) Chamber. (4) Springs (six). (5) Discs (four). (6) Guides (six). (7) Brake hub. (8) Piston.

The disc brakes are positioned at all four of the interfaces between the spindles and axle housings. The disc brakes are activated by hydraulic oil. The heat from the friction of the brakes is removed by the oil in the compartment for the service brake.

Brake anchor (1) is fastened between the spindle and the axle housing. The brake anchor does not turn. The splines on the outside circumference of plates (2) engage with the splines which are positioned on the inside of the brake anchor.

There are splines on the outside circumference of brake hub (7). These splines engage with the splines on the inside circumference of discs (5). This causes both the brake hub and the discs to turn together.

Oil pressure flows from the brake control valve into chamber (3) when a brake pedal is pushed. The oil in chamber (3) pushes piston (8) against plates (2) and against discs (5). This causes friction between plates (2). The plates are held stationary by anchor (1) and by discs (5), which turn with the rotation of the axle shafts. This friction causes the wheels to turn at a slower rate or to stop.

The discs have grooves which allow cooling oil to pass between the plates and the discs. These grooves allow the oil to flow in either the activated position or the released position. If the depth of the grooves in the friction discs is adequate, the cooling oil constantly flows between the discs and the plates. This happens even when the service brakes are applied.

The oil from chamber (3) flows back to the service brake control valve, and to the hydraulic tank when the brake pedal is released. Springs (4) pull piston (8) away from the plates. The flow of oil between the plates and the discs helps to separate the stack as the brake is released.

i02424351

Parking Brake

SMCS Code: 4267

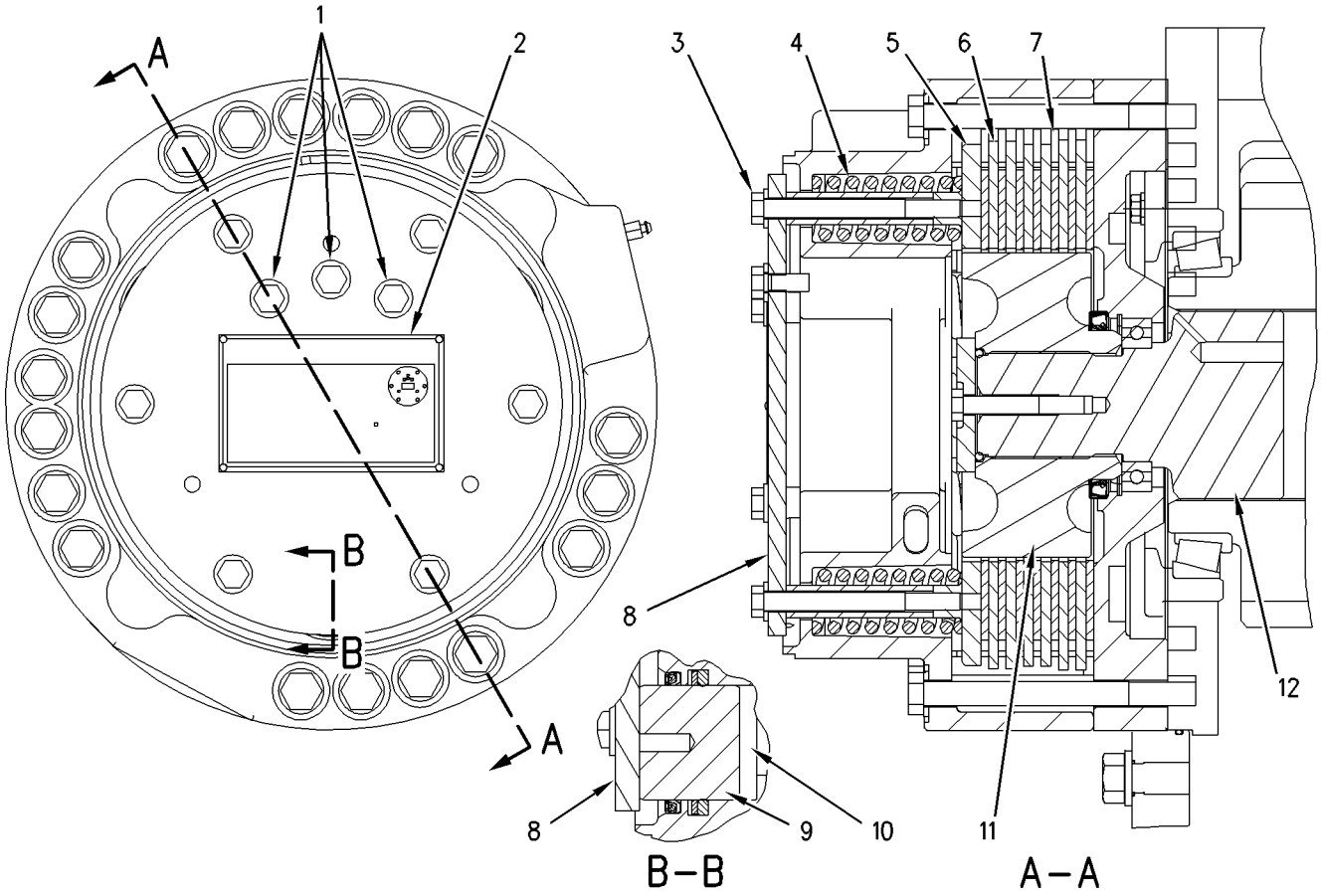


Illustration 15 g00852602

Components of the Parking Brake

(1) Manual release bolts
(2) Warning plate
(3) Bolt (six)
(4) Spring (nine)
(5) Plate
(6) Clutch plate (six)
(7) Brake disc (seven)
(8) Retaining plate
(9) Piston (three)
(10) Chamber
(11) Hub
(12) Brake shaft

The parking brake is positioned on the rear of the output transfer gear case. The parking brake is a multiple disc brake with a dry cavity which is engaged by spring pressure.

Clutch plates (6) are held in place by four pins that are anchored by the brake housing. Brake discs (7) have splines on the inside diameter which engage with hub (11). The hub is splined to brake shaft (12). The brake shaft is driven by one of the transfer gears. The discs turn with the brake shaft. Bolts (3) are inserted through springs (4). The bolts are fastened to plate (5).

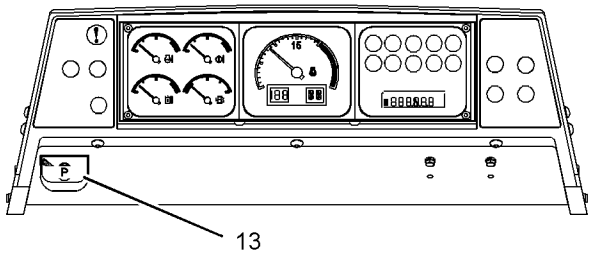


Illustration 16 g01211347

Instrument Panel Console

(13) Parking brake control knob

Parking brake control knob (13) is positioned on the left side of the dashboard. This knob operates the parking brake control valve.

When parking brake control knob (13) is pushed in, the parking brake control valve diverts oil flow from the accumulators to chamber (10) behind piston (9). If the oil pressure is sufficient, the piston will force retaining plate (8) and bolts (3) to the left. Springs (4) will be compressed as plate (5) is pulled out by the bolts. This releases the pressure from the stack of clutch plates and brake discs. Brake shaft (12) is able to rotate when the pressure on clutch plates (6) and on brake discs (7) is released.

When parking brake control knob (13) is pulled out, the parking brake control valve stops the flow of oil from the accumulator. Oil in chamber (10) drains back to the hydraulic oil tank. Springs (4) then exert force on plate (5) which will exert pressure on the stack of clutch plates (6) and brake discs (7). This pressure will cause the parking brake to engage.

The parking brake will stay engaged until sufficient hydraulic pressure is supplied regardless of the position of the control knob.

When the machine is unable to be started, there is a procedure to manually disengage the parking brake. Bolts (1) are for use in this procedure. Follow the instructions that are on warning label (2).

The parking brake is designed to hold the machine on a maximum thirty degree slope.

i02427586

Parking Brake Interlock

SMCS Code: 3030; 4267; 4284; 4800

When the parking brake control knob is pushed in, the parking brake is disengaged. The gear selection is not affected when the parking brake control knob is in the disengaged position.

When the parking brake control knob is pulled out, the parking brake is engaged. The transmission will not shift out of neutral into first speed forward or into first speed reverse when the parking brake control knob is in the engaged position.

The transmission can be engaged if the transmission is in second speed forward, in third speed forward, in second speed reverse or in third speed reverse. However, a Warning Category 3 will occur.

When the transmission is in first speed forward or in first speed reverse and the parking brake is engaged, the transmission automatically shifts into neutral.

After the electronic control module (ECM) has shifted the transmission into neutral, the parking brake must first be disengaged. The direction switch on the STIC steering control lever must then be shifted to NEUTRAL before the ECM will shift the transmission into a forward speed or into a reverse speed.

To shift the transmission to second speed forward, to third speed forward, to second speed reverse or to third speed reverse, you must first shift the transmission to neutral. Next, shift the transmission to the desired gear.

Approximately 10300 kPa (1494 psi) of oil pressure is supplied to the parking brake during normal operation. This prevents the springs inside the parking brake from engaging the parking brake.

Note: The following information is provided in case of a malfunction of the parking brake interlock.

The parking brake control valve expels pressure during a malfunction in the hydraulic system. One type of malfunction in the hydraulic system is a loss of system pressure. The parking brake control valve then allows the internal springs to engage the parking brake.

If there is a hydraulic failure and pressure oil is not available to release the parking brake, a drive-through mode is available. The drive-through mode functions when the operator pushes in the parking brake control knob.

Before the ECM will allow the transmission to shift into a forward speed or into a reverse speed, push in on the parking brake control knob in order to disengage the parking brake. Next, shift the direction switch on the STIC steering control lever to the NEUTRAL position. Then shift the direction switch on the STIC steering control lever to first speed forward or to first speed reverse.

Note: First speed forward or first speed reverse must be used in order to drive through a parking brake that functions correctly.

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RENR8820-07 (en-us)
August 2018

Testing and Adjusting

990H Wheel Loader and , 844H Wheel Dozer
Braking System

BTW 1-UP (Machine)
BWX 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Testing And Adjusting Section

Troubleshooting

i01670437

Machine Preparation for Troubleshooting

SMCS Code: 4250-035

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Move away from other operating machines and away from personnel. Park the machine on a smooth, level surface. Lower the work tools to the ground. Stop the engine.
2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.
3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

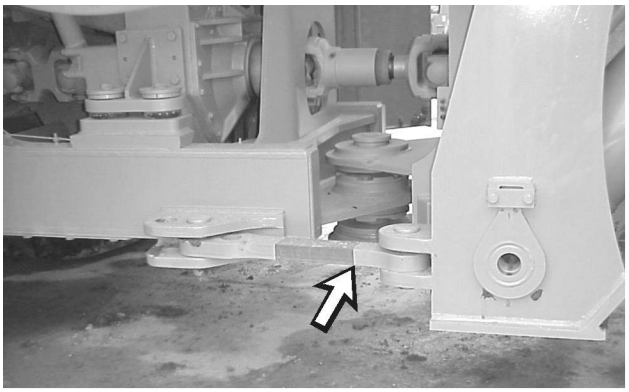


Illustration 1 g00853163
Steering frame lock in the LOCKED position

4. Install the steering frame lock in the LOCKED position so the machine can not articulate.
5. Depress the brake pedal repeatedly in order to relieve any pressure that may be present in the brake hydraulic system. This may require more than ten applications of the service brakes.
6. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the FLOAT position. Place the tilt control lever in the HOLD position.

7. Turn the STIC steering control lever several times in both directions in order to relieve the pressure in the steering system.

8. This machine is equipped with two hydraulic oil tanks. In order to relieve all of the pressure in each of the hydraulic oil tanks, carefully remove the hydraulic tank cap. The hydraulic tank for the implement system and the braking system is located outside the cab on the right side of the machine under the floorplate. The hydraulic tank for the steering system and the hydraulic fan system is located outside the cab on the left side of the machine under the floorplate.

i06890478

Machine Preparation for Troubleshooting

SMCS Code: 4250-035

S/N: BWX1–Up

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Park the machine on a smooth, level surface. Move away from other operating machines and away from personnel. Lower the implements to the ground. Stop the engine.

2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.

3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

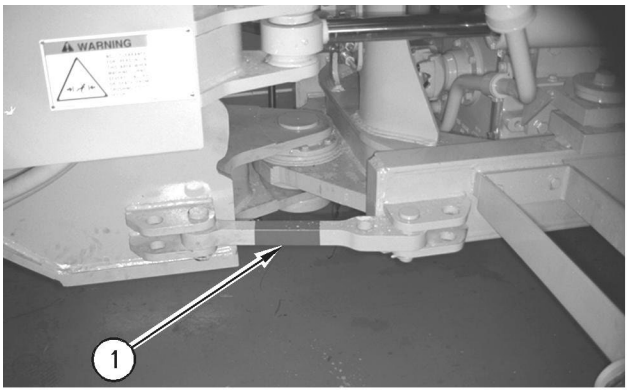


Illustration 2 g00501895
Typical example of a steering frame lock
(1) Steering frame lock in the LOCKED position.

4. Install steering frame lock (1) in the LOCKED position so the machine can not articulate.

5. Depress the brake pedal repeatedly. This will relieve any pressure that may be present in the brake hydraulic system.

Note: If the machine is equipped with electro-hydraulic controls, turn the engine start switch key to the ON position before performing step 6 and step 7. The engine start switch key must then be turned back to the OFF position before proceeding.

6. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the HOLD position. Place the tilt control lever in the HOLD position.

7. Turn the steering wheel several times in both directions in order to relieve the pressure in the steering system.

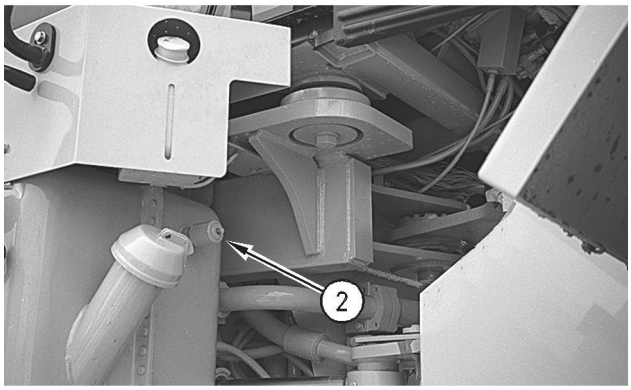


Illustration 3 g00495483

Typical example of a breaker relief valve.

(2) Breaker relief valve

8. In order to relieve all of the pressure in the hydraulic oil tank, press and hold down the plunger on breaker relief valve (2). The breaker relief valve is located on the top of the hydraulic oil tank.

Note: If the machine is not equipped with a hydraulic tank breaker relief valve, the hydraulic tank cap may be removed slowly in order to relieve tank pressure.

i02424683

Visual Inspection

SMCS Code: 4250-035

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the systems is one of the first steps when you are troubleshooting a problem. Before any tests are performed, visually inspect the systems for oil leaks and for damaged parts.

1. When possible, talk to the operator. Ask about the symptoms of the problem: machine performance, noises, smells and frequency of the problem.

2. Prepare the machine for troubleshooting. Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced.

3. Check the display of the monitoring system for the following machine conditions: alert indicators, warnings and service codes.

4. Be aware of the work environment. An extreme work environment can greatly affect the symptoms of a machine.

5. Check the hydraulic oil levels in the sight gauges on both of the tanks. The 844H Wheel Dozer and the 990H Wheel Loader have two separate hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. The tank for the hydraulic fan system and the steering system is located on the left side of the cab under the floorplate. The sight gauges can be seen from the ground on either side of the machine.

6. Look for air in the hydraulic tank oil immediately after the engine is stopped. Use a clear container to obtain a sample of the oil. Look for air bubbles in the oil in the container.

7. Remove the hydraulic oil filter and cut the filter open with a filter cutter. Look for particles in the filter elements. A magnet will separate the ferrous particles such as iron and steel from the nonferrous particles such as brass, aluminum and rubber.

8. Check all hydraulic hose and connections. Look for damage, tightness of fasteners, and leaks.

9. Inspect all of the hydraulic cylinders for damage and leaks.

10. Inspect all of the control linkages for components that are bent, broken, or damaged.

i02424990

Brake System Troubleshooting

SMCS Code: 4250-035

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

This section provides possible causes to problems. Since there may be several possible causes, specific inspections or instrument tests may be recommended. These inspections and tests will help to identify the causes that are most probable.

Note: Use oil with the correct viscosity for the operating conditions.

Problem List

- **Possible Problem List for the Service Brakes**

1. The accumulator pressure will not reach cutout pressure at low idle. This may cause a Warning Category 3 to occur. This may also engage the parking brake.

2. The front service brakes do not operate, and the warning system is not activated.

3. The rear service brakes do not operate, and the warning system is not activated.

4. Service brakes slip, and the warning system is not activated.

5. Too much force needed to push the brake pedals, and the warning system is not activated.

- **Possible Causes of Brake Problems**

Problem 1

The accumulator pressure does not reach the cutout pressure at low idle. This typically causes a Warning Category 3 to occur. The oil pressure light for the brakes will flash. The action lamp will flash, and the action alarm will sound. This problem may also engage the parking brake.

Possible cause

1. When the hydraulic oil is hot and the engine is running at low idle, the output of a bad pump is not sufficient to overcome the pump's own internal losses.

2. The combination valve is not functioning properly.

Problem 2

The front service brakes do not operate, and the warning system is not activated.

Possible causes

1. The brake group within the axle housing is damaged.

2. The lines to the front service brakes are obstructed.

3. The service brake control valve is not diverting oil to the front brake circuit.

4. The combination valve is not supplying oil pressure to the accumulator for the front service brake circuit.

Problem 3

The rear service brakes do not operate, and the warning system is not activated.

Possible causes

1. The brake group within the axle housing is damaged.

2. The lines to the rear service brakes are obstructed.

3. The service brake control valve is not diverting oil to the rear brake circuit.

4. The combination valve is not supplying oil pressure to the accumulator for the rear service brake circuit.

Problem 4

The service brakes slip, and the warning system is not activated.

Possible causes

1. One or both axles contain an incorrect hydraulic oil additive.

2. The brake discs in the axle housing are worn.

3. The lines to one or both axles could be obstructed.

4. The hydraulic system is contaminated. This can cause the control valves to malfunction.

5. The service brake control valve is faulty.

Problem 5

Too much force is needed to push the brake pedal, and the warning system is not activated.

Possible causes

1. The brake pedals and/or brake pedal linkages are damaged.

2. The brake valve is sticking because of contaminated oil.

- **Possible Problem List for the Parking Brake**

1. The parking brake does not hold the machine stationary.

2. The parking brake does not engage when the parking brake control knob is pulled out.

- **Possible Causes of Parking Brake Problems**

Problem 1

The parking brake does not hold the machine stationary.

Possible causes

1. The brake discs are badly worn.

2. Springs in the brake are damaged or broken.

3. There is grease or oil on the brake components.

Problem 2

The parking brake does not engage when the parking brake control knob is pulled out.

Possible causes

1. The parking brake cable is disconnected.

2. The parking brake cable has stretched until the cable will not actuate the parking brake.

3. The bolts that are used for the manual release of the parking brake are in the positions for disengagement of the brake.

- **Problem List for the Service Brake Charging System**

1. The low oil pressure warning will not turn off.

- **Possible Causes of problem in the Service Brake Charging System**

Problem 1

The low oil pressure warning will not turn off.

Possible causes

1. There is inadequate pump pressure for the brake system.

Note: If you can turn off the warning by increasing the rpm of the engine, the cause of the problem is the brake pump.

2. If the service brakes are NOT functioning properly, and the parking brake is NOT disengaging properly, the braking system relief valve is bad.

3. If the service brakes are functioning properly and the parking brake is disengaging properly, the oil pressure switch is bad.

4. If service brakes are functioning properly and the parking brake is NOT disengaging properly, the combination valve is not diverting oil to the parking brake circuit.

5. The hydraulic oil is too hot.

Testing and Adjusting

i02424955

System Pressure - Release

SMCS Code: 4250-553-PX

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: The 844H Wheel Dozer and the 990H Wheel Loader are equipped with two hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. The tank for the hydraulic fan system and the steering system is located on the left side of the cab under the floorplate. If maintenance is performed on any of the hydraulic systems, the hydraulic pressure should be released from both of the hydraulic tanks.

Reference: Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced before performing the following procedure.

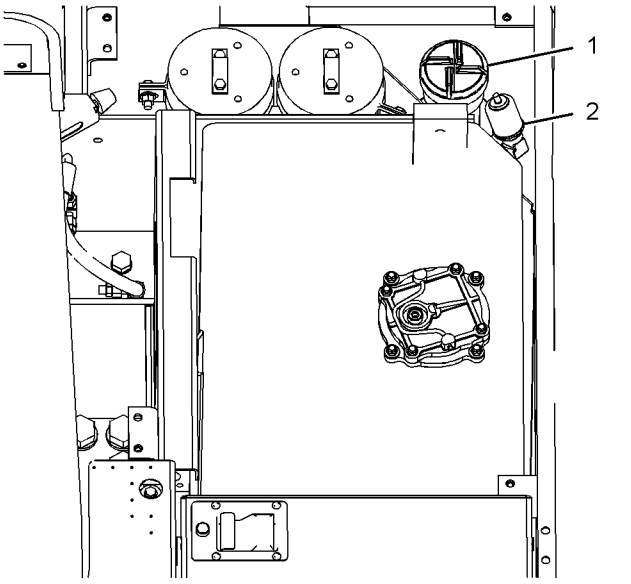


Illustration 4 g01212015

Brake and Implement Hydraulic Tank

(1) Filler cap
(2) Breaker relief valve

To manually purge the pressure that is in the hydraulic tanks, the following procedure should be done.

1. Park the machine on a smooth, level surface. Engage the parking brake. Turn the ignition key to the OFF position.
2. In order to release the pressure in the accumulators, apply the brakes repeatedly.
3. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the HOLD position. Place the tilt control lever in the HOLD position.
4. Move the STIC steering control lever several times through the full range of motion in order to relieve the pressure in the steering system.

5. In order to purge the pressure that is in the hydraulic oil tanks, press the plunger on breaker relief valve (2) on each tank.

i02424706

Hydraulic Oil Contamination - Test

SMCS Code: 4250-008

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Table 1

Required Tools		
Part Number	**Description**	**Quantity**
8T-9208	Probe Assembly	1
169-8373	Fluid Sampling Bottle	1

The hydraulic oil in this system is SAE 10. If the hydraulic oil becomes contaminated, premature component failure could result. Contaminated hydraulic oil can also contribute to overheating.

Note: The 844H Wheel Dozer and the 990H Wheel Loader are equipped with two hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. Refer to the Operation and Maintenance Manual, SEBU7886 or the Operation and Maintenance Manual, SEBU7893 for the location of the fluid sampling valve.

The following procedure is for sampling the oil under pressure while the engine is running.

1. Start the engine and run the engine at high idle. Exercise the implements and exercise the brakes in order for the oil temperature to reach the normal operating temperature.

2. Park the machine on level ground. Lower all attachments and engage the parking brake.

3. Run the engine at low idle. Secure all systems in a safe mode.

4. Make sure that the control levers are in the HOLD position. Do not operate the brakes or the hydraulic controls during the sampling procedure.

5. The fluid sampling valve for the brake system is located next to the pressure tap on the right side of the combination valve. Remove the dust cover from the fluid sampling valve. Clean the fluid sampling valve with a lint free cloth.

6. Purge the hydraulic oil sampling valve.

Note: Insert an 8T-9208 Probe Assembly into the hydraulic oil sampling valve. Drain approximately 100 mL (4 fl oz) of oil into a container for disposal. This will clean out the sampling port so that a good oil sample may be obtained.

Note: Accelerate the engine if the flow of oil is slow at low idle.

7. Use the 169-8373 Fluid Sampling Bottle to collect the oil sample through the probe assembly.

Note: Rinse the bottle with the system oil in order to remove any contamination. Fill the bottle halfway with system oil. Install the cap and shake the bottle vigorously for a few seconds. Dispose of this oil into a suitable container. Fill the bottle to the line that is marked “FILL RANGE” . Place the lid on the bottle. This will be the oil sample that will be checked for contamination.

8. The recommended level of cleanliness for the hydraulic system is ISO Code 18/15. See Table 2 for the maximum allowable particle count.

Table 2

Hydraulic Oil Contamination		
ISO Code	**Particle Size (Microns)**	**Maximum Number of Particles Per 1 mL Sample**
18	5	2500
15	15	320

Note: The concentration of the particles by size should be monitored over a series of samples. This information can be used in order to spot abnormal wear before a failure occurs. A spectrographic analysis of the samples can be used in order to identify the composition of the particles. The analysis of the oil sample may be used in order to identify the components that are failing.

Refer to Contamination Control Guidelines, SEBF8482, “Obtaining Oil Samples for Analysis” for more information on oil sampling.

i04149289

Pump Performance (Pilot, Brake) - Test

SMCS Code: 4014-081-GT; 5073-081-P&B

Table 3

Required Tools	
Part Number	**Description**
1U-5481	Pressure Gauge Group
6V-7788	Flow Meter

The pilot and braking pump is a fixed displacement gear pump. Measuring the oil flow can provide an indication of the condition of the pump. An inadequate amount of oil flow from the gear pump indicates that there is excessive internal leakage in the pump. This leakage can be caused by wear or damage of the pump components.

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Machine Preparation for Testing

Reference: For more information about preparing to test the pilot pump, refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced.

On the 844H Wheel Dozer and the 990H Wheel Loader , the implement hydraulic system and the brake hydraulic system share the same hydraulic tank. Before fittings, hoses, or components are loosened, tightened, removed, or adjusted, the pressure must be purged from both systems.

1. Start the engine. Move the transmission direction control switch to the NEUTRAL position.

2. Engage the parking brake.

3. Move the steering frame lock to the locked position.

4. Stop the engine.

5. Exercise the brakes repeatedly in order to purge the pressure in the hydraulic brake system.

6. When the engine has stopped, move the hydraulic control levers to all positions in order to purge the pressure in the hydraulic implement system. Place the lift control lever in the FLOAT position. Place the tilt control lever in the HOLD position.

7. Slowly remove the filler cap on the hydraulic oil tank in order to purge the pressure.

8. Release all hydraulic pressure before any fitting, any hose, or any component is loosened, tightened, removed, or adjusted.

Reference: For more information about releasing system hydraulic pressure, refer to the Service Manual module Testing and Adjusting, “System Pressure - Release”.

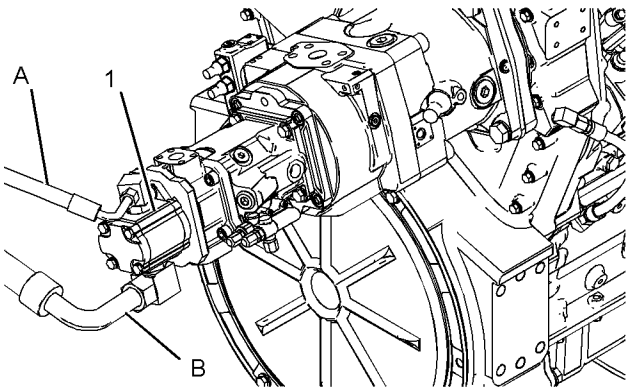


Illustration 5 g01212034

Location of the outlet hose for the pilot/brake pump

(1) Pilot/brake pump
(A) Outlet hose
(B) Inlet hose from hydraulic tank

9. Disconnect the high-pressure outlet hose from the pilot/brake pump.

10. Install 6V-7788 Flow Meter between the pilot/brake pump and the high-pressure outlet hose.

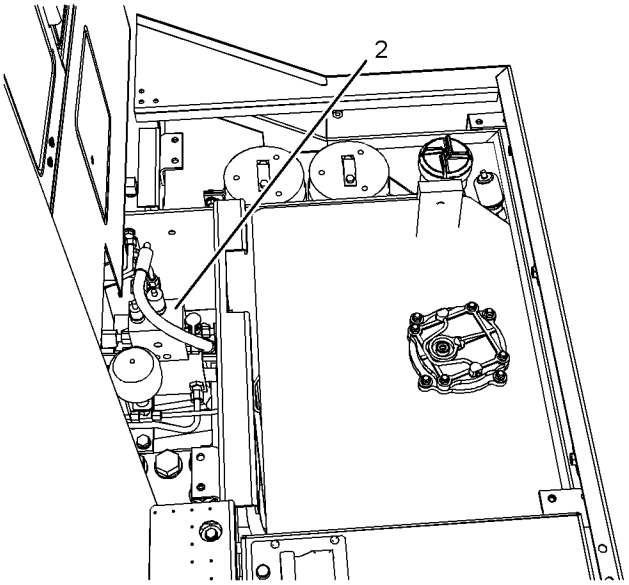


Illustration 6 g02346177

Location of the combination valve

(2) Combination valve

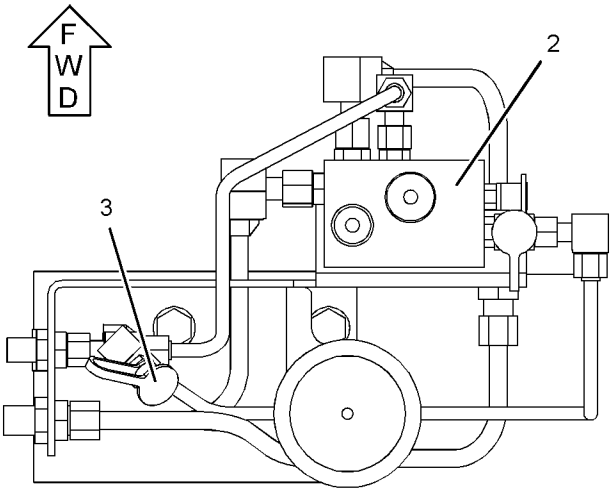


Illustration 7 g02346178

Location of accumulator pressure tap (Top view)

(2) Combination valve
(3) Accumulator pressure tap

11. Install a pressure gauge from 1U-5481 Pressure Gauge Group to the pressure tap for the accumulators.

Testing Procedure

1. Start the engine. Warm the hydraulic oil to the normal operating temperature.

2. Run the engine. Use the throttle lock to set the engine speed at 2000 rpm.

3. Determine if the brake accumulators are charging. If the brakes are not exercised, the accumulators should be charged after approximately 30 seconds. Cut out pressure for the combination valve is approximately 14600 kPa (2125 psi). Do not record the oil flow while the brake accumulators are charging.

4. Adjust the braking system relief valve until the pressure gauge measures 6900 kPa (1000 psi).

Note: Mark the original position of the valve. The mark will allow you to reset the valve back to the original setting.

Note: For more information on the procedure for adjusting the relief valve, refer to the Service Manual module Testing and Adjusting, “Relief Valve (Braking System Backup) - Test and Adjust”.

5. The oil flow should be approximately 42.5 L/min (11.2 US gpm). The pilot/brake pump will need to be repaired or replaced if the oil flow rate measures a loss of more than 10 percent.

6. Disengage the throttle lock. Stop the engine.

7. Move the hydraulic control levers to all positions in order to purge the pressure in the hydraulic system.

8. Exercise the brakes repeatedly in order to purge the pressure in the hydraulic brake system.

9. Slowly remove the hydraulic tank filler cap in order to purge the pressure in the hydraulic oil tank.

10. Purge all hydraulic pressure before any fitting, any hose, or any component is loosened, tightened, removed, or adjusted.

Reference: For more information about releasing system hydraulic pressure, refer to the Service Manual module Testing and Adjusting, “System Pressure - Release” for the machine that is being serviced.

11. Remove the test equipment. Connect the high-pressure outlet hose to the pilot/brake pump.

i02425002

Service Brake System Pressure - Test

SMCS Code: 4250-032-PX

Table 4

Required Tools	
Part Number	**Description**
1U-5481	Pressure Gauge Group

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

Personal injury or death can result if two persons are not used in the following procedure.

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Machine Preparation

Reference: Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced before performing the following procedure. The 844H Wheel Dozer and the 990H Wheel Loader have separate hydraulic circuits for the front service brakes and the rear service brakes. The pressure taps for the circuits are located on the front axle and the rear axle.

1. Engage the parking brake.

2. Stop the engine. Place the transmission direction selector in the NEUTRAL position.

3. Depress the brake pedal repeatedly in order to release all oil pressure from the brake circuit. This may require more than ten applications of the brakes.

4. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Lower the implement to the ground. Place the lift control lever in the FLOAT position. Place the tilt control lever in the HOLD position.

5. Slowly remove the hydraulic tank filler cap in order to release the pressure. The hydraulic tank for the brake system is located on the right side of the machine.

6. Install the filler cap on the hydraulic tank.

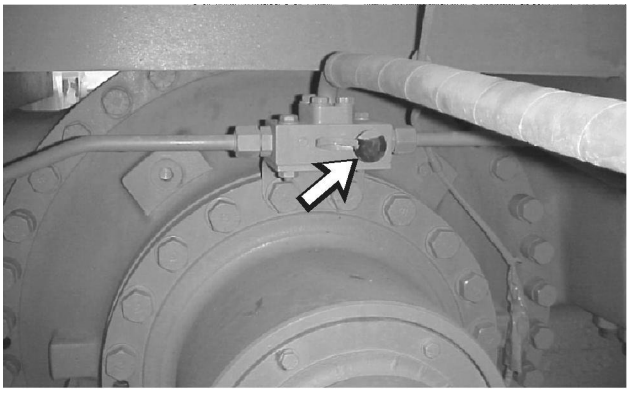


Illustration 8 g00855837
Location of the Pressure Tap for the Service Brakes

7. Remove the protective cap from the brake pressure tap on the rear axle. Install a 0 to 15850 kPa (0 to 2300 psi) pressure gauge.

Testing Procedure

1. Look at the pressure gauge. Before starting the engine, the oil pressure must be at the pressure of the hydraulic oil tank.

2. Start the engine and allow the hydraulic oil to reach normal operating temperature and normal operating pressure.

3. Hold down the brake pedal and look at the pressure gauge. The brake pressure should be at approximately 4310 ± 350 kPa (625 ± 50 psi).

4. In order to check the front service brake pressure, repeat the procedure for machine preparation and the test procedure .

Note: The pressure measurement for the rear service brakes should be approximately 210 kPa (30 psi) higher than the pressure measurement for the front service brakes.

5. If the brake pressure is not in the correct range but the brake accumulator charging valve is functioning correctly, replace the brake control valve.

i02441632

Relief Valve (Brake System Backup) - Test and Adjust

SMCS Code: 5069-081-BRK; 5069-025-BRK

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

When problems with the hydraulic pressure in the brake system occur, one possible cause may be a malfunction in the backup relief valve.

Reference: Refer to the Service Manual module Testing and Adjusting, “System Pressure - Release” before performing the following procedure.

This test procedure must be done on a hydraulic test bench. The test bench must have a hydraulic pump that will supply at least 38 ± 4 L/min (10 ± 1 US gpm) of oil flow. The pump must supply at least 18000 ± 500 kPa (2600 ± 72 psi) of oil pressure.

The test should be performed with the oil at a temperature of at least 49° ± 3°C (120° ± 5°F).

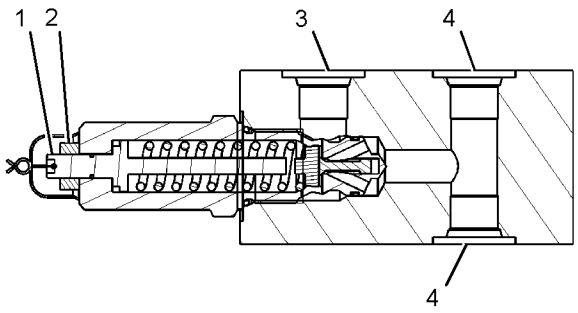


Illustration 9 g01235809

Backup Relief Valve (Brake System)

(1) Retainer assembly
(2) Nut
(3) Tank return port
(4) Pressure port

1. Remove the backup relief valve for the brake system from the machine. The backup relief valve is located under the cab on the right side. Removal of the floorplate that is outside the cab on the right side may be necessary.

2. Install a plug into one pressure port (4) on the relief valve.

3. Install the pressure hose from the test bench into the other pressure port (4) on the relief valve.

4. Install the drain hose from the test bench into tank return port (3) on the relief valve.

5. Start the hydraulic pump. Apply oil flow and pressure into the relief valve. At a flow rate of 38 ± 4 L/min (10 ± 1 US gpm), the oil pressure should be 18000 ± 500 kPa (2600 ± 72 psi) before the relief valve releases the pressure back to the tank. If the pressure measurement is not within the tolerance, adjust the relief valve. When the relief valve is open, the oil pressure at tank return port (3) should measure 70 ± 7 kPa (10 ± 1 psi).

Note: In order to adjust the relief valve, loosen nut (2). Turn retainer assembly (1) clockwise in order to increase the pressure setting. Turn the retainer assembly counterclockwise in order to decrease the pressure setting. When the required pressure setting is reached, tighten nut (2). If adjustment of the relief valve does not allow the required pressure to be reached, replace the relief valve.

6. When the procedure is complete, install the backup relief valve on the machine.

i02441652

Brake Accumulator - Test and Charge

SMCS Code: 4263-045; 4263-081

Test Procedure

Reference: For more information on preparing the machine for troubleshooting, refer to the Service Manual module for Testing and Adjusting, “Machine Preparation for Troubleshooting”.

1. Turn the engine start switch key to the ON position.

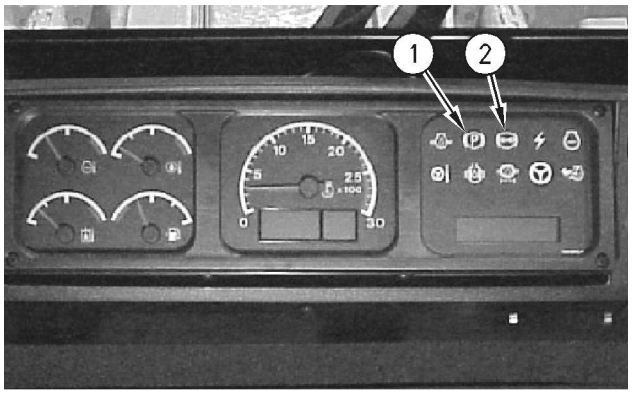


Illustration 10 g00855402

2. Brake oil pressure indicator (2) should come ON if the brake oil is not at normal operating pressure.

3. Start the engine. Run the engine at half speed for two minutes in order to increase the accumulator pressure. Brake oil pressure indicator (2) should turn OFF. Stop the engine.

4. Turn the engine start switch key to the ON position. Apply the service brake pedal and release the service brake pedal repeatedly until brake oil pressure indicator (2) comes ON. This decreases the pressure in the brake accumulators. For new brakes, a full discharge of the accumulators should require approximately nine applications of the service brake pedal. For worn brakes, a full discharge of the accumulators should require approximately four applications of the service brake pedal.

5. Parking brake indicator (1) will turn ON when brake oil pressure indicator (2) turns ON.

6. For new brakes, if brake oil pressure indicator (2) turns ON after less than nine applications of the brake, use the following procedure to charge the brake accumulators. For worn brakes, if brake oil pressure indicator (2) turns ON after less than four applications of the brake, use the following procedure to charge the brake accumulators.

Charge Procedure

⚠ WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

⚠ WARNING

High Pressure Cylinder

Failure to read and follow these instructions can cause rapid discharging gas which can cause personal injury or death.

Incorrect use or charging of the accumulator may cause the accumulator to explode. Use only dry nitrogen N_2 for charging and the recommended equipment when you test and/or charge an accumulator.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Table 5

Required Tools	
Part Number	**Description**
7S-5437	Nitrogen Charging Equipment

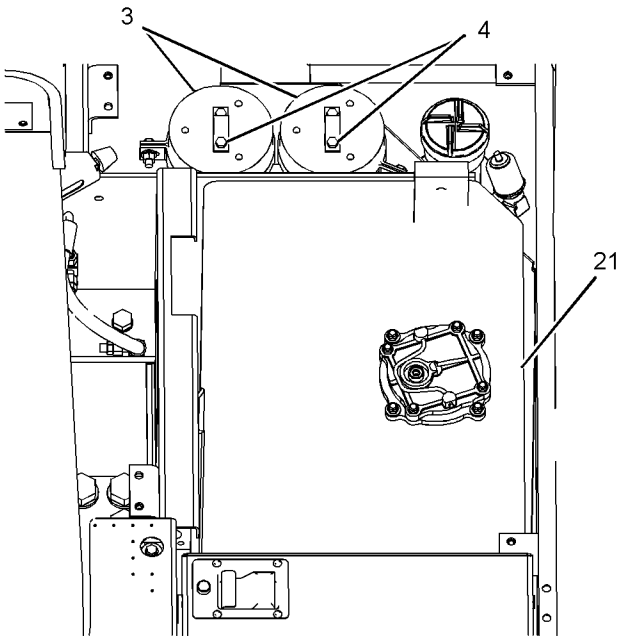


Illustration 11 g01211875

Location of the Brake Accumulators

(3) Accumulators
(4) Cap
(21) Hydraulic Oil Tank for the Brake and Implement Systems

Hydraulic brake accumulators (3) are located in front of the hydraulic oil tank. This tank is located on the right side of the machine.

Stop the engine. Depress the brake pedal repeatedly until there is no brake pressure.

To ensure that the nitrogen charge is correct, each brake accumulator piston must be at the bottom of the accumulator cylinder. Nitrogen gas pressure varies with the temperature. To obtain the most accurate nitrogen charge, the temperature of each accumulator must be identical to the air temperature around the accumulators.

However, the temperature of the accumulators could be higher than the air temperature around the accumulators. In this case, the temperature of the accumulator should be used instead of the surrounding air temperature.

Note: The pressures in the following table are for an ambient air temperature of 21°C (70°F). Adjust the pressure for other ambient conditions, as required.

Table 6

Accumulator Precharge Pressure/Temperature Relationship for the 5520 kPa (800 psi) Service Brake Accumulator	
Temperature	**Pressure**
−7°C (20°F)	5000 kPa (726 psi)
−1°C (30°F)	5105 kPa (741 psi)
4°C (40°F)	5235 kPa (760 psi)
10°C (50°F)	5340 kPa (775 psi)
16°C (60°F)	5420 kPa (787 psi)
21°C (70°F)	5500 kPa (798 psi)
27°C (80°F)	5605 kPa (813 psi)
32°C (90°F)	5735 kPa (832 psi)
38°C (100°F)	5840 kPa (848 psi)
43°C (110°F)	5920 kPa (859 psi)
49°C (120°F)	6000 kPa (871 psi)

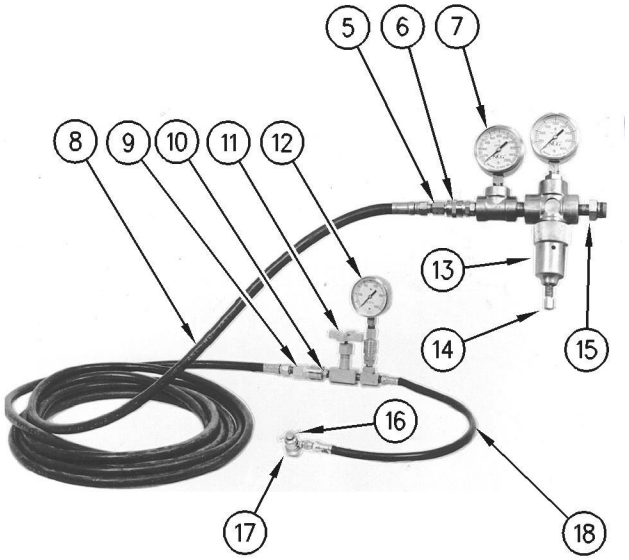


Illustration 12 g00855511

Nitrogen Charging Equipment

(5) Nipple. (6) Coupling assembly. (7) Pressure gauge. (8) Hose assembly. (9) Coupling assembly. (10) Nipple. (11) Valve. (12) Pressure gauge. (13) Regulator assembly. (14) Pressure regulating screw. (15) Chuck for the nitrogen cylinder valve. (16) Valve handle. (17) Chuck. (18) Hose assembly.

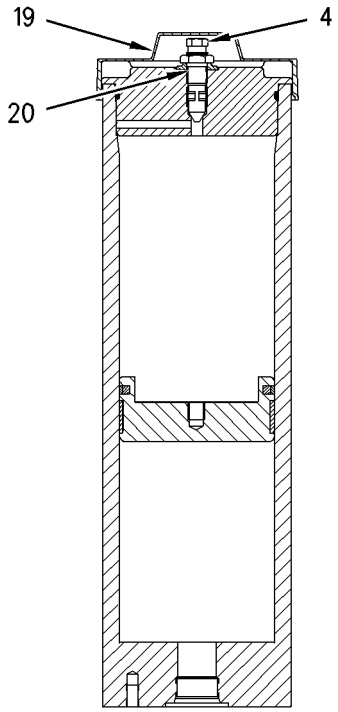


Illustration 13 g00855446

(19) Cover
(4) Cap
(20) Nitrogen charging valve

1. In order to release any oil pressure that is in the accumulators, apply the service brakes repeatedly. This may require more than ten applications of the brakes.
2. Remove cover (19) from the brake accumulator. Remove cap (4) from the valve assembly on the brake accumulator.
3. Use a 20700 kPa (3000 psi) pressure gauge (12) to check the nitrogen charge in the brake accumulator.
4. Turn valve (11) and valve (16) clockwise in order to close the valves. Install chuck (17) onto nitrogen charging valve (20) for the brake accumulator.
5. OPEN valve (16) by turning counterclockwise slowly in order to check the nitrogen pressure that is in the accumulator. Refer to Table 6 .
6. Check the temperature of the air around the brake accumulator. The reading on the pressure gauge must be within the tolerances in Table 6 .
7. If the reading on the pressure gauge is too high, slowly OPEN valve (11) in order to lower the pressure. If the reading on the pressure gauge is too low, use the following procedure to charge the brake accumulator:

   a. Connect chuck (15) and hose (8) to the nitrogen cylinder. Connect hose coupling (9) to nipple (10) on valve (11).

   b. **Make sure that valve (11) is CLOSED.** OPEN the valve on the nitrogen cylinder. Adjust screw (14) on regulator assembly (13) until pressure gauge (7) is at the correct charging pressure. Refer to Table 6 for the correct charging pressure.

   c. OPEN valve (11) and charge the brake accumulator. Then, CLOSE valve (11). If pressure gauge (12) and pressure gauge (7) show the same reading and the readings do not change, the brake accumulator has the correct charge.

      If the pressure reading on gauge (12) decreases, OPEN valve (11) and allow more nitrogen to fill the brake accumulator.

      Perform this procedure until pressure gauge (12) and pressure gauge (7) show the same reading. Make sure that neither reading changes when valve (11) is closed.

8. **CLOSE the valve on the nitrogen cylinder.**
9. CLOSE valve (16) and remove chuck (17) from the accumulator valve assembly.
10. Install cap (4) and cover (17) on the accumulator.
11. Perform this procedure for the other brake accumulator.

Note: If an accumulator has less than half of the required amount of precharge pressure, the accumulator should be charged, and then charged again after operating the service brakes several times. This prevents trapping a quantity of oil in the accumulator which will give an inaccurate precharge reading.

i01670652

Service Brakes - Test

SMCS Code: 4251-081

⚠ WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and move the parking and secondary brake control to the ENGAGED position.

⚠ WARNING

A change in the braking characteristics or a low pressure warning may be an indication of a failure in one of the brake circuits. Personal injury or death may occur if the machine is operated before repairs have been made or before all circuits have been checked. Always check the brakes after brake repairs have been made and before the machine is put back into use.

This procedure should be used to determine if the service brakes are functioning properly. This procedure is not intended to measure the maximum brake holding effort. The brake holding effort that is required to sustain a machine at a specific engine rpm varies depending on the machine.

Test the service brakes on a dry, level surface.

Check the area around the machine. Make sure that the machine is clear of personnel and clear of obstacles.

Make sure that the steering frame lock is in the STORED position.

Fasten the seat belt before you test the service brakes.

1. Start the engine. Raise the work tool slightly.
2. Apply heavy force on the right service brake pedal.
3. Disengage the parking brake.
4. Move the trigger switch on the steering control lever to “F” for FORWARD position. Place the transmission speed control in “3” for THIRD SPEED.
5. Gradually increase the engine speed to high idle. The service brakes should prevent the machine from moving.
6. Reduce the engine speed to low idle. Place the transmission direction and speed control in the NEUTRAL position.
7. Lower the work tool to the ground. Engage the parking brake. Turn the ignition key to the OFF position.
8. If the machine was able to move during the testing of the service brakes, inspect the brake components for wear or damage. Service the brake system before you return the machine to operation.
9. After the brakes are serviced, perform this procedure again.

i02424797

Service Brake Discs - Check

SMCS Code: 4251-535; 4255-535

⚠ WARNING

A change in the braking characteristics or a low pressure warning may be an indication of a failure in one of the brake circuits. Personal injury or death may occur if the machine is operated before repairs have been made or before all circuits have been checked. Always check the brakes after brake repairs have been made and before the machine is put back into use.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Reference: For more information on preparing the machine for troubleshooting, refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting”.
Brake service life can vary greatly because of the different applications and operator technique.

Excessive heat can be generated if the service brakes are used as a retarder. Excessive heat can be generated if the service brakes are used as a device to maintain a slower ground speed. This type of operation should be avoided by using a lower transmission gear speed.

Check the grooves on both sides of each disc in both the front and rear service brakes. The wear of the service brake disc may vary from one end of the machine to the other end, and from one side of the machine to the other side. The estimated wear for a given groove depth is shown in table 7 .

It is very important to change the friction discs as soon as possible once the groove depth has reached the maximum wear limit. As the depth of the grooves is reduced, the flow of the cooling oil is reduced. This causes heat to build up. The heat causes the rapid wear of the disc material. Eventually, the friction material will wear off the disc. This will cause metal to metal contact between the disc and plates. This problem is known as spalling.

Spalling will destroy the very smooth surface finish of the plate. This will make replacement of these brake components necessary.

If the failure has progressed to metal to metal contact, the complete axle must be thoroughly cleaned. This process of cleaning the axle must be done correctly, or the debris will continue to contaminate the oil. This will cause the material on the service brake disc to wear rapidly. This condition will cause premature failure of the service brakes.

If excessive brake wear or premature brake wear is suspected, perform a scheduled oil sampling. This report could help establish a possible cause for failure of the service brakes.

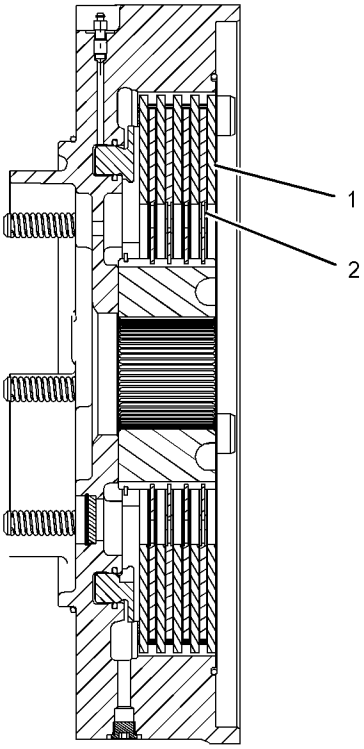


Illustration 14 g01211854

Components to Check for Wear in the Service Brakes

(1) Plate
(2) Friction disc

The thickness of a new friction disc (2) is 6.10 ± 0.13 mm (.240 ± .005 inch).

The recommended minimum thickness of a worn friction disc is 5.05 mm (.199 inch).

Replace the friction disc when the minimum thickness is reached.

Note: Check each service brake disc in each service brake.

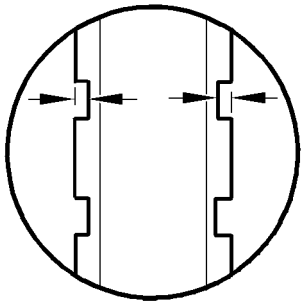


Illustration 15 g00478267

Measuring the Depth of the Oil Grooves on the Service Brake Disc

Note: Groove depth is the most critical dimension. If the depth of the grooves on the service brake discs are too shallow, oil flow to the service brakes will be inadequate. The oil flow cools the brakes.

1. Check the groove depth on both sides of the service brake disc. Check all service brake discs in each service brake.

2. The depth of the oil grooves must be greater than 0.53 mm (.021 inch).

Table 7

Disc Thickness Wear Chart		
Estimated Percentage of Remaining Brake Disc Life	**Width of Disc**	**Oil Groove Depth(1)**
100	6.1 mm (.240 inch)	1.05 mm (.041 inch)
80	5.89 mm (.232 inch)	0.94 mm (.037 inch)
60	5.68 mm (.224 inch)	0.83 mm (.033 inch)
40	5.47 mm (.215 inch)	0.72 mm (.028 inch)
20	5.26 mm (.207 inch)	0.61 mm (.024 inch)
0	5.05 mm (.199 inch)	0.53 mm (.021 inch)

(1) Groove depth is the most critical measurement.

Note: In order to calculate the wear of the oil groove depth, 50% of the new groove depth is used.

Reference: For more information on checking the service brakes, refer to the Service Manual module Disassembly and Assembly, “Final Drive and Brake Assemblies” for the machine that is being serviced.

i01670664

Brake System Air - Purge

SMCS Code: 4250-542-AI

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

⚠ WARNING

Personal injury or death can result if two persons are not used in the following procedure.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Machine Preparation

Prepare the machine for testing by completing the procedure that is specified in the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting”.

Purge Procedure

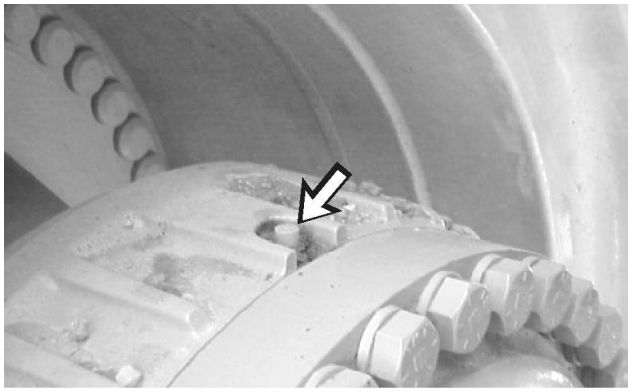


Illustration 16 g00857296

The Location of the Purge Screw on the Service Brake.

The four air purge screws for the service brakes are located on the top of the corresponding axle housing.

Note: Perform this procedure for one service brake at a time.

1. Check the hydraulic tank oil level. Make sure that you maintain the correct oil level in the hydraulic oil tank throughout the air removal procedure.
2. Start the engine. Allow the oil pressure to increase to the cut-out pressure.
3. The operator should slightly depress the brake pedal. Hold the brake pedal in this position throughout Step 4 and Step 5. Use 700 kPa (100 psi) or less of brake pressure.
4. Fasten one end of a transparent tube that is 6.4 mm (.25 inch) in diameter to an air purge screw. Put the other end of the tube into a suitable container for collecting the hydraulic oil. The tube may also be routed back to the hydraulic oil tank. Loosen the air purge screw.
5. As the hydraulic oil flows through the tube, look for air bubbles in the oil. When no air bubbles are observed in the flow of oil, tighten the air purge screw. Release the brake pedal. Repeat Steps 4 and 5 until no air bubbles are observed in the flow of oil.
6. Perform this procedure for each of the other service brakes. Make sure that all air purge screws are tightened.
7. Fill the hydraulic tank, if necessary.

Note: If the brake pedal is spongy during the first hours of operation, perform this procedure again.

i03210787

Limit Switch (Stop Light) - Adjust

SMCS Code: 4269-025-ZS

⚠ WARNING

Personal injury or death can result if two persons are not used in the following procedure.

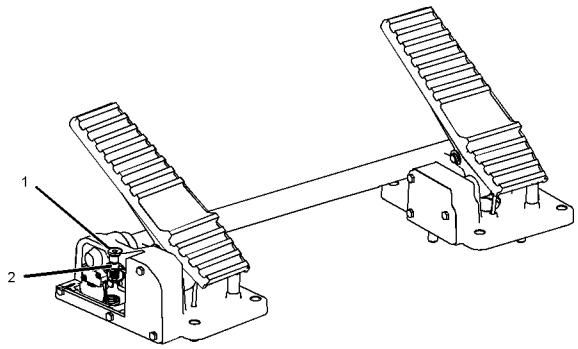


Illustration 17 g01131873

(1) Plug
(2) Adjustment screw

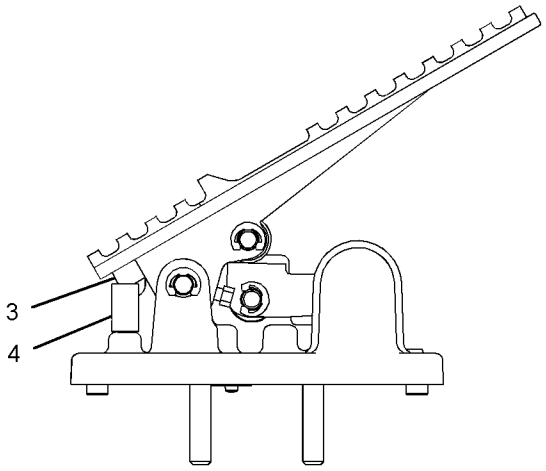


Illustration 18 g01131969

Side view of the right service brake pedal

(3) Pedal stop
(4) Treadle heel stop

1. Move the machine to a hard, level surface. The surface must also be dry and free of debris. Engage the parking brake. Turn the ignition switch to the OFF position.

2. Ensure that there is no interference with other components when both of the brake pedals are applied and released. When both brake pedals are in the released position, the stop lights for the machine should be in the OFF position.

3. Insert a 3.5 mm (0.14 inch) shim between Treadle heel stop (4) and pedal stop (3) of both the left brake pedal and the right brake pedal. Monitor the stop lights. When the shims are in place, the stop lights should be in the ON position. Remove the shims.

4. Insert a 1.5 mm (0.06 inch) shim between Treadle heel stop (4) and pedal stop (3) of both the left brake pedal and the right brake pedal. Monitor the stop light. When the shims are in place, the stop lights should be in the OFF position. Remove the shims.

5. Ensure that the stop lights go ON and OFF when the brake pedals are applied and released. If the stop lights work properly no adjustments are necessary at this time.

6. If steps 3, 4, and 5 are not satisfied perform the following procedure.

7. Insert a 3.5 mm (0.14 inch) shim between Treadle heel stop (4) and pedal stop (3) of both the left brake pedal and the right brake pedal.

8. Remove plug (1) and turn the adjustment screw for switch (2) counterclockwise in order to turn the stop lights OFF. Then, turn the adjustment screw for the switch clockwise until the stop lights turn ON. When the shims are in place, the stop lights should be in the ON position. Remove the shims. The stop light should go to the OFF position.

9. Insert the 1.5 mm (0.06 inch) shim between Treadle heel stop (4) and pedal stop (3) of both the left brake pedal and the right brake pedal. Monitor the stop lights. When the shims are in place, the stop lights should be in the OFF position. Remove the shims.

10. Ensure that the stop lights go ON and OFF when both of the brake pedals are applied and released. Repeat steps 7, 8, and 9 if the stop lights do not work properly.

Note: If the stop lights will not operate properly after the adjustment procedure, remove the cover for the enclosure. The limit switch may need to be replaced.

11. Install plug (1). If necessary, install the enclosure cover.

i03729781

Limit Switch (Throttle Lock Deactivation) (Electronic Technician) - Adjust

SMCS Code: 4269-025-ZS

Table 8

Required Tools		
Part Number	**Description**	**Quantity**
139-4166	Data Link Cable	1
7X-1425	Cable	1
4C-6805	Adapter	1
171-4400	Communication Adapter Tool	1

The software program that will be used for this test procedure is the Caterpillar Electronic Technician (ET). The Caterpillar Electronic Technician is a software program that can be used on an IBM-compatible personal computer.

1. Connect the laptop computer to the service connector in the cab.

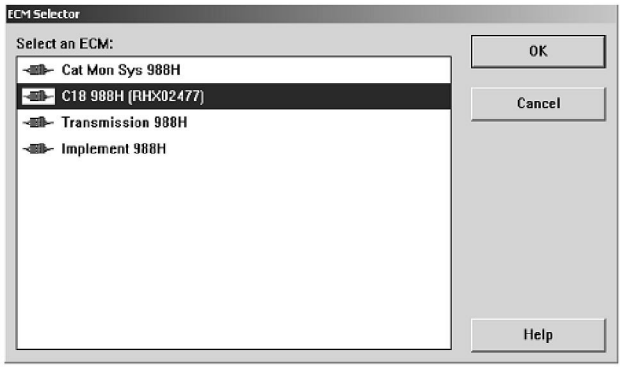


Illustration 19 g01261519

Typical example of ET menu

2. Open the software program (ET). Select the engine ECM from the “ECM Selector” menu.

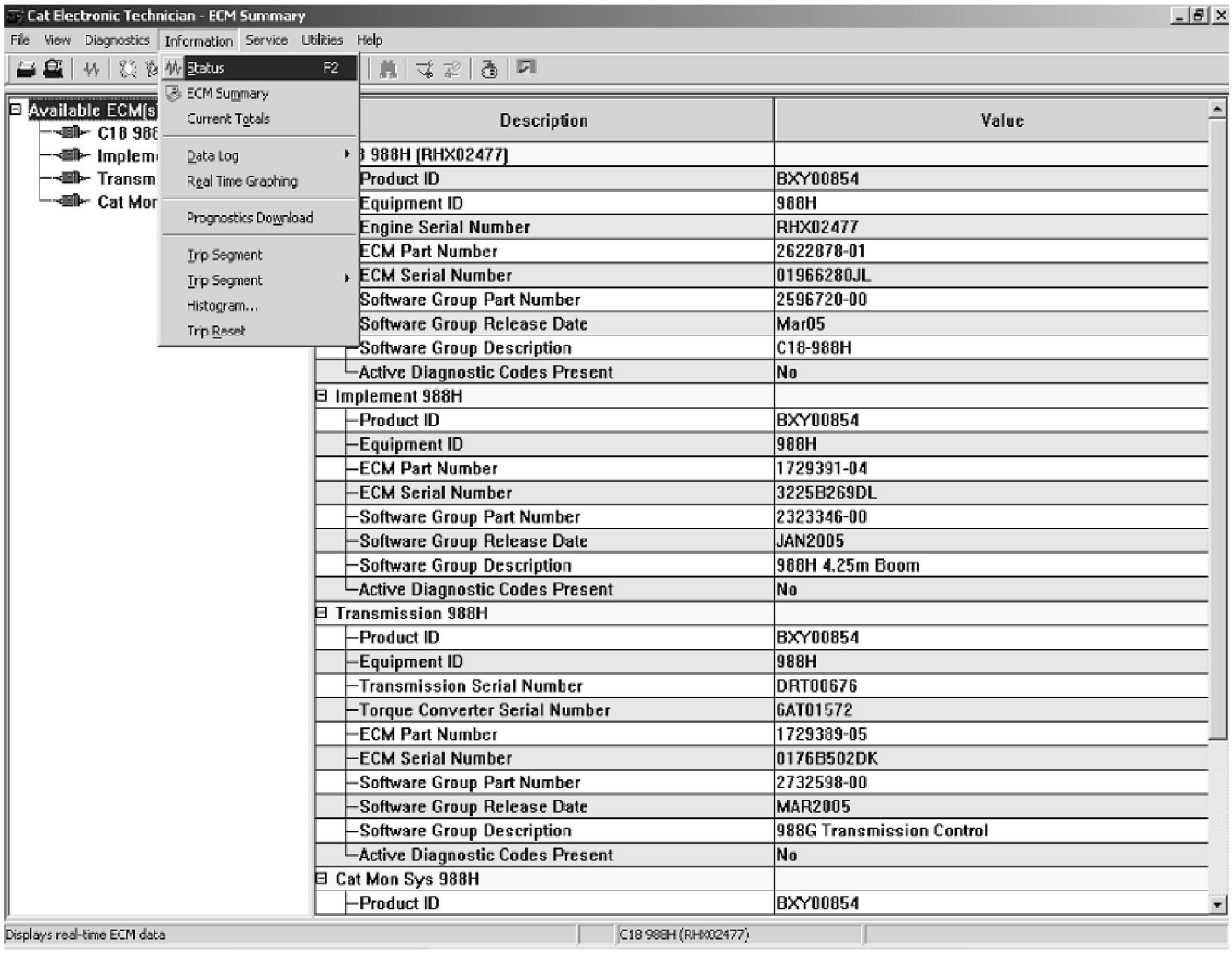


Illustration 20 g01261520

Typical example of ET menu

3. Select the “Information” menu item from the toolbar. Select the “Status” menu item.

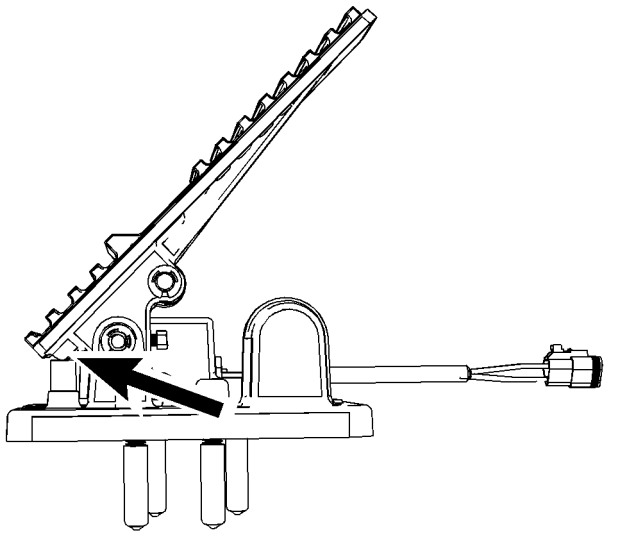


Illustration 21 g01148913

Location for the shim

4. Place a 1.55 mm (0.062 inch) shim between the pedal stop and the right hand brake pedal.

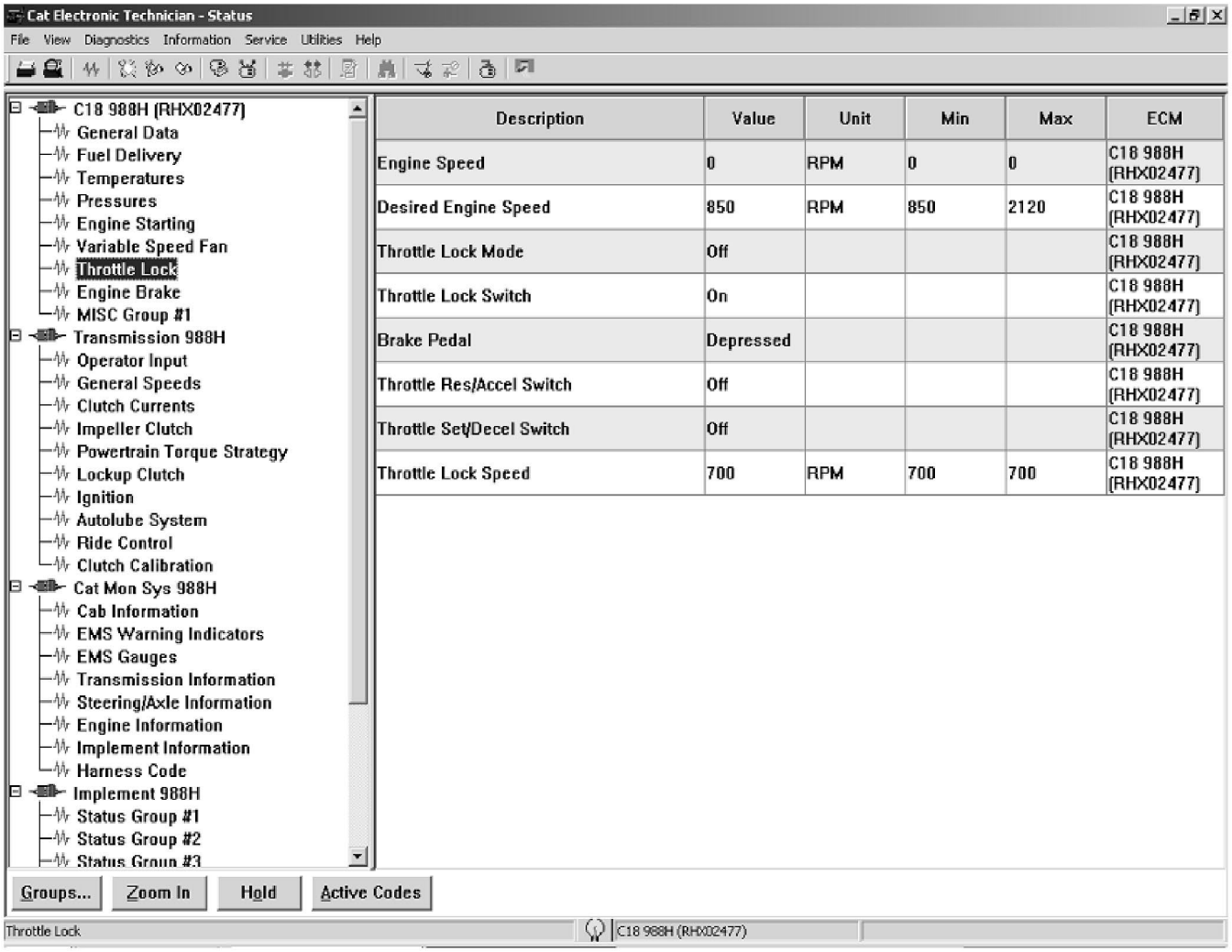


Illustration 22 g01261612

Typical example of ET menu

“Depressed” status of the brake pedal

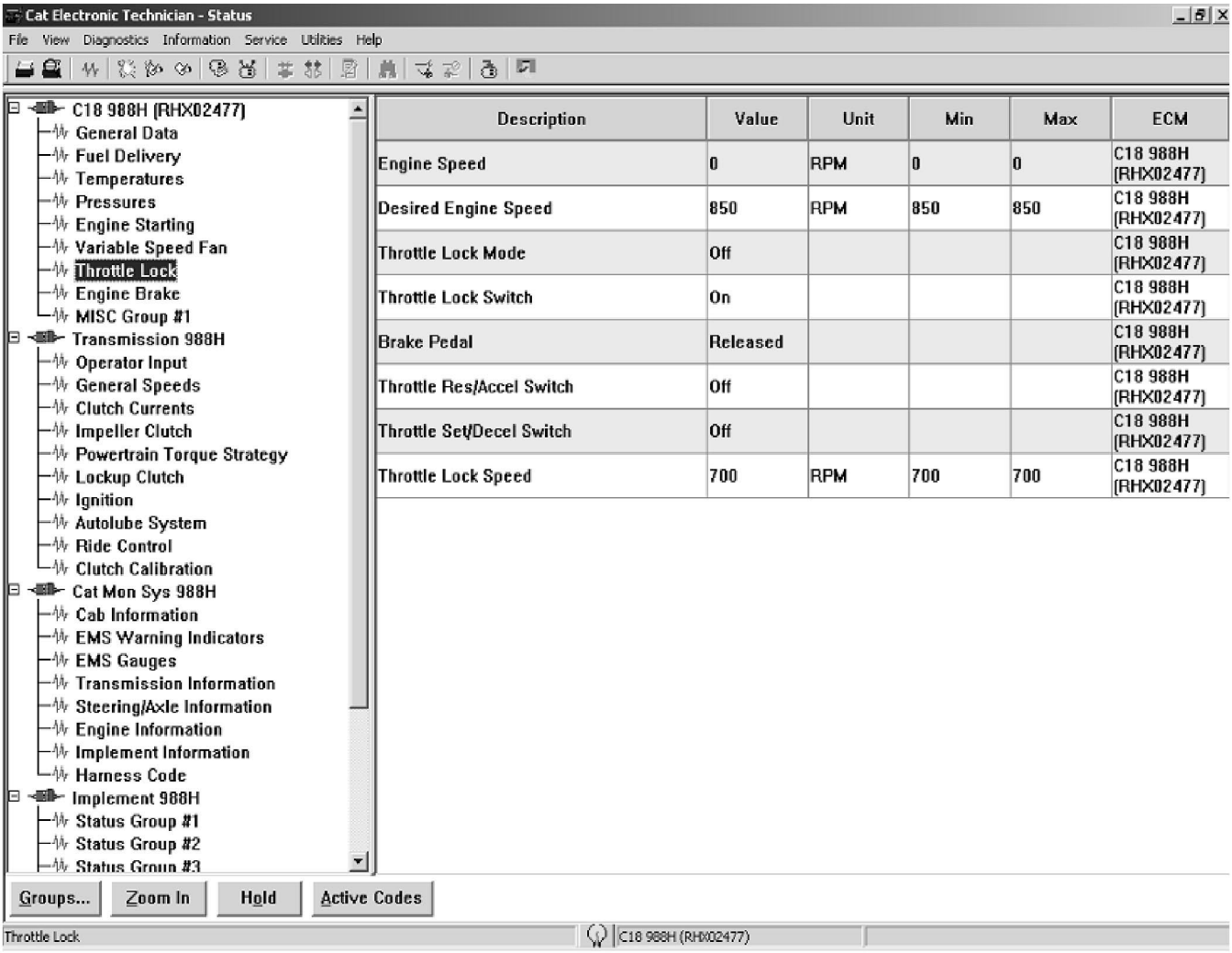


Illustration 23 g01261615

Typical example of ET menu

“Released” status of the brake pedal

5. Select “Throttle Lock” in ET. If “Depressed” appears in the “Brake Pedal” row under the “Value” column, proceed to Step 10. If “Released” appears, proceed to Step 6.

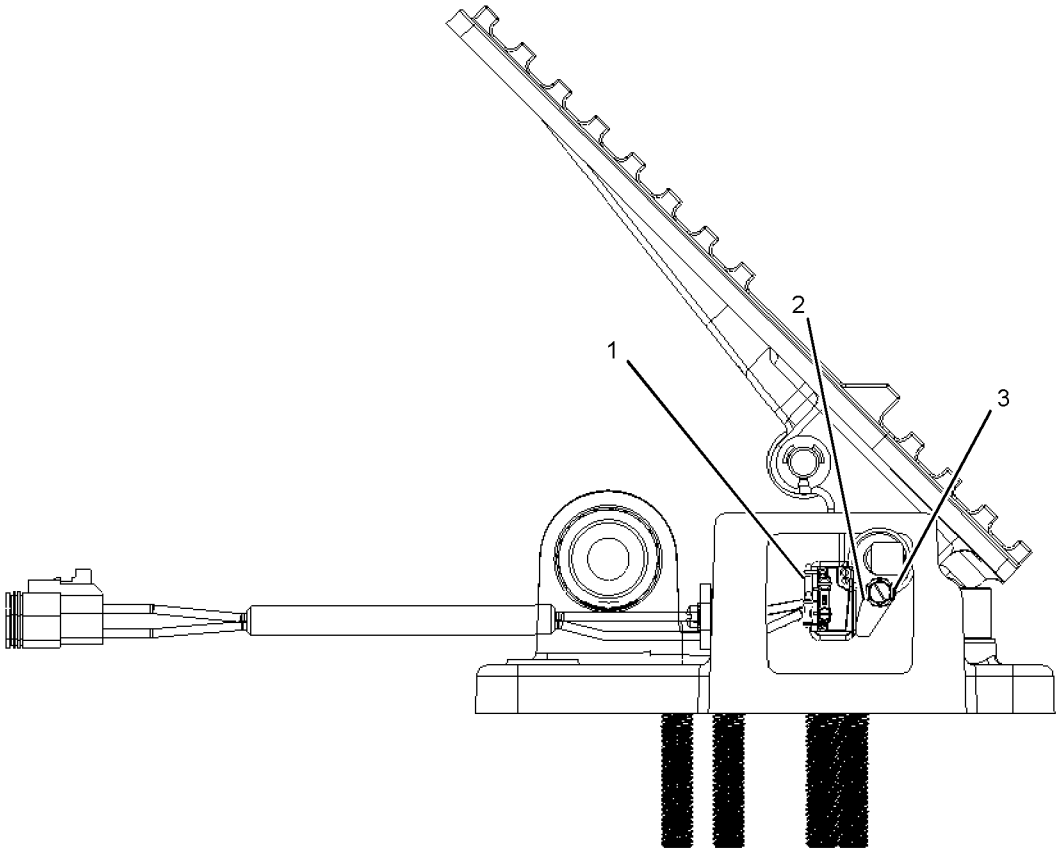


Illustration 24 g01148943

(1) Limit switch for throttle lock deactivation (2) Adjustment plate (3) Adjustment screw

6. Remove the three screws from the cover plate on the right hand brake pedal switch in order to access adjustment screw (3).

7. Place a 1.55 mm (0.062 inch) shim between the pedal stop and the right hand brake pedal.

8. Loosen adjustment screw (3). Adjust adjustment plate (2) until “Depressed” appears in the “Brake Pedal” row under the “Value” column in ET. Then, torque adjustment screw (3) to 1.4 ± 0.3 N·m (12 ± 3 lb in).

9. Remove the shim from the pedal stop.

10. Place a 0.775 mm (0.031 inch) shim between the pedal stop and the right hand brake pedal.

11. Verify that “Released” appears in the “Brake Pedal” row under the “Value” column in ET. If “Released” now appears, proceed to Step 12. If “Released” does not appear, repeat Step 6 through Step 10.

12. Remove the shim from the pedal stop.

13. If the cover plate was removed, replace the cover plate with the three screws.

i04684470

Limit Switch (Parking Brake) - Adjust

SMCS Code: 4284-025-ZS

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

Note: Refer to callout (2) of the illustrations below to determine the procedure for your machine. Callout (2) of Illustration 25 has a plateau. Callout (2) of Illustration 26 has a full ramp.

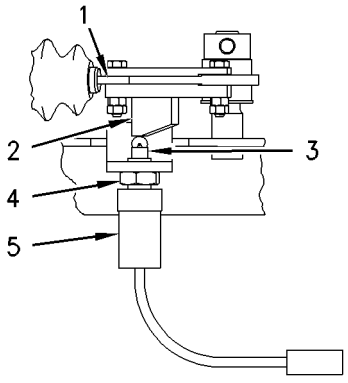


Illustration 25 g00856535

Parking Brake Limit Switch (Plateau)

(1) Valve stem
(2) Block assembly
(3) Switch actuator
(4) Jam nut
(5) Plate

When the ignition key is in ON position and the parking brake knob is pulled out, the alert indicator for the parking brake should flash. If the alert indicator does not flash, adjustment of parking brake limit switch (3) is required. The parking brake limit switch is located under the left side of the cab.

1. Park the machine on a hard level surface. Install the steering lock. Stop the engine. Pull the parking brake knob outward in order to engage the parking brake. Chock the wheels.

2. Fully extend valve stem (1). Loosen jam nut (4).

3. Test limit switch (3) in order to verify that the switch is functioning properly. Depress switch actuator (3). Turn the ignition key to the ON position. When the switch actuator is depressed, the alert indicator for the parking brake should flash. If this condition does not happen, replace the switch. Turn the ignition key to the OFF position.

4. Rotate limit switch (3) clockwise until the wheel rolls freely on the incline of block assembly (2). Rotate limit switch (3) clockwise by an additional 1 1/2 turn. Tighten locknut (4) to a torque of 10 N·m (7 lb ft).

Note: If actuator (3) does not contact the flat area on block assembly (2), the parking brake control cable may need adjustment.

Reference: For more information about adjusting the parking brake control cable, refer to the Service Manual module Testing and Adjusting, “Parking Brake Control Cable - Adjust”.

5. Check the alert indicator for the parking brake. The alert indicator should flash when the ignition key is turned to the ON position. If the alert indicator does not flash, repeat step 2. Rotate the limit switch clockwise for an additional half turn. Repeat until the alert indicator flashes. Repeat step 5.

.

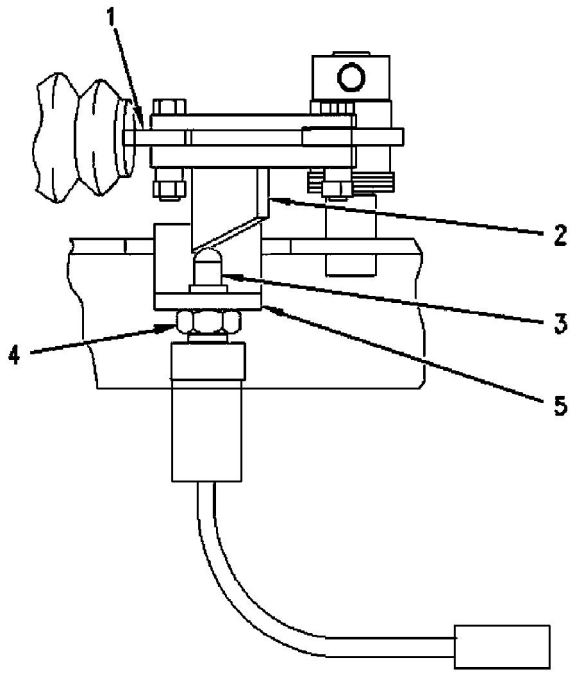


Illustration 26 g02797626

Parking Brake Limit Switch (Full Ramp)

(1) Valve stem
(2) Block assembly
(3) Switch actuator
(4) Jam nut
(5) Plate

1. Park the machine on a hard level surface. Install the steering lock. Stop the engine. Pull the parking brake knob outward in order to engage the parking brake. Chock the wheels.

2. Retract valve stem (1) fully “Park Brake Off” .

3. Install switch (3) in plate (5) until the wheel just contacts the flat area on block assembly (2).

4. Rotate switch (3) clockwise or counter clockwise quarter turn until the wheel orients to roll freely on the incline of block assembly (2).

5. Tighten locknut (4) to a torque of 10 N·m (7 lb ft).

6. Check the alert indicator for the parking brake. The alert indicator should flash when the ignition key is turned to the ON position. If the alert indicator does not flash, repeat step 2. Rotate the limit switch clockwise for an additional half turn. Repeat until the alert indicator flashes. Repeat step 6.

i01670867

Parking Brake - Test

SMCS Code: 4267-081

This procedure should be used to determine if the parking brake is functioning properly. This procedure is not intended to measure the maximum brake holding effort. The brake holding effort that is required to sustain a machine at a specific engine rpm varies depending on the machine.

⚠ WARNING

Personal injury can result if the machine moves while testing the parking brake.

If the machine begins to move during the test, reduce the engine speed immediately and apply the service brakes.

Test the parking brake on a dry, level surface.

Check the area around the machine. Make sure that the machine is clear of personnel and clear of obstacles.

Make sure that the steering frame lock is in the STORED position.

Fasten the seat belt before you test the parking brake.

1. Start the engine. Run the engine until the hydraulic oil reaches the normal operating temperature. Raise the work tool slightly.

2. Engage the parking brake. Move the trigger switch on the steering control lever to “F” for FORWARD position. Place the transmission speed control in “3” for THIRD SPEED.

Note: When the transmission is shifted to “F” or “R” position with the parking brake engaged, a Warning Category 2 will occur.

3. Gradually increase the engine speed to high idle. The engaged parking brake should prevent the machine from moving.

4. Reduce the engine speed to low idle. Place the transmission direction and speed control in the NEUTRAL position.

5. Lower the work tool to the ground. Stop the engine.

6. If the machine was able to move during the testing of the parking brake, inspect the parking brake components for wear or damage. Replace any damaged components before you return the machine to service.

i01661248

Parking Brake - Manual Release

SMCS Code: 4267-553-MA

⚠ WARNING

When the parking brakes are released manually, the machine has no brakes.

To avoid possible personal injury, the tires must be blocked securely before the parking brakes are manually released.

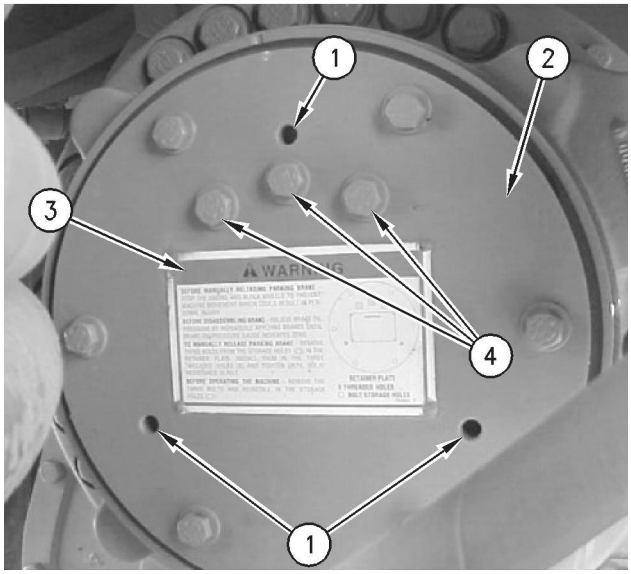


Illustration 27 g00857336

Parking Brake

(1) Threaded bolt holes
(2) Retainer plate
(3) Warning plate
(4) Bolts in the storage locations

When the machine can not be operated or if the brake system does not have sufficient hydraulic pressure, the parking brake will be automatically engaged. The parking brake can be manually released when it is necessary. Perform the following procedure in order to manually release the parking brake.

The parking brake is located under the cab of the machine between the articulated hitches.

1. Block the wheels securely before manually releasing the parking brake.

2. Remove three bolts (4) from the storage locations.

3. Install bolts (4) into threaded holes (1).

4. Tighten the bolts in threaded holes (1) until solid resistance is felt. This will force retainer plate (2) outward in order to release the parking brake.

5. When the manual release of the parking brake is no longer necessary, remove bolts (4). This will engage the parking brake. Install the bolts in the storage locations.

Note: Instructions for this procedure are located on warning plate (3).

i01661607

Parking Brake Control Cable - Adjust

SMCS Code: 4284-025-KA

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

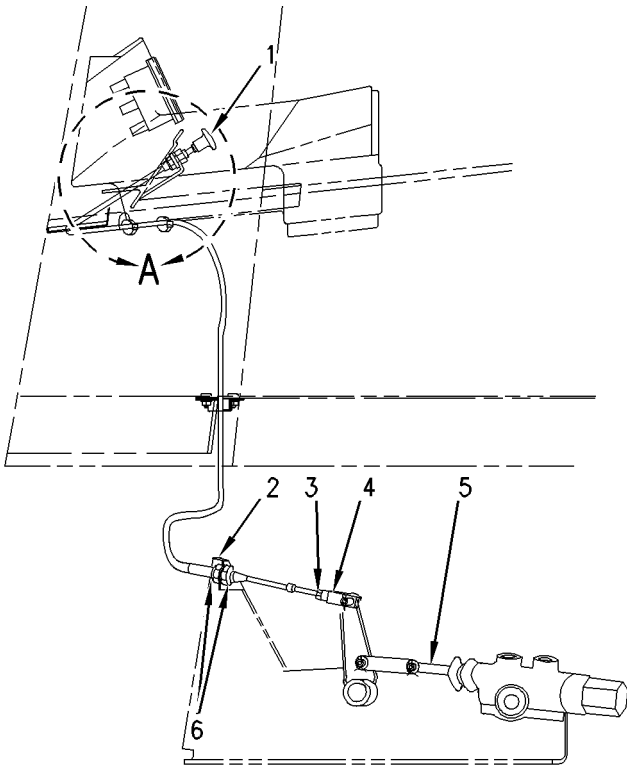


Illustration 28 g00857570

(1) Parking brake control knob. (2) Bulkhead mount. (3) Locknut. (4) Clevis. (5) Control valve stem. (6) Bulkhead nuts.

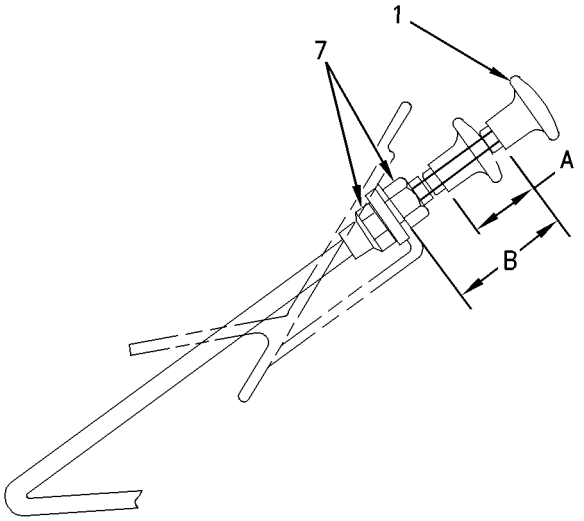


Illustration 29 g00857655

Detail A

(1) Parking brake control knob. (7) Bulkhead nuts.

The parking brake control cable is the connector between parking brake control knob (1) and the parking brake control valve. The control cable may need to be adjusted if the parking brake does not release properly. Adjustment of the parking brake limit switch may also require the parking brake control cable to need adjustment.

1. Park the machine on a hard, level surface. Stop the engine. Install the steering lock.

2. Pull out parking brake control knob (1) until dimension (B) is 55 mm (2 inch). If necessary, adjust bulkhead nuts (7) in order to reach this dimension.

3. Adjust bulkhead nuts (6) in order to allow control valve stem (5) to be fully extended. Jam nut (3) can be loosened in order to thread clevis (4) on the cable rod end . This will also cause control valve stem (5) to extend.

Note: Control valve stem (5) must be fully extended before the bulkhead nuts are tightened. If adjustment of bulkhead nuts (6) or adjustment of clevis (4) does not allow the control valve stem to be fully extended, the parking brake control cable should be replaced.

4. Tighten bulkhead nuts (6) and bulkhead nuts (7) to a torque of 38 ± 7 N·m (28 ± 5 lb ft). Do not allow the nuts to damage the seals. If necessary, tighten jam nut (3).

Note: Dimension (A) is the total amount of travel for the parking brake cable. Dimension (A) equals 33.6 mm (1.32 inch).

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RENR8835
October 2005

Specifications

844H Wheel Dozer
Hydraulic System

BTW 1-Up (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Specifications Section

i02364855

Hydraulic Tank and Filter (Implement, Brake)

SMCS Code: 5056-II; 5056-BRK

Part No.: 237-4228

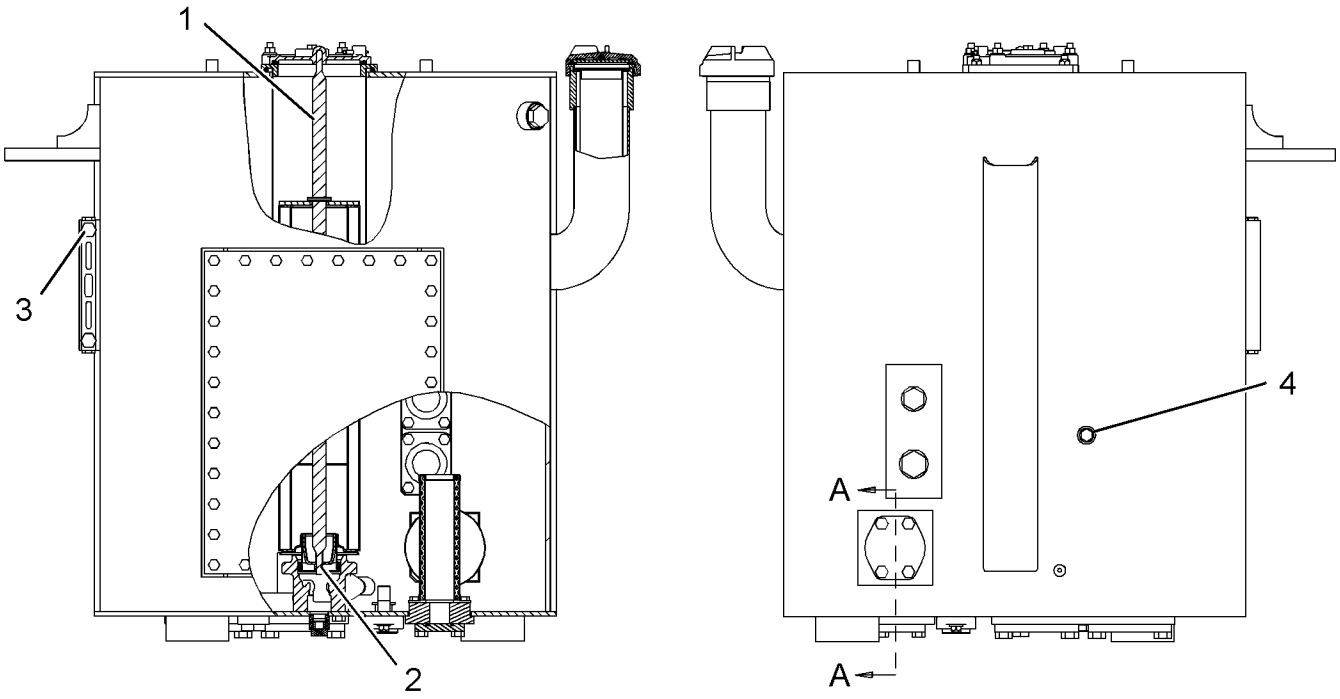


Illustration 1 g01181084

Front view and rear view

(1) Torque for the stud.....35 ± 5 N·m (26 ± 4 lb ft)

(2) Torque for the nut .....20 ± 1.5 N·m (15 ± 1 lb ft)

(3) Torque for the gauge bolts.....7 ± 1 N·m (60 ± 9 lb in)

(4) Use air in order to pressure test the tank. ..... 150 ± 35 kPa (22 ± 5 psi)

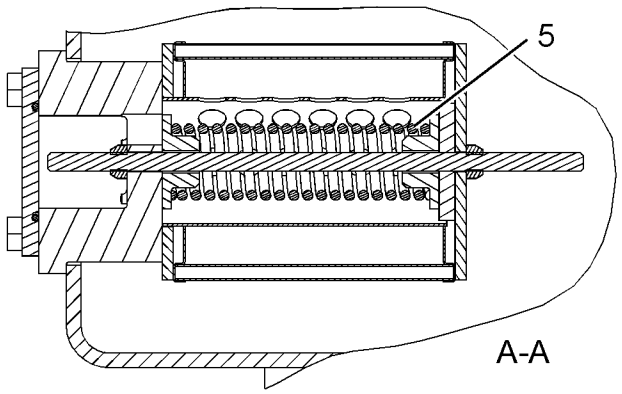


Illustration 2 g01181085
Section A-A

(5) 9F - 8175 Spring

Length under test force ..... 122 mm (4.8 inch)
Test force.....667 ± 31 N (150 ± 7 lb)
Free length after test ..... 192 mm (7.56 inch)
Outside diameter..... 41.4 mm (1.63 inch)

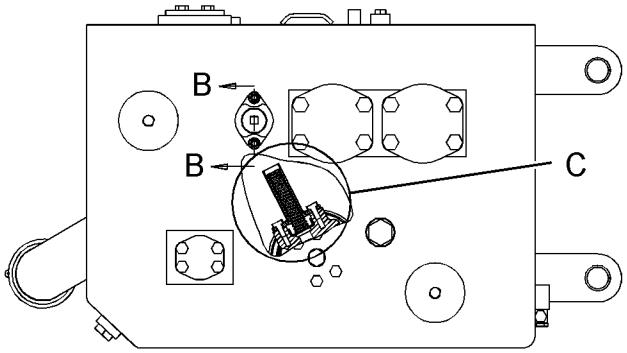


Illustration 3 g01181086
Bottom view

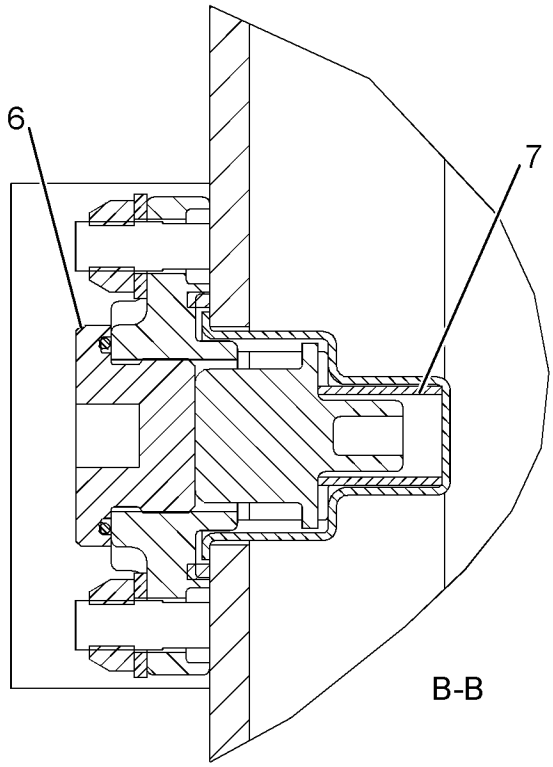


Illustration 4 g01181087
Section B-B

(6) Torque for the plug.....68 ± 7 N·m (50 ± 5 lb ft)

(7) 7B - 3039 Spring

Length under test force ..... 26.19 mm (1.03 inch)
Test force.....15.55 ± 1.25 N (3.50 ± 0.3 lb)
Free length after test ..... 36.5 mm (1.44 inch)
Outside diameter..... 19.8 mm (0.78 inch)

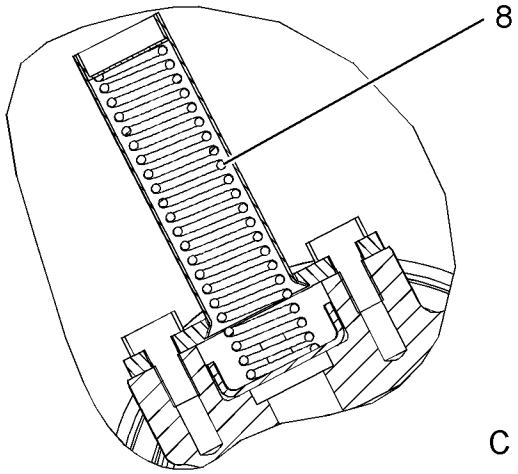


Illustration 5 g01181088
Section C

(8) 1L - 4349 Spring

Length under test force ..... 106.0 mm (4.17 inch)
Test force..... 83.9 ± 6.7 N (19 ± 1.5 lb)
Free length after test ..... 139.7 mm (5.5 inch)
Outside diameter..... 24.41 mm (0.96 inch)

i02361244

Temperature Sensor (Implement, Brake Oil)

SMCS Code: 509T

Part No.: 134 - 2252

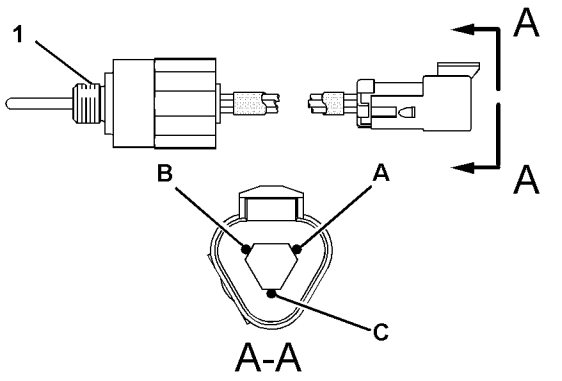


Illustration 6 g01071376

(1) Torque for installing the sensor .....20 ± 3 N·m
(15 ± 2 lb ft)

i02362004

Hydraulic Tank and Filter (Steering, Hydraulic Fan)

SMCS Code: 5056-HFN; 5056-ZH

Part No.: 6E-4683

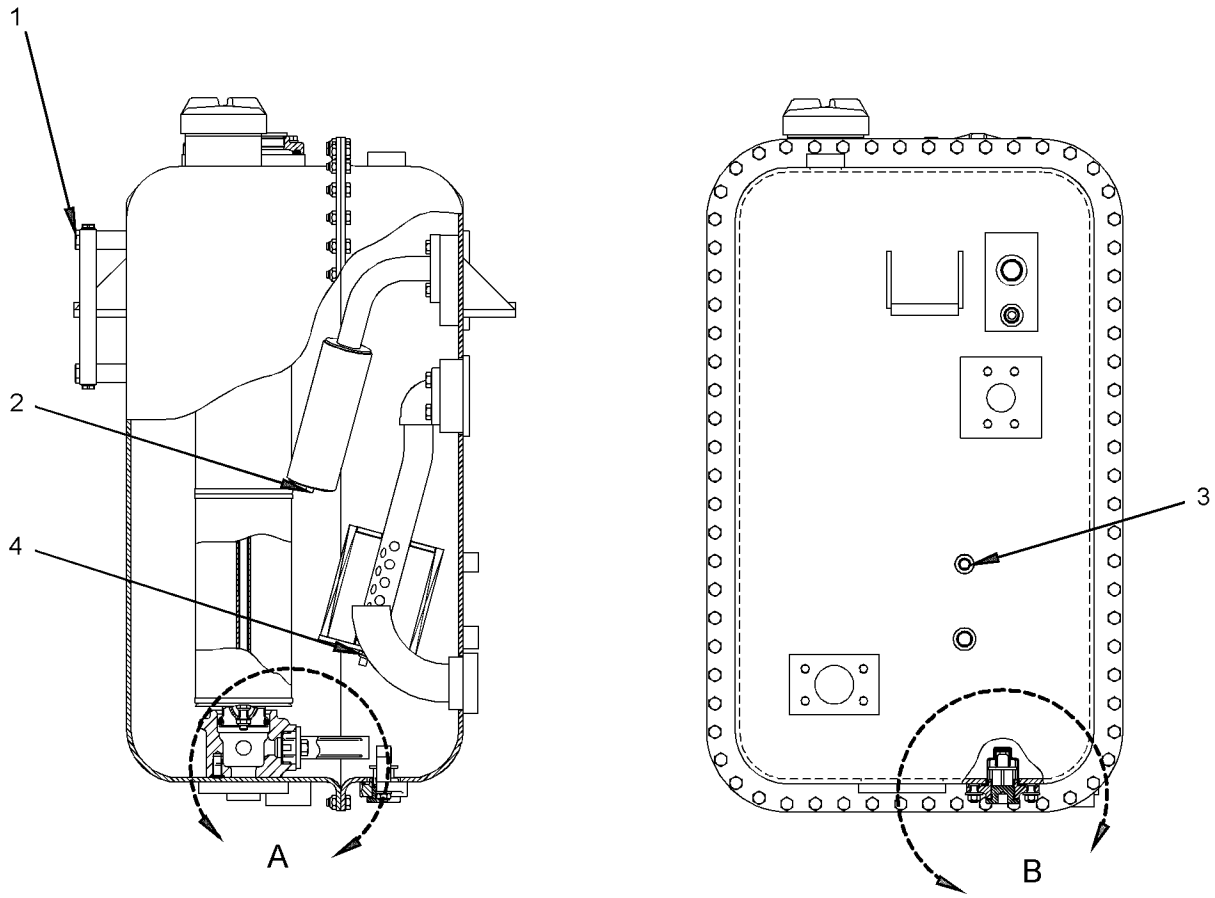


Illustration 7
g01179935

(1) Torque for the gauge bolts.....7 ± 1 N·m (5 ± 1 lb ft)

(2) Tightening torque for nut .....20 ± 5 N·m (15 ± 4 lb ft)

(3) Use air and pressure test the tank. ... 150 ± 35 kPa (22 ± 5 psi)

(4) Tightening torque for nut .....20 ± 5 N·m (15 ± 4 lb ft)

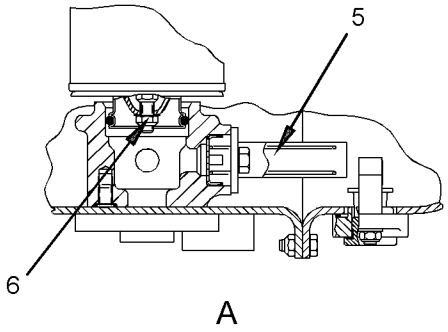


Illustration 8 g01179938

(5) 1L - 4349 Spring

Length under test force ..... 106 mm (4.2 inch)
Test force.....84 ± 7 N (19 ± 1.6 lb)
Free length after test ..... 139.7 mm (5.5 inch)
Outside diameter..... 24.4 mm (1 inch)

(6) Tightening torque for nut .....10 ± 1.5 N·m (7 ± 1 lb ft)

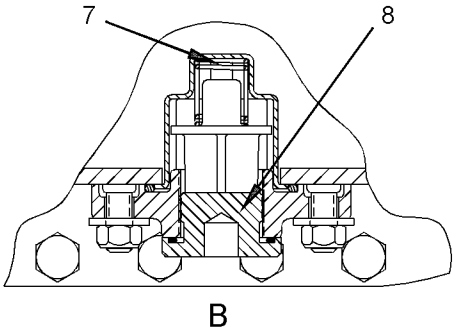


Illustration 9 g01179940

(7) 7B - 3039 Spring

Length under test force ..... 26.2 mm (1 inch)
Test force..... 15.55 ± 1.5 N (3.5 ± 0.3 lb)
Free length after test ..... 36.5 mm (1.4 inch)
Outside diameter..... 16.5 mm (0.7 inch)

(8) Tightening torque for plug .....68 ± 7 N·m (50 ± 5 lb ft)

i02368717

Breaker Relief Valve

SMCS Code: 5118

Part No.: 220 - 0812

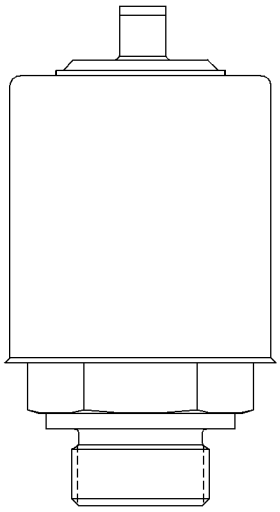


Illustration 10 g01047312

Vacuum relief cracking pressure ..... 1 kPa (0.2 psi)

Pressure relief cracking pressure for the 133 - 1963 Breaker Relief Valve ..... 130 ± 20 kPa (19 ± 3 psi)

Pressure relief cracking pressure for the 220 - 0812 Breaker Relief Valve ..... 35 ± 7 kPa (5 ± 1 psi)

Burst Pressure.....620 kPa (90 psi)

Temperature Range..... −40 to 121 °C (−40 to 250 °F)

i02361263

Temperature Switch (Steering, Hydraulic Fan Oil)

SMCS Code: 1435-HFN; 1435-ZH

Part No.: 131 - 4135

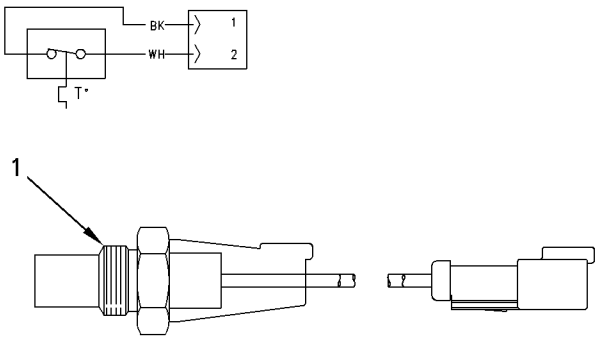


Illustration 11 g00274508

The switch has a normally closed position.

Actuation temperature ..... 102° ± 3°C (216° ± 5°F)

Minimum deactuation temperature..... 90°C (194°F)

(1) Final installation torque .....82 ± 8 N·m (60 ± 6 lb ft)

i02365961

Gear Pump (Pilot, Brake)

SMCS Code: 4014-GT; 5073-P&B

Part No.: 230-0914

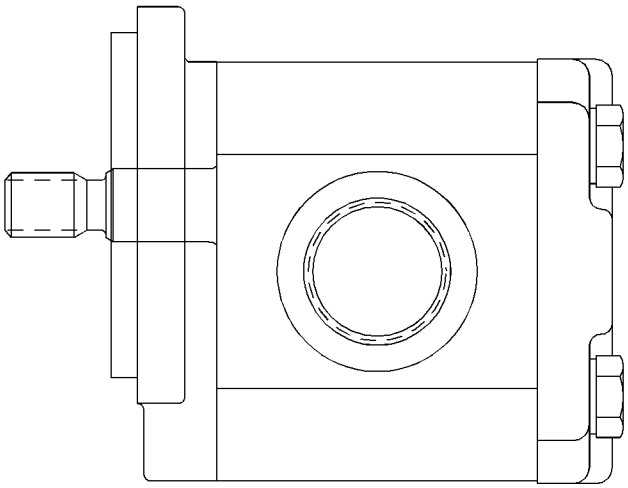


Illustration 12 g01181451

The rotation of the shaft is counterclockwise when the pump is viewed from the shaft end.

For testing purposes, use SAE 10 oil at 65°C (150°F) .

Test at full speed:

Output .....46 L/min (12 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed .....2040 rpm
Engine speed .....2000 rpm

Output ..... 44 L/min (11.5 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed .....2040 rpm
Engine speed .....2000 rpm

Test at half speed:

Output .....23 L/min (6 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed .....1020 rpm
Engine speed .....1000 rpm

Output .....22 L/min (5.8 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed .....1020 rpm
Engine speed .....1000 rpm

i01633191

Vane Pump (Implement)

SMCS Code: 5055-II; 5084-VA

Part No.: 157-0956

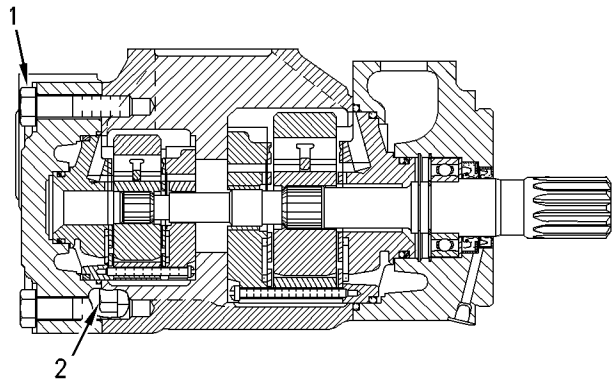


Illustration 13 g00324923

The rotation of the shaft is counterclockwise when the pump is viewed from the drive end.

Type: Vane Pump

For testing purposes, use SAE 10 oil at 65°C (150°F) .

(1) Torque for the four bolts.....95 ± 7 N·m (70 ± 5 lb ft)

(2) Torque for the four bolts.....203 ± 14 N·m (150 ± 10 lb ft)

Large Section (Shaft End)

Test at full speed:

Output .....234 L/min (62 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed ..... 2128 rpm
Engine speed .....2000 rpm

Output .....211 L/min (56 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed ..... 2128 rpm
Engine speed .....2000 rpm

Test at half speed:

Output .....117 L/min (31 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed ..... 1064 rpm
Engine speed .....1000 rpm

Output .....106 L/min (28 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed ..... 1064 rpm
Engine speed .....1000 rpm

Small Section (Cover End)

Test at full speed:

Output .....104 L/min (27.5 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed ..... 2128 rpm
Engine speed .....2000 rpm

Output .....94 L/min (25 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed ..... 2128 rpm
Engine speed .....2000 rpm

Test at half speed:

Output .....52 L/min (14 US gpm)
Pressure.....690 kPa (100 psi)
Pump speed ..... 1064 rpm
Engine speed .....1000 rpm

Output .....47 L/min (12.5 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump speed ..... 1064 rpm
Engine speed .....1000 rpm

i02366014

Piston Pump (Hydraulic Fan with Standard to Mid Range Ambient Temperature Cooling)

SMCS Code: 1387-QP; 5070-HFN

Part No.: 229-0099

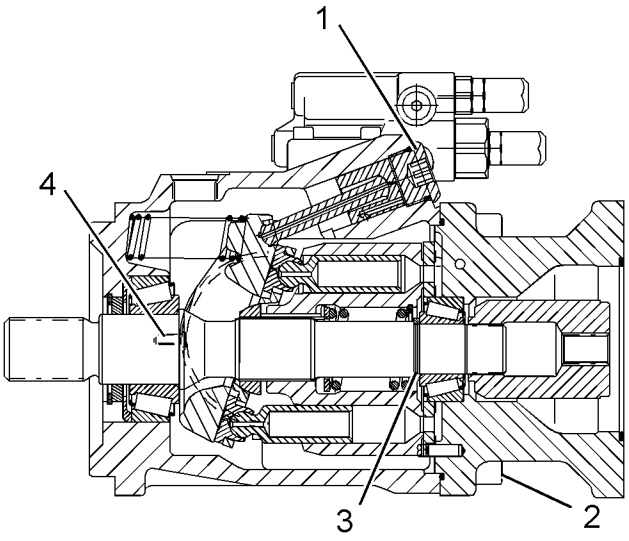


Illustration 14 g01181487

(1) Torque for the plug..... 190 N·m (140 lb ft)

(2) Torque for four bolts..... 165 N·m (120 lb ft)

(3) Grind the spacer to the required thickness. The spacer must be ground parallel to less than 0.05 mm (0.002 inch).

(4) Apply 7M-7456 Bearing Mount Compound to the threads before assembly. Tighten the screw to the following torque.....5 N·m (45 lb in)

Test at Full Speed:

Output .....121 L/min (32.0 US gpm)
Pressure.....690 kPa (100 psi)
Pump Speed ..... 2040 rpm
Engine Speed .....2000 rpm

Output .....120 L/min (31.7 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump Speed ..... 2040 rpm
Engine Speed .....2000 rpm

Test at Half Speed:

Output .....60.5 L/min (16.0 US gpm)
Pressure.....690 kPa (100 psi)
Pump Speed ..... 1020 rpm
Engine Speed .....1000 rpm

Output .....60 L/min (15.9 US gpm)
Pressure.....6900 kPa (1000 psi)
Pump Speed ..... 1020 rpm
Engine Speed .....1000 rpm

207 - 0697 Pressure and Flow Compensator Valve

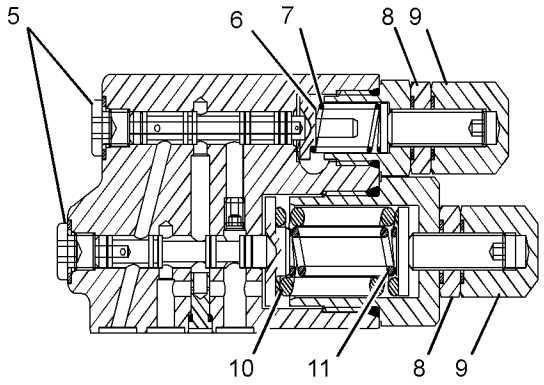


Illustration 15 g01162448

Pump Control Valve

(5) Apply 9S - 3263 Thread Lock Compound to the threads before installation.

(6) 6E - 3275 Spring

Free length ..... 20.5 mm (0.8 inch)
Outside diameter..... 10.7 mm (0.4 inch)

(7) 6E - 3274 Spring

Free length ..... 15.9 mm (0.6 inch)
Outside diameter..... 7.7 mm (0.3 inch)

(8) Torque for the locking nuts .....21 N·m (15.5 lb ft)

(9) Torque for the nuts.....21 N·m (15.5 lb ft)

(10) 6E - 3276 Spring

Free length ..... 35.6 mm (1.402 inch)
Outside diameter..... 19.2 mm (0.756 inch)

(11) 193 - 1036 Spring

Free length ..... 31.1 mm (1.225 inch)
Outside diameter..... 8.3 mm (0.327 inch)

i02366061

Piston Pump (Hydraulic Fan with High Ambient Temperature Cooling)

SMCS Code: 1387-QP; 5070-HFN

Part No.: 235 - 0843

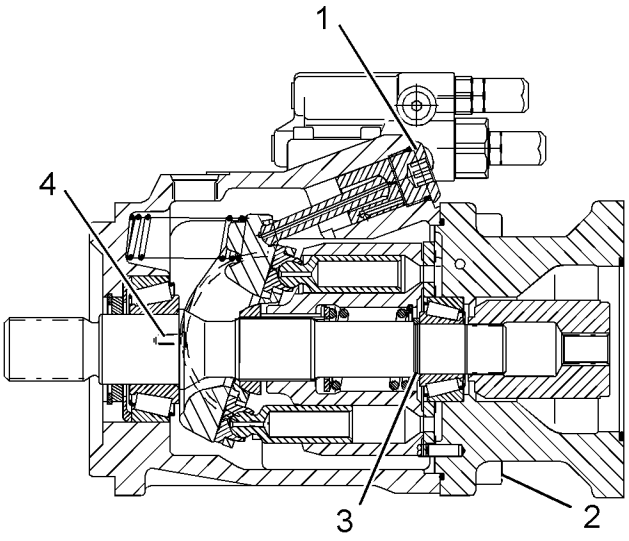


Illustration 16 g01181510

(1) Torque for the plug..... 190 N·m (140 lb ft)

(2) Torque for four bolts..... 165 N·m (120 lb ft)

(3) Grind the spacer to the required thickness. The spacer must be ground parallel to less than 0.05 mm (0.002 inch).

(4) Apply 7M - 7456 Bearing Mount Compound to the threads before assembly. Tighten the screw to the following torque.....5 N·m (45 lb in)

Test at Full Speed:

Output ..... 121 L/min (32 US gpm)
Pressure..... 690 kPa (100 psi)
Pump Speed ..... 2040 rpm
Engine Speed ..... 2000 rpm

Output ..... 120 L/min (31.7 US gpm)
Pressure..... 6900 kPa (1000 psi)
Pump Speed ..... 2040 rpm
Engine Speed ..... 2000 rpm

Test at Half Speed:

Output ..... 60.5 L/min (16.0 US gpm)
Pressure..... 690 kPa (100 psi)
Pump Speed ..... 1020 rpm
Engine Speed ..... 1000 rpm

Output ..... 60 L/min (15.9 US gpm)
Pressure..... 6900 kPa (1000 psi)
Pump Speed ..... 1020 rpm
Engine Speed ..... 1000 rpm

207 - 0697Pressure and Flow Compensator Valve

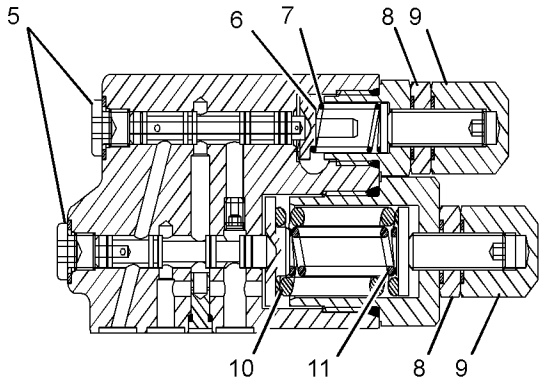


Illustration 17 g01162448

Pump Control Valve

(5) Apply 9S - 3263 Thread Lock Compound to the threads before installation.

(6) 6E - 3275 Spring

Free length ..... 20.5 mm (0.8 inch)
Outside diameter..... 10.7 mm (0.4 inch)

(7) 6E - 3274 Spring

Free length ..... 15.9 mm (0.6 inch)
Outside diameter..... 7.7 mm (0.3 inch)

(8) Torque for the locking nuts .....21 N·m (15.5 lb ft)

(9) Torque for the nuts.....21 N·m (15.5 lb ft)

(10) 6E - 3276 Spring

Free length ..... 35.6 mm (1.402 inch)
Outside diameter..... 19.2 mm (0.756 inch)

(11) 193 - 1036 Spring

Free length ..... 31.1 mm (1.225 inch)
Outside diameter..... 8.3 mm (0.327 inch)

i02364743

Piston Motor (Hydraulic Fan)

SMCS Code: 1386-QP; 5058-HFN

Part No.: 229 - 0100

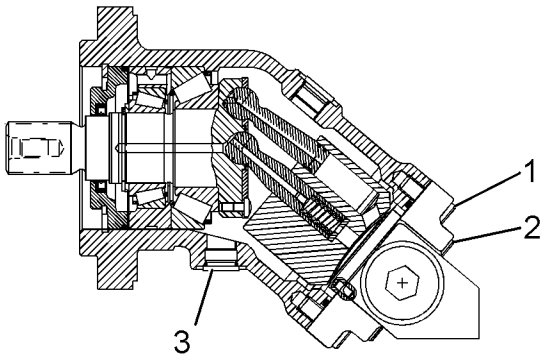


Illustration 18 g01181017

The rotation of the shaft is counterclockwise when the motor is viewed from the shaft end.

(1) Torque for 2 bolts.....100 ± 20 N·m (75 ± 15 lb ft)

(2) Torque for 4 bolts.....100 ± 20 N·m (75 ± 15 lb ft)

(3) Torque for the plug.....620 ± 80 N·m (460 ± 60 lb ft)

i02363153

Demand Fan Valve

SMCS Code: 5264-HFN; 5479-HFN

Part No.: 191 - 8735

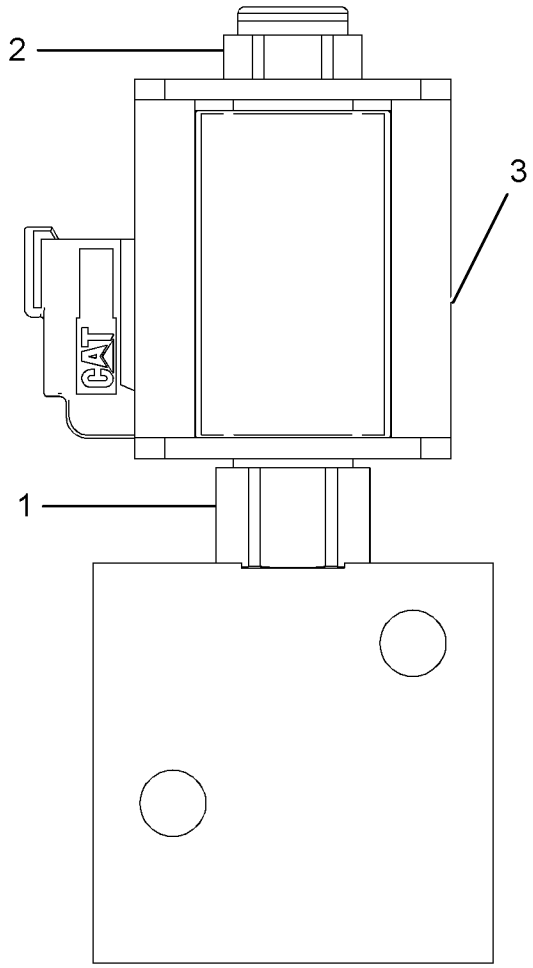


Illustration 19 g01180278

(1) Torque for installing the solenoid valve .....50 ± 7 N·m (37 ± 5 lb ft)

(2) Torque for the nut .....35 ± 3 N·m (26 ± 2 lb ft)

(3) 183 - 7595 Solenoid Valve Gp

Maximum supply pressure.....23000 kPa (3350 psi)
Nominal coil voltage .....24 VDC
Maximum current ..... 1.9 amp
Resistance of the coil at 25 °C (77 °F) ..... 24.9 ohms

i02361340

Combination Valve (Pilot, Brake)

SMCS Code: 5064-P&B

Part No.: 9T-9551

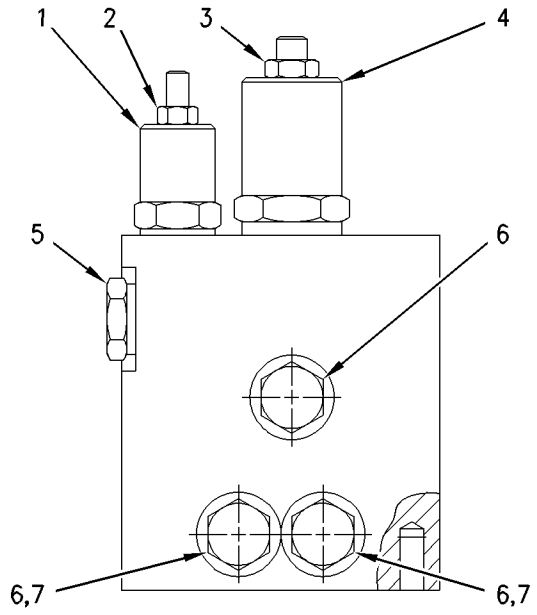


Illustration 20 g00845811

Cut-in pressure ..... 11800 kPa (1725 psi)

Cutout pressure .....14500 kPa (2125 psi)

(1) Torque for the 6E - 6293 Relief Valve .....61 ± 6 N·m (45 ± 4 lb ft)

(2) The torque for the locking nut.....13 ± 2 N·m (115 ± 17 lb in)

(3) The torque for the locking nut.....12 N·m (105 lb in)

(4) The torque for the unloading valve.....88 N·m (65 lb ft)

(5) The torque for the shuttle valve.....61 N·m (45 lb ft)

(6) The torque for the check valve .....48 N·m (35 lb ft)

(7) Torque for the plug.....14 N·m (10 lb ft)

i02363039

Relief Valve (Pilot)

SMCS Code: 5072

Part No.: 6E-6293

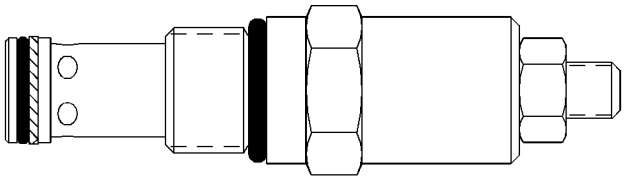


Illustration 21 g01180190

Pressure setting at 19 ± 2 L/min (5 ± 0.5 US gpm) at 49° ± 3°C (120° ± 5°F) ..... 2520 ± 70 kPa (365 ± 10 psi)

i02363183

Check Valve (Steering Oil Cooler Bypass), (Hydraulic Fan Oil Cooler Bypass)

SMCS Code: 5067; 5071

Part No.: 6E-1454

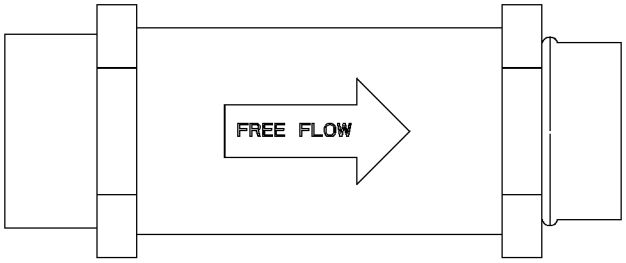


Illustration 22 g01180307

Cracking pressure ..... 345 ± 45 kPa (50 ± 6.5 psi)

i01279253

Oil Filter (Case Drain)

SMCS Code: 5091-HR

Part No.: 166-4647

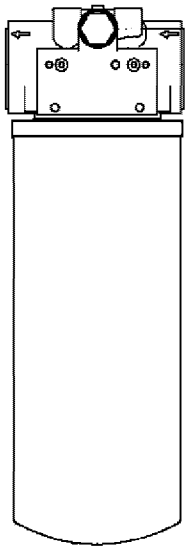


Illustration 23 g00678486

Maximum operating pressure..... 2758 kPa (400 psi)

Pressure setting for the hydraulic oil filter bypass valve ..... 172 kPa (25 psi)

i02363214

Accumulator (Pilot)

SMCS Code: 5077-PS

Part No.: 226-0420, 230-3489

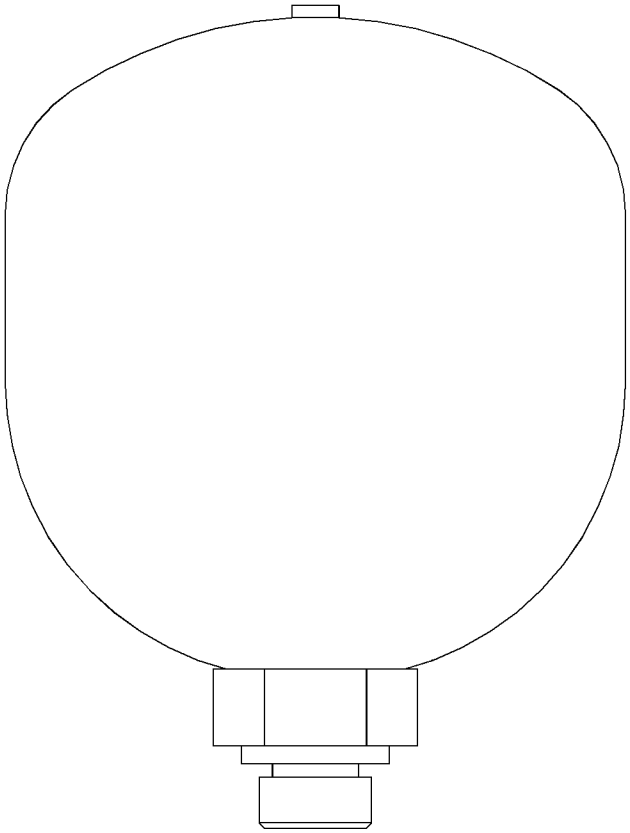


Illustration 24 g01180318

Internal volume of the gas chamber .... 0.50 L (0.53 qt)

Dry nitrogen precharge pressure..... 900 ± 100 kPa (130 ± 15 psi)

Installation torque .....30 ± 5 N·m (22 ± 4 lb ft)

i02364611

Pilot Operated Hydraulic Control (Joystick)

SMCS Code: 5059; 5063; 5705

Part No.: 238 - 9084

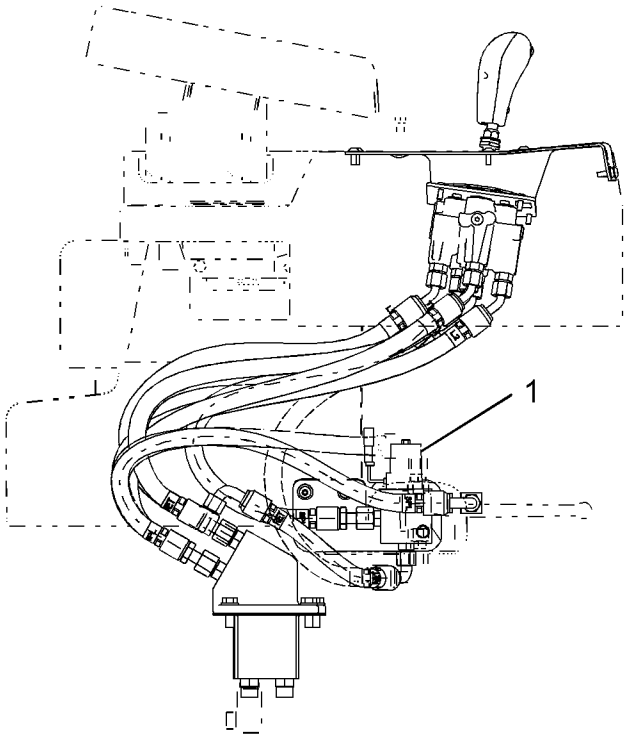


Illustration 25 g01180907

View from right side of cab

(1) 152 - 8385 Solenoid Valve

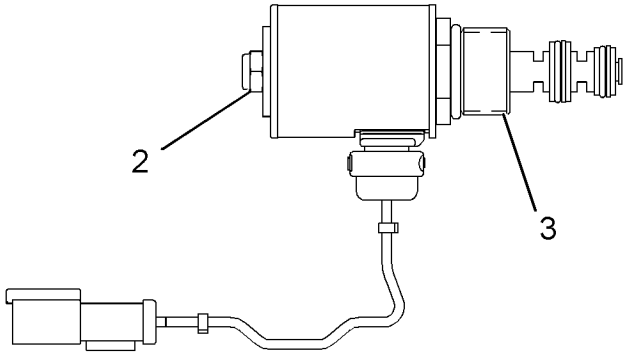


Illustration 26 g01180909

152 - 8385 Solenoid Valve

(1) 152 - 8385 Solenoid Valve

Nominal pressure rating.....2750 kPa (400 psi)
Nominal coil voltage .....24 VDC
Resistance at 25° ± 5°C (77° ± 9°F) .... 32.6 ± 1.6 ohms
Operating temperature range..... −40 °C to 121 °C (−40 °F to 250 °F)

(2) Torque for the nut .....9 ± 0.5 N·m (80 ± 4 lb in)

(3) Torque for the solenoid.....25 ± 5 N·m (18 ± 4 lb ft)

i02364473

Pilot Valve

SMCS Code: 5059

Part No.: 229-8724

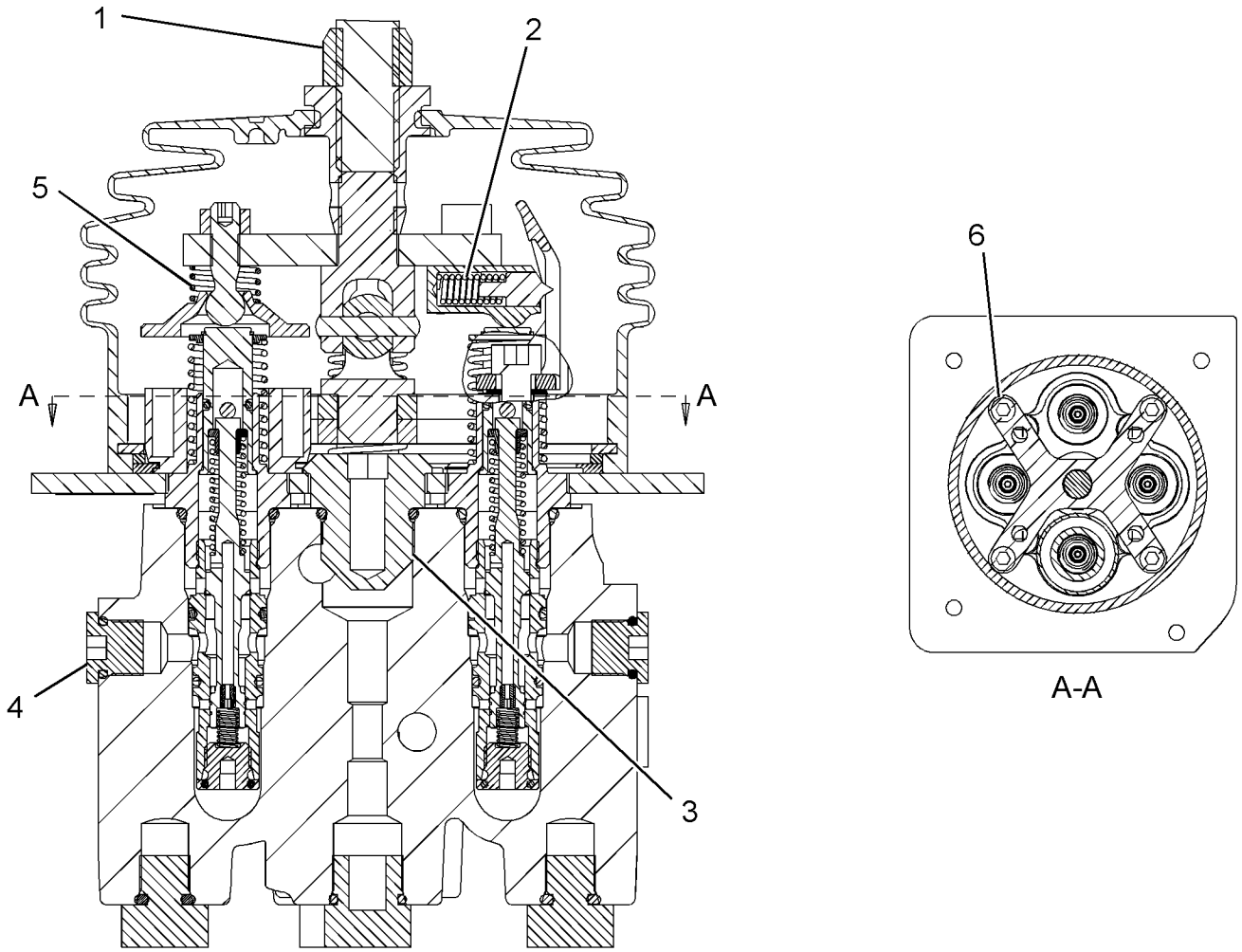


Illustration 27 g01180834

(1) Torque for the nut .....45 ± 5 N·m (33 ± 4 lb ft)

(2) 202 - 0599 Spring

Length under test force ..... 14 mm (0.55 inch)
Test force..... 50 ± 3.5 N (11 ± 0.8 lb)
Free length after test ..... 18.55 mm (0.73 inch)
Outside diameter..... 6 mm (0.24 inch)

(3) Torque for the adapter .....45 ± 5 N·m (33 ± 4 lb ft)

(4) Torque for eight plugs.....12 ± 3 N·m (105 ± 26 lb in)

(5) 159 - 3781 Springs

Length under test force ..... 7.60 mm (0.30 inch)
Test force..... 24.0 ± 2.0 N (5.4 ± 0.4 lb)
Free length after test ..... 17.46 mm (0.69 inch)
Outside diameter..... 14.28 mm (0.56 inch)

(6) Torque for four bolts.....20 ± 3 N·m (15 ± 2 lb ft)

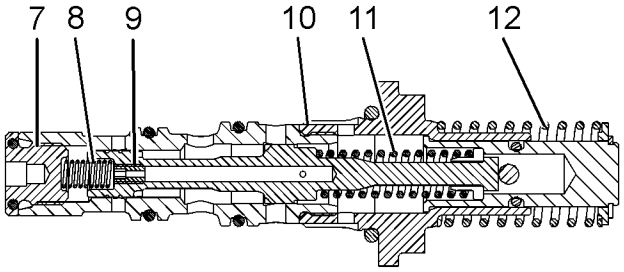


Illustration 28 g01180843
203 - 3312 Pilot Cartridge Valve

(7) Torque for the stop.....6 ± 1 N·m (55 ± 9 lb in)

(8) 153 - 8926 Spring

Length under test force ..... 8.00 mm (0.32 inch)
Test force..... 3.7 ± 0.2 N (0.83 ± 0.05 lb)
Free length after test ..... 10.58 mm (0.42 inch)
Outside diameter..... 4.2 mm (0.17 inch)

(9) Torque for the orifice.....2.5 ± 0.5 N·m (22 ± 4 lb in)

(10) Torque for the cage ....15 ± 2 N·m (130 ± 18 lb in)

(11) 203 - 3313 Spring

Length under test force ..... 23.9 mm (0.94 inch)
Test force..... 9.5 ± 0.5 N (2.2 ± 0.1 lb)
Free length after test ..... 26.07 mm (1.03 inch)
Outside diameter..... 7.3 mm (0.29 inch)

(12) 157 - 2152 Spring

Length under test force ..... 25.20 mm (0.99 inch)
Test force..... 12.0 ± 0.8 N (2.7 ± 0.2 lb)
Free length after test ..... 40.2 mm (1.58 inch)
Outside diameter..... 16 mm (0.63 inch)

i02363856

Main Control Valve

SMCS Code: 5051-MV

Part No.: 229-8722

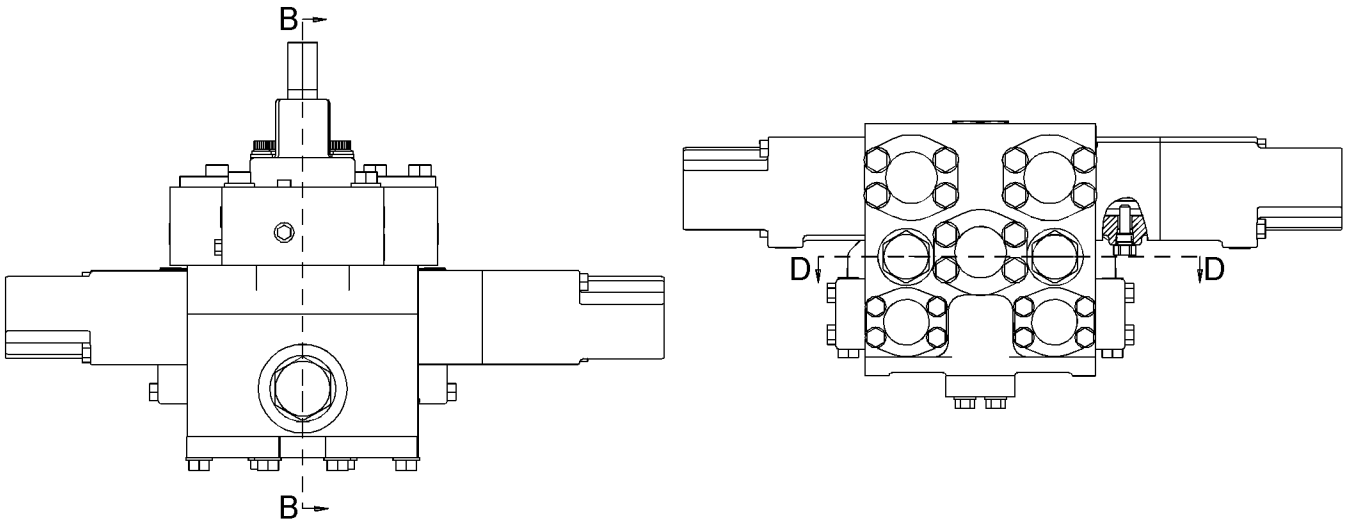


Illustration 29 g01180701

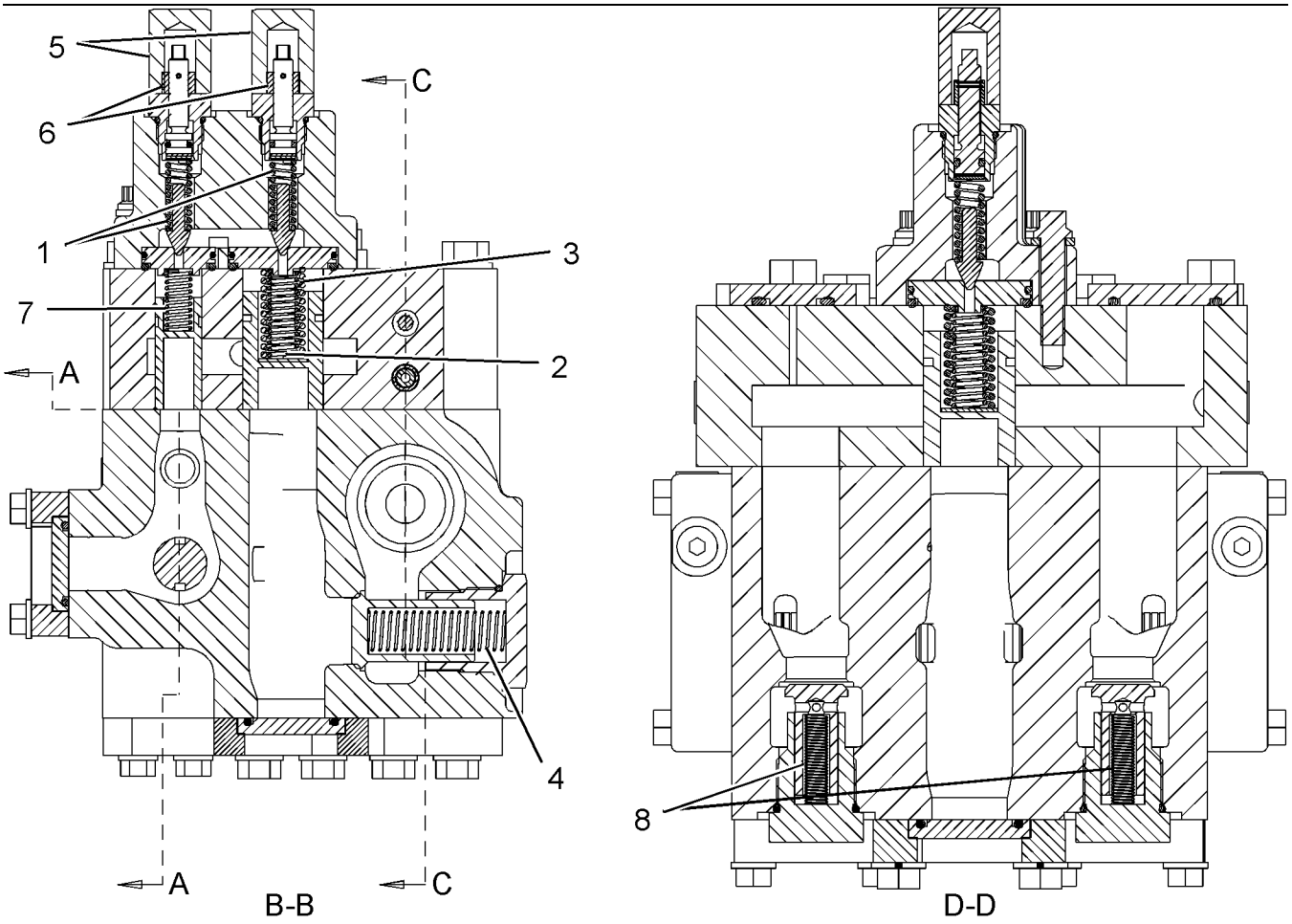


Illustration 30 g01180702

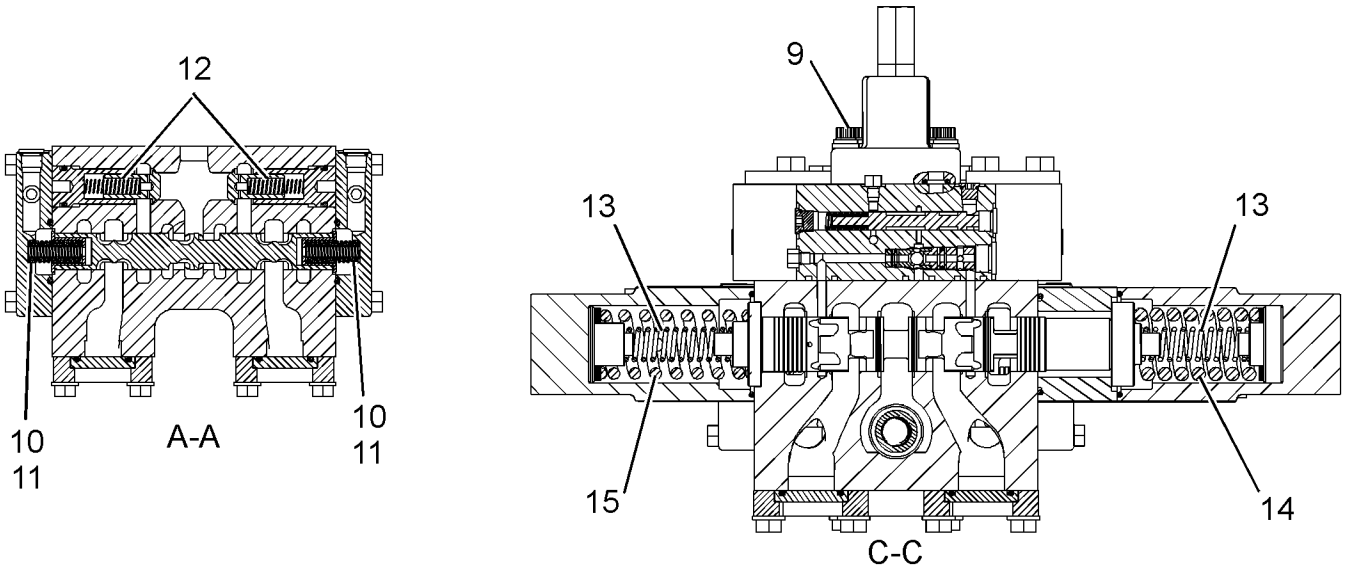


Illustration 31 g01180704

(1) 2J - 6089 Springs

Color code ..... yellow stripe
Length under test force ..... 36.25 mm (1.427 inch)
Test force..... 278 ± 14 N (62.5 ± 3.1 lb)
Free length after test ..... 44.12 ± 0.50 mm (1.737 ± .020 inch)
Outside diameter..... 12.5 mm (.492 inch)

Shims (relief valve)
Thickness of 3J - 7473 Shim ..... 0.12 mm (.005 inch)
Thickness of 3J - 7470 Shim ..... 1.22 mm (.048 inch)

Note: The thickest shim must be installed against springs (1) of the relief valves.

(2) 9J - 5499 Spring

Length under test force ..... 46.02 mm (1.812 inch)
Test force..... 89.0 ± 4.4 N (20.0 ± 1.0 lb)
Free length after test ..... 68.1 mm (2.68 inch)
Outside diameter..... 14.68 mm (.578 inch)

(3) 9J - 5498 Spring

Length under test force ..... 46.02 mm (1.812 inch)
Test force..... 200.2 ± 10.0 N (45.0 ± 2.25 lb)
Free length after test ..... 68.8 mm (2.71 inch)
Outside diameter..... 20.96 mm (.825 inch)

(4) 2A - 5885 Spring

Length under test force ..... 50.8 mm (2.00 inch)
Test force..... 6.9 ± 0.5 N (1.55 ± .11 lb)
Free length after test ..... 84.2 mm (3.32 inch)
Outside diameter..... 19.05 mm (.750 inch)

(5) Torque for the nut over the jam nut..... 20 ± 6 N·m (15 ± 4 lb ft)

(6) Torque for the jam nuts on the adjustment screws of the relief valves..... 35 ± 6 N·m (25 ± 4.4 lb ft)

(7) 5J - 4664 Spring

Length under test force ..... 29.0 mm (1.14 inch)
Test force..... 38 ± 4 N (8.6 ± .9 lb)
Free length after test ..... 36.3 mm (1.43 inch)
Outside diameter..... 12.70 ± 0.41 mm (.500 ± .016 inch)

(8) 3G - 3475 Springs

Length under test force ..... 51.38 mm (2.023 inch)
Test force..... 3.9 ± 0.2 N (.88 ± .04 lb)
Free length after test ..... 62.5 mm (2.46 inch)
Outside diameter..... 9.40 mm (.370 inch)

(9) Torque for the four bolts..... 80 ± 10 N·m (59 ± 7 lb ft)

(10) 9J - 5753 Springs

Length under test force ..... 38.51 mm (1.516 inch)
Test force..... 31.2 ± 2.7 N (7.0 ± 0.6 lb)
Free length after test ..... 47.2 mm (1.86 inch)
Outside diameter..... 9.91 mm (0.390 inch)

(11) 9J - 5754 Springs

Length under test force ..... 38.51 mm (1.516 inch)
Test force..... 66.7 ± 5.3 N (15.0 ± 1.2 lb)
Free length after test ..... 50.5 mm (1.99 inch)
Outside diameter..... 15.09 mm (.594 inch)

(12) 2N - 7029 Springs

Length under test force ..... 31.0 mm (1.22 inch)
Test force..... 18 N (4.0 lb)
Free length after test ..... 50.0 mm (1.97 inch)
Outside diameter..... 9.53 mm (.375 inch)

(13) 2S - 8410 Springs

Length under test force ..... 57.15 mm (2.25 inch)
Test force..... 167 ± 8 N (37.5 ± 1.8 lb)
Free length after test ..... 75.7 mm (2.98 inch)
Outside diameter..... 23.9 mm (0.94 inch)

(14) 235 - 4104 Spring

Length under test force ..... 75.3 mm (3.0 inch)
Test force..... 2215.5 ± 230 N (500 ± 50 lb)
Free length after test ..... 88 mm (3.5 inch)
Outside diameter..... 50.5 mm (2.0 inch)

(15) 235 - 4106 Spring

Length under test force ..... 86.13 mm (3.4 inch)
Test force..... 2087 ± 245 N (470 ± 55 lb)
Free length after test ..... 107 mm (4.2 inch)
Outside diameter..... 48 mm (1.9 inch)

i02363712

Tilt Control Valve (Dual)

SMCS Code: 5051-T2

Part No.: 225-2321

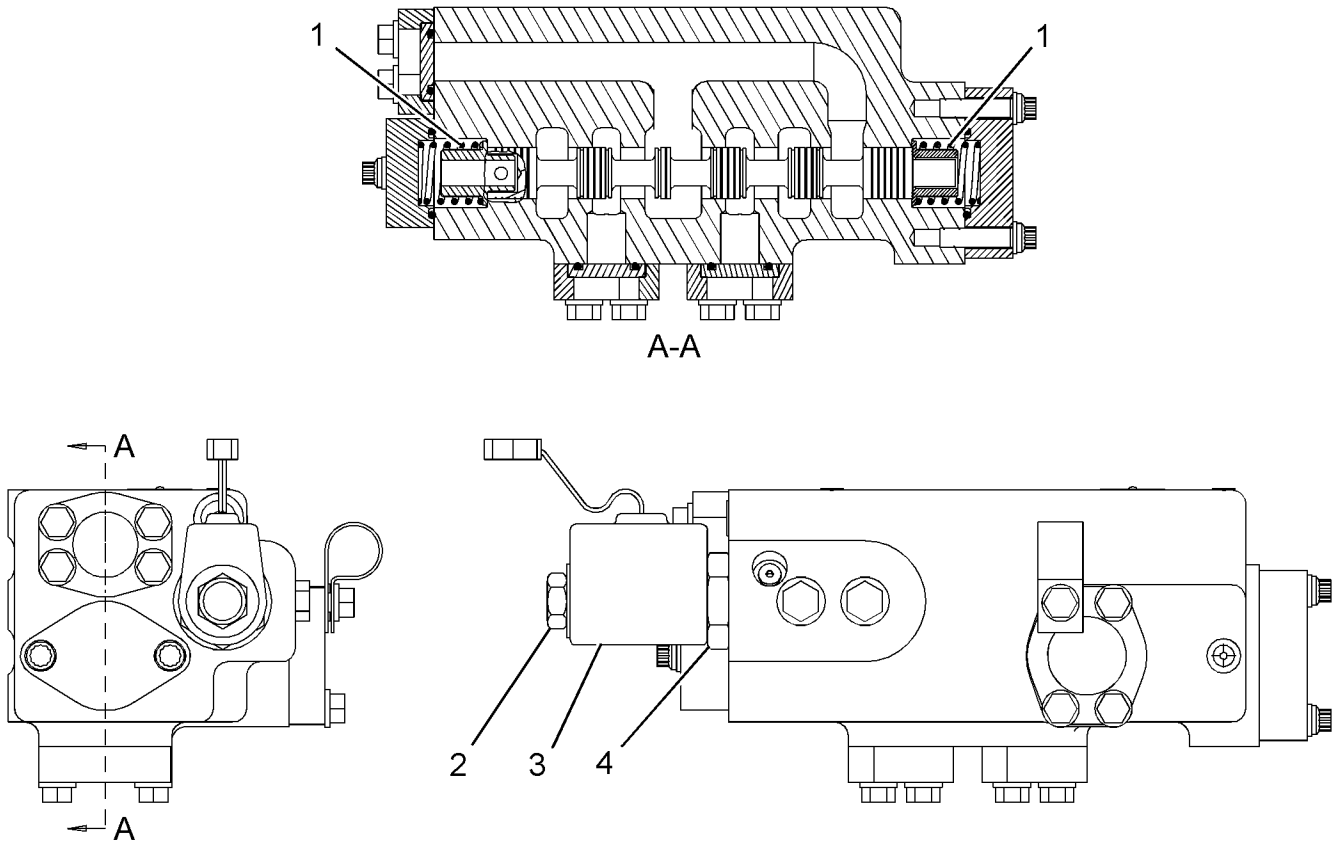


Illustration 32 g01180606

(1) 8J-8621 Spring

Length under test force ..... 40.6 mm (1.60 inch)
Test force..... 45 ± 3.6 N (10.2 ± 0.8 lb)
Free length after test ..... 46.0 mm (1.81 inch)
Outside diameter..... 30.7 mm (1.21 inch)

(2) Apply 4C-4030 Thread Lock Compound to the threads. Torque for nut.....14 ± 3 N·m (10 ± 2 lb ft)

(3) 3E-9205 Solenoid Valve Gp

(4) Torque for installing the solenoid valve .....30 ± 4 N·m (22 ± 3 lb ft)

i02362227

Solenoid Valve (Tilt/Tip Function)

SMCS Code: 5479-T2; 5479-TIP

Part No.: 3E-9205

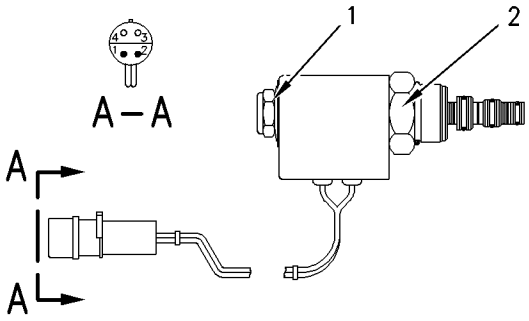


Illustration 33 g00853194

(1) Torque for the nut .....14 ± 2 N·m (10 ± 1.5 lb ft)

(2) Torque for installing the solenoid valve .....30.5 ± 3.5 N·m (22.5 ± 2.6 lb ft)

Flow of SAE 10 oil at 700 kPa (100 psi) pressure drop and 121°C (250°F) ..... 11.6 L/min (3.1 US gpm)

Nominal pressure rating .....20700 kPa (3000 psi)

Maximum pressure rating.....20700 kPa (3000 psi)

Nominal coil voltage .....24 VDC

Maximum coil voltage .....28.8 VDC

Minimum voltage for actuation of solenoid valve .... 18 VDC

Minimum current for actuation of solenoid valve 25° ± 5°C (77° ± 9°F) .....0.45 Amperes

Coil resistance at 25° ± 5°C (77° ± 9°F) .... 24.9 ± 0.4 Ohms

i01644661

Lift Cylinder

SMCS Code: 5102

Part No.: 4Z-6424

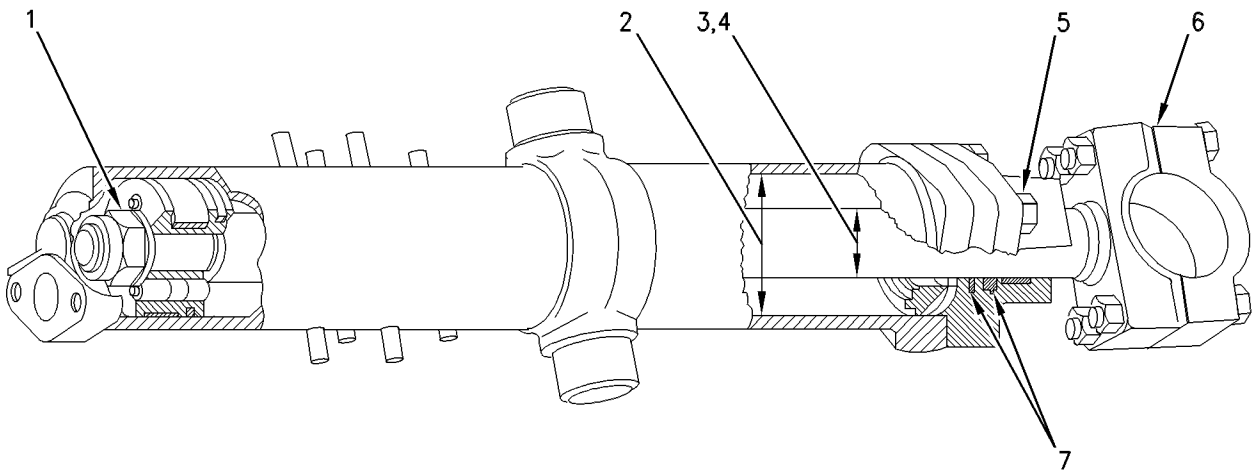


Illustration 34 g00323543

Note: Extend the rod fully before tightening the head bolts.

(1) Lubricate the threads of the cylinder rod with a minimal amount of the lubricant. Torque for the nut ..... 3000 ± 300 N·m (2210 ± 220 lb ft)

(2) Bore of the lift cylinder ..... 133.40 ± 0.10 mm (5.251 ± .004 inch)

(3) Bore of the head ..... 76.48 ± 0.03 mm (3.011 ± .001 inch)

(4) Diameter of the rod ..... 76.150 ± 0.038 mm (2.9980 ± .0015 inch)

(5) Torque for the four bolts ..... 430 ± 60 N·m (317 ± 44 lb ft)

(6) Install approximately 12 3G-0911 Shims in order to get a clearance between the trunnion and the rod assembly. Each shim should have a thickness of 0.80 mm (.032 inch).

(7) Lubricate the sealing lips with a minimal amount of the lubricant that is being sealed.

i02362328

Tilt and Tip Cylinder

SMCS Code: 5104; 5106

Part No.: 6E-4835, 6E-4836

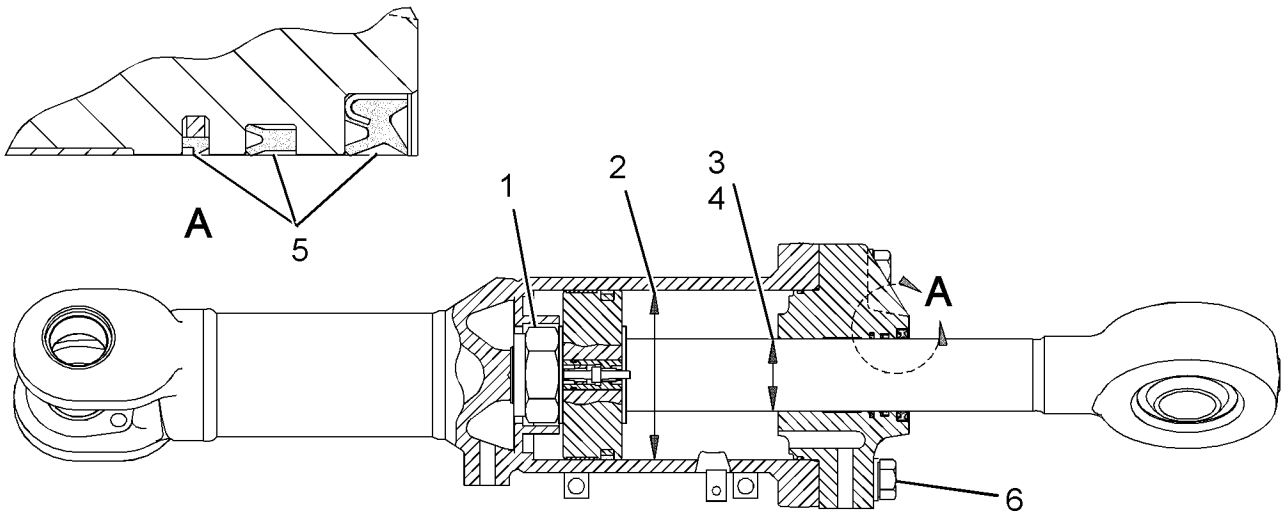


Illustration 35 g01180021

(1) Lubricate the threads of the cylinder rod with a minimal amount of the lubricant. Torque for the nut ..... 8000 ± 800 N·m (5900 ± 590 lb ft)

(2) Bore of the tilt cylinder ..... 209.60 ± 0.100 mm (8.252 ± .004 inch)

(3) Bore of the head ..... 89.18 ± 0.03 mm (3.511 ± 0.001 inch)

(4) Diameter of the rod ..... 88.850 ± 0.038 mm (3.4980 ± .0015 inch)

(5) Lubricate the sealing lips with a minimal amount of the lubricant that is being sealed.

(6) Torque for the six bolts ..... 1050 ± 150 N·m (774 ± 111 lb ft)

i01645126

Stabilizer Link

SMCS Code: 6071

Part No.: 149-5959

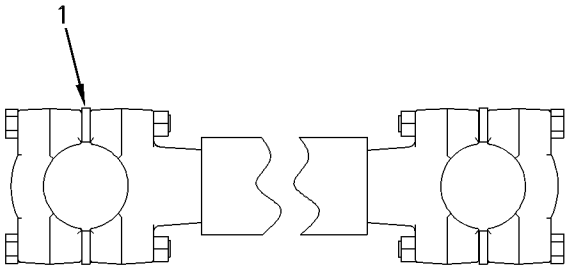


Illustration 36 g00324783

(1) Install approximately 26 4T-9470 Shims in order to get a clearance between the trunnion and the link. Each shim should have a thickness of 0.8 mm (.032 inch).

i02362298

Bulldozer Trunnion

SMCS Code: 6069

Part No.: 7T-2879

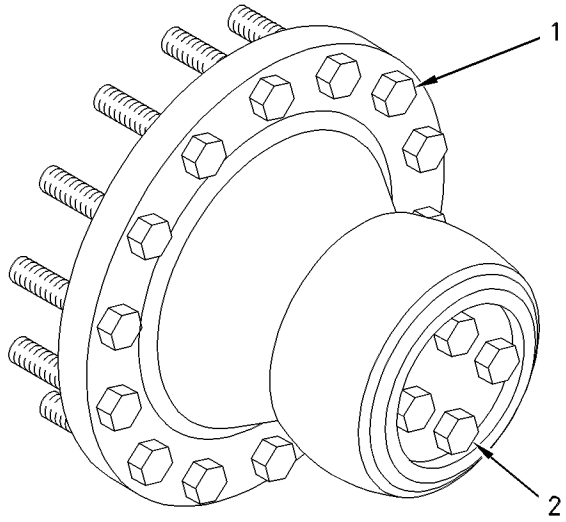


Illustration 37 g00324623

(1) Torque for the 28 bolts.....900 ± 100 N·m
(660 ± 75 lb ft)

(2) Torque for the four bolts.....240 ± 40 N·m
(175 ± 30 lb ft)

i01645152

Push Arm

SMCS Code: 6061

Part No.: 149-5956, 149-5957

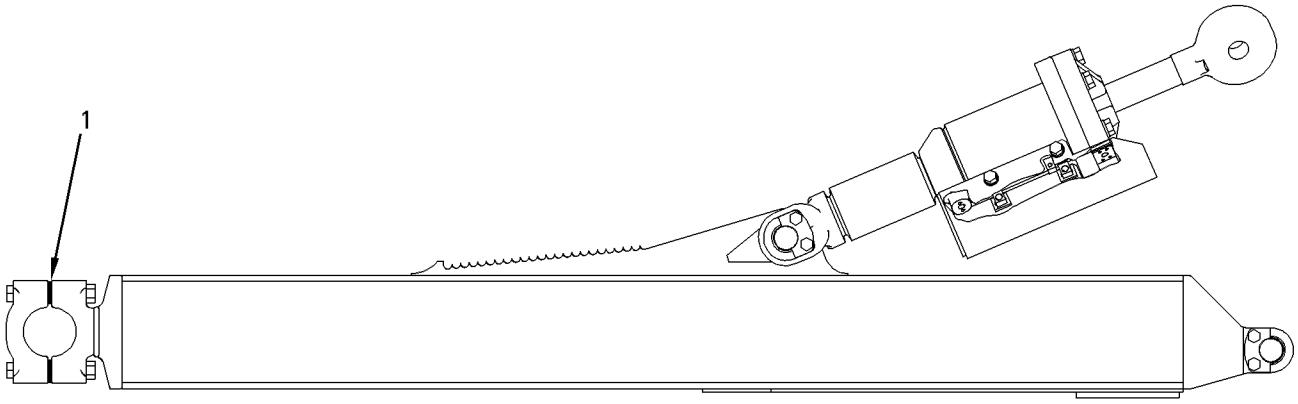


Illustration 38 g00324843

(1) Install approximately 26 7T-2425 Shims in order to get a clearance between the trunnion and the link. Each shim should have a thickness of 0.8 mm (.032 inch).

i02362282

Bulldozer Pin Group

SMCS Code: 5104-PN; 6061-PN

Part No.: 212-1329

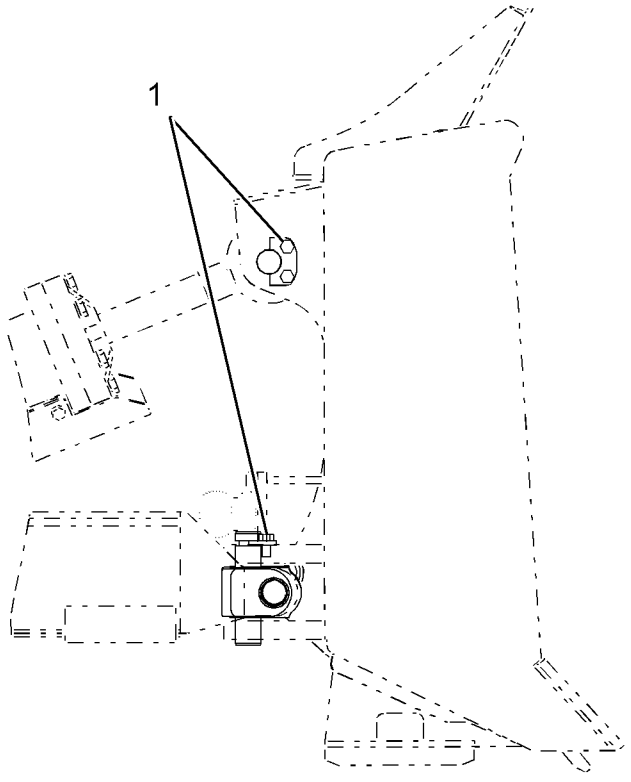


Illustration 39 g01179971

Torque for eight bolts .....700 ± 90 N·m (520 ± 65 lb ft)

i01645179

Ground Engaging Tool Torques

SMCS Code: 6801; 6804; 6822

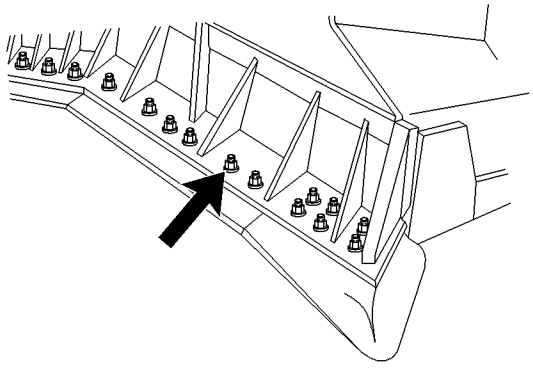


Illustration 40 g00353122

Typical Blade

Table 1

Bolt Size	Recommended Torque(1)	
	N·m	lb ft
5/8 inch	270 ± 40	200 ± 30
3/4 inch	475 ± 60	350 ± 45
7/8 inch	750 ± 90	550 ± 65
1 inch	1150 ± 150	850 ± 110
1 1/4 inch	2300 ± 300	1700 ± 220

(1) These values are only for Caterpillar bolts for cutting edges.

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RENR8836-02 (en-us)
August 2018

Systems Operation

844H Wheel Dozer
Hydraulic System

BTW 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

i02404873

General Information

SMCS Code: 5050

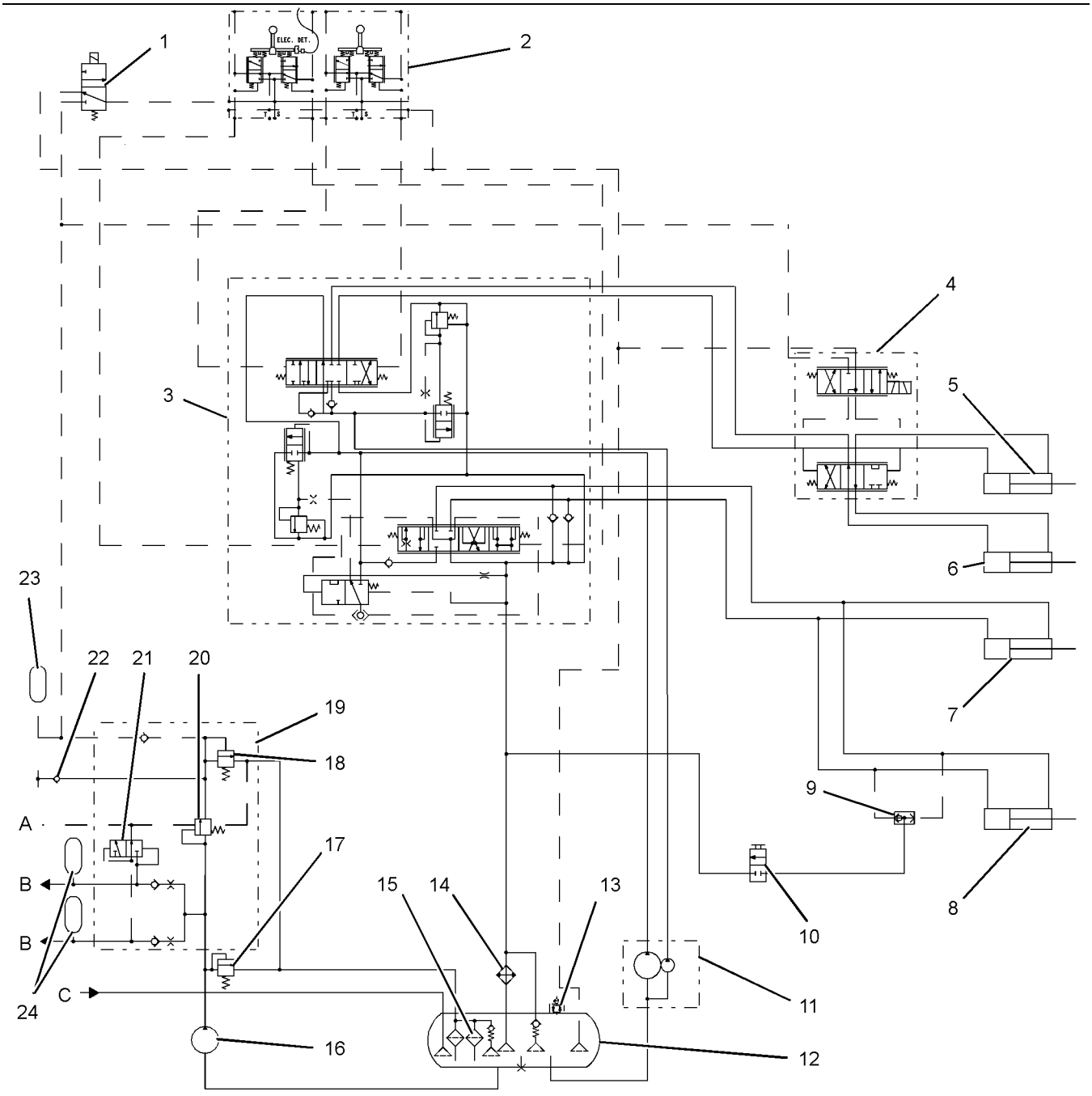


Illustration 1 g01201258

Hydraulic Schematic of the Brake and the Implement System

(1) Pilot on/off control valve
(2) Pilot control valve
(3) Main control valve
(4) Dual tilt control valve
(5) Tilt cylinder (left)
(6) Tilt cylinder (right)

(7) Lift cylinder (left)
(8) Lift cylinder (right)
(9) Shuttle valve
(10) Manual lowering control
(11) Implement pump
(12) Hydraulic oil tank for the brake and implement systems
(13) Breaker relief valve
(14) Oil cooler
(15) Filter
(16) Pilot/brake pump
(17) Relief valve for pilot/brake pump
(18) Pilot relief valve
(19) Combination valve
(20) Unloading valve
(21) Shuttle valve
(22) Fluid sampling valve
(23) Accumulator for the pilot hydraulic system
(24) Brake accumulators
(A) Port for the pressure switch
(B) Pressure port for the supply of brake oil
(C) Return line for the brake oil

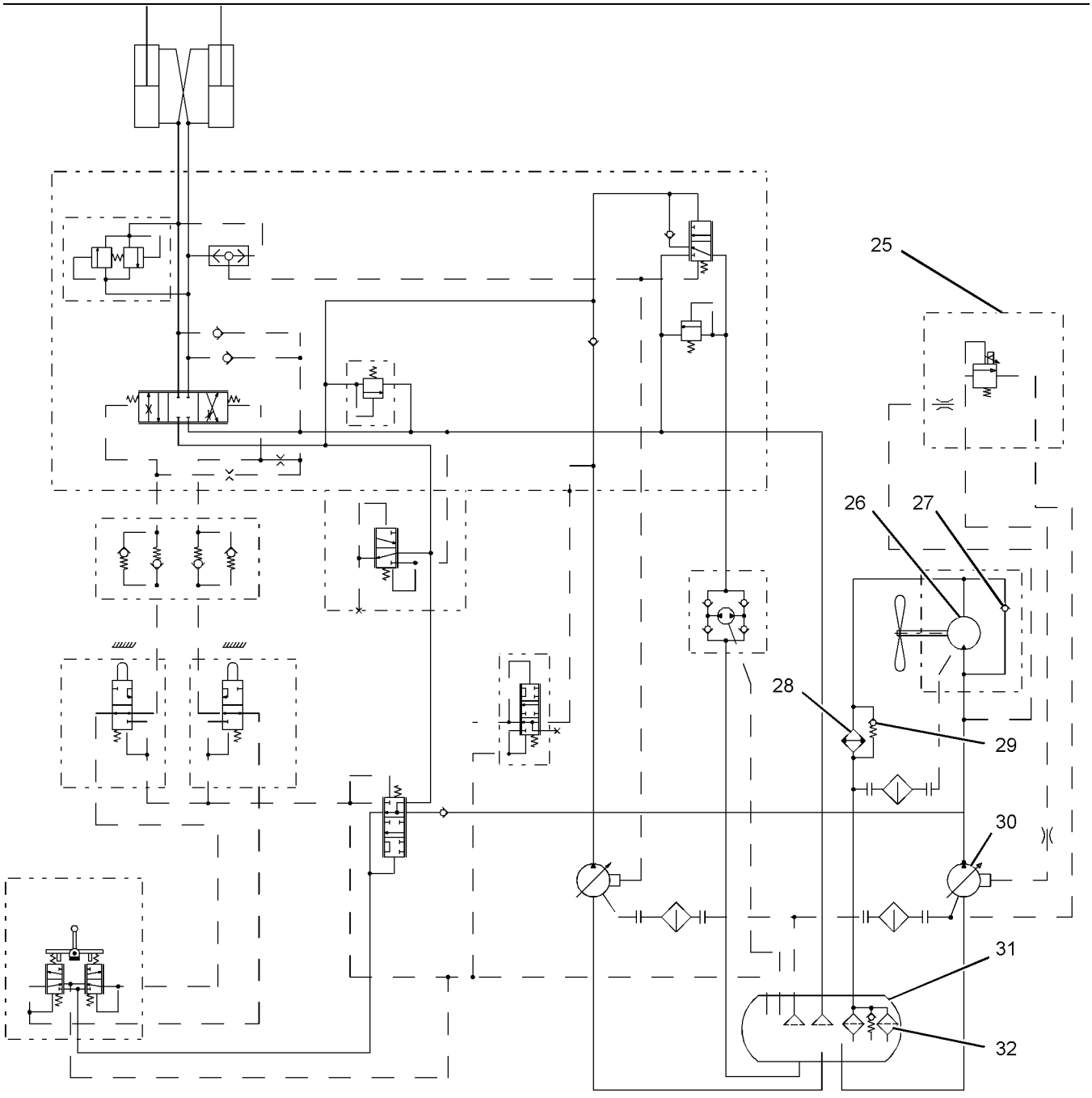


Illustration 2 g01201259

Hydraulic Schematic of the Fan Drive and Steering System

(25) Valve
(26) Fan drive motor
(27) Makeup valve
(28) Oil cooler
(29) Oil cooler bypass valve
(30) Fan drive pump
(31) Hydraulic oil tank for the fan drive and steering systems
(32) Hydraulic oil filter

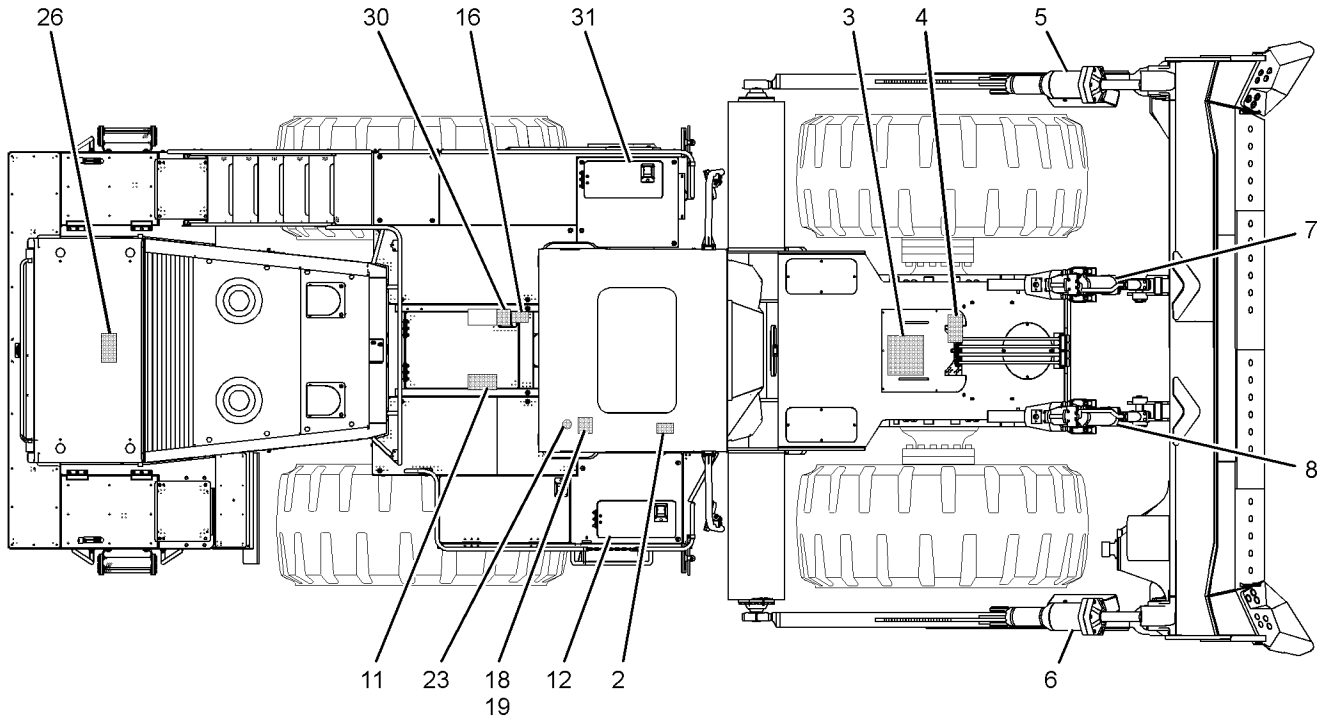


Illustration 3 g01201261

Top View of the Machine

(2) Pilot control valve
(3) Main control valve
(4) Dual tilt control valve
(5) Tilt cylinder (left)
(6) Tilt cylinder (right)
(7) Lift cylinder (left)
(8) Lift cylinder (right)
(11) Implement pump
(12) Hydraulic oil tank for the brake and implement systems
(16) Pilot/brake pump
(18) Pilot relief valve
(19) Combination valve
(23) Accumulator for the pilot hydraulic system
(26) Fan drive motor
(30) Fan drive pump
(31) Hydraulic oil tank for the fan drive and steering systems

The 844H Wheel Tractor hydraulic system is made up of three systems: pilot hydraulic system, main hydraulic system and fan drive system.

Note: The main hydraulic system and the pilot hydraulic system draw oil from the hydraulic oil tank on the right side of the machine. The fan drive system draws oil from the hydraulic oil tank on the left side of the machine.

Pilot Hydraulic System

The pilot hydraulic system controls the machine's main control valve. The pilot hydraulic system also charges the brake accumulators.

The pilot hydraulic system is composed of the following components: pilot control valve (2), dual tilt control valve (4), main control valve (3), accumulator (23), combination valve (19), relief valve for the pilot/brake pump (17), pilot/brake pump (16) and hydraulic oil tank (12).

Main Hydraulic System

The main hydraulic system controls the machine's lift and tilt functions.

The main hydraulic system is composed of the following components: main control valve (3), left tilt cylinder (5), right tilt cylinder (6), left lift cylinder (7), right lift cylinder (8), implement pump (11) and hydraulic oil tank (12)

Fan Drive System

The fan drive system cools the oil in the hydraulic system. Also, the fan drive system provides pilot oil to the steering system.

The fan drive system is composed of the following components: fan drive motor (26), oil cooler (28), makeup valve (27), oil cooler bypass valve (29), fan drive pump (30) and hydraulic oil tank (31).

i02381085

Monitoring System (Hydraulic Functions)
(Caterpillar Monitoring System)

SMCS Code: 7490

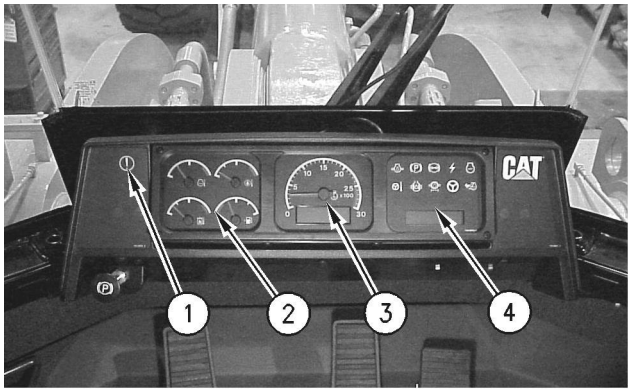


Illustration 4 g00850830

The Caterpillar Monitoring System consists of the following components.

- action alarm
- master action light (1)
- gauge display (2)
- tachometer (3)
- monitoring panel with alert indicators for the numerous machine systems (4)

The Caterpillar Monitoring System continuously monitors the numerous machine systems. The alert indicators show any abnormal condition of the machine.

General Function

The monitoring system provides three warning categories.

A Warning Category 1 requires only operator awareness. When a Warning Category 1 occurs, the monitoring system causes an alert indicator to turn on.

A Warning Category 2 requires operator response. When a Warning Category 2 occurs, the monitoring system causes one or more indicators to turn on. A Warning Category 2 also causes action light (1) to turn on.

A Warning Category 3 requires immediate shutdown of machine systems. When a Warning Category 3 occurs, the monitoring system causes one or more alert indicators to turn on. The monitoring system also causes action light (1) to flash. The action alarm also sounds.

Note: Do NOT operate the machine until the cause of the warning has been corrected.

Monitoring Hydraulic Functions

For the hydraulic system, there is no condition which would cause a Warning Category 1 to occur.

For the hydraulic system, a Warning Category 2 indicates excessive hydraulic oil temperature. If the temperature gauge is reading abnormally high oil temperatures, reduce the load on the system. Allow the hydraulic oil to cool. If the temperature gauge continues to read abnormally high oil temperatures, stop the machine in a convenient place and investigate the cause.

For the hydraulic system, a Warning Category 3 occurs when the hydraulic oil tank level is low. The action light (1) will flash and the action alarm will sound.

When a Warning Category 3 occurs during machine operation, stop the machine immediately and engage the parking brake. Stop the engine. Investigate the cause of the warning before returning the machine to service.

Reference: For additional information about the Caterpillar Monitoring System, refer to the Service Manual, “Caterpillar Monitoring System” for the machine that is being serviced.

i02409581

Pilot Hydraulic System

SMCS Code: 5050-PS

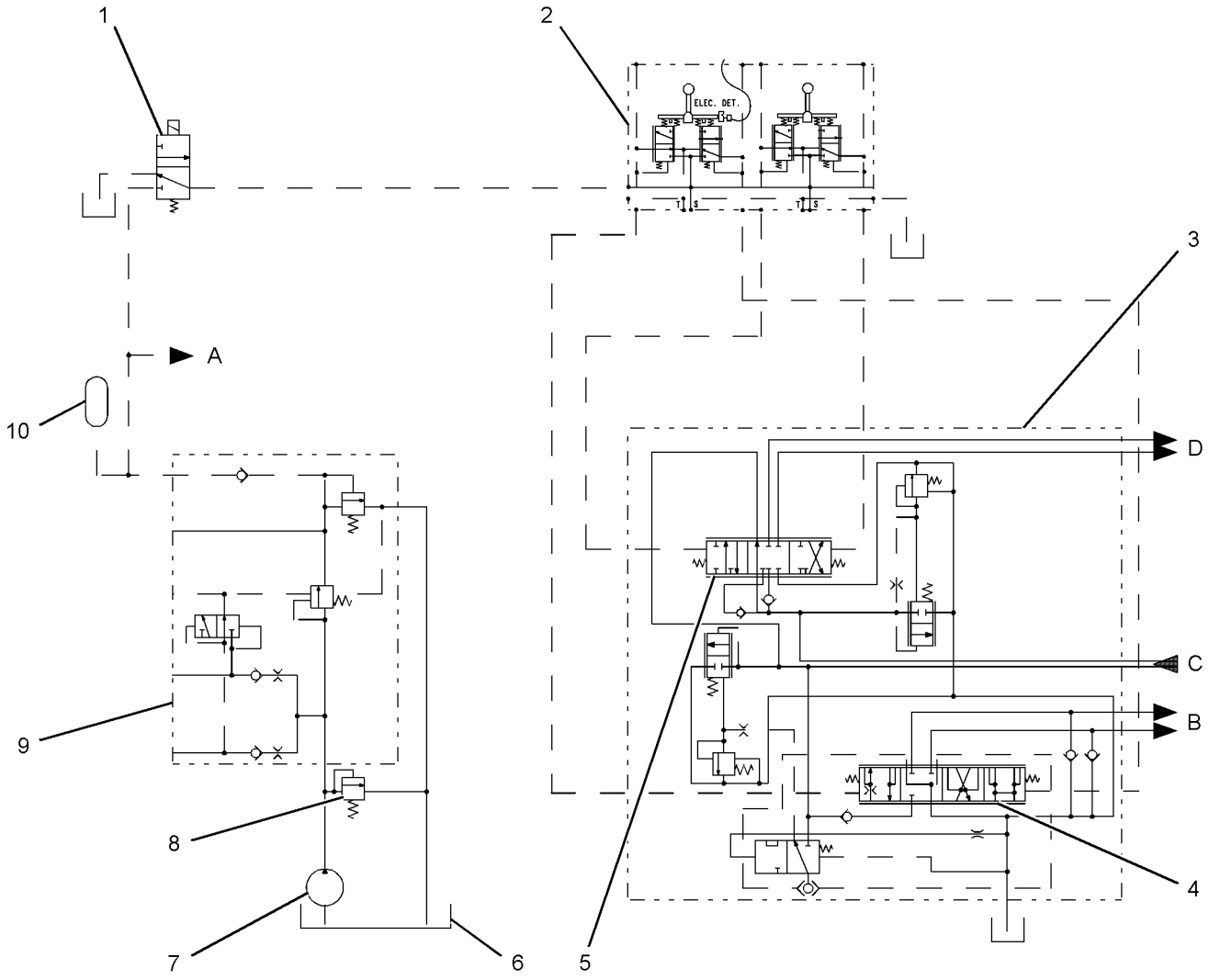


Illustration 5 g01204033

Pilot Hydraulic System

(1) Pilot on/off solenoid valve
(2) Pilot valve
(3) Main control valve
(4) Blade lift control spool
(5) Blade tilt control spool
(6) Hydraulic tank
(7) Pilot/brake pump
(8) Relief valve for the pilot/brake pump
(9) Combination valve
(10) Pilot accumulator
(A) Pilot supply oil to dual tilt control valve
(B) Supply oil to lift cylinders
(C) Supply oil from implement pump
(D) Supply oil to tilt cylinders

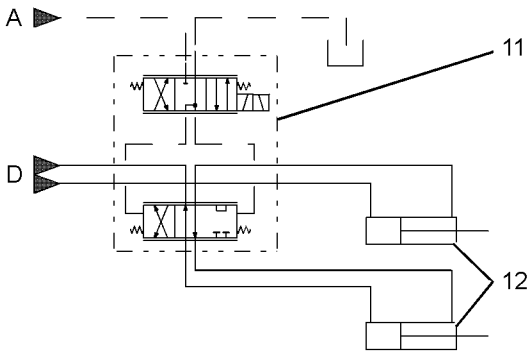


Illustration 6 g01204032

Pilot Hydraulic System

(11) Dual tilt control valve. (12) Tilt cylinders. (A) Pilot supply oil to dual tilt control valve. (D) Supply oil to tilt cylinders.

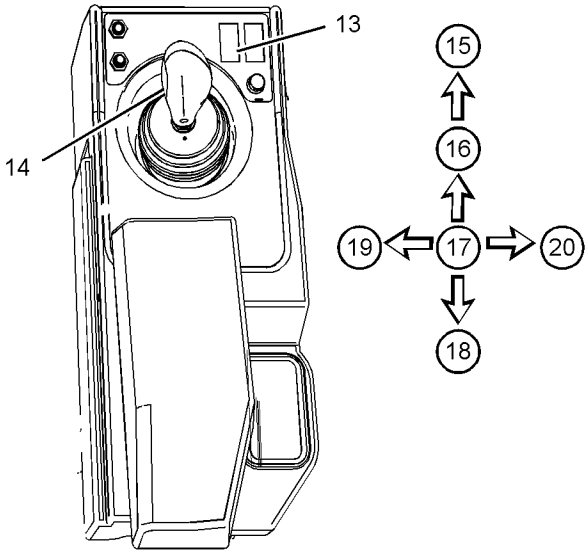


Illustration 7 g01204056

Dozer Blade Control

(13) Switch for dual tilt control. (14) Blade control lever. (15) FLOAT position. (16) LOWER position. (17) HOLD position. (18) RAISE position. (19) TILT LEFT position or TIP BACK position. (20) TILT RIGHT position or TIP FORWARD position.

The pilot hydraulic system controls the movement of blade lift control spool (4) and blade tilt control spool (5) in main control valve (3).

The pilot hydraulic system consists of the following components: Pilot on/off solenoid valve (1), Pilot valve (2), Main control valve (3), Pilot/brake pump (7), Relief valve for pilot/brake pump (8), Combination valve (9), Pilot accumulator (10), Dual tilt control valve (11) and Blade control lever (14)

The pilot hydraulic system is controlled in the cab by the operator. The operator of the machine controls the tilt function and the lift function of the blade by moving blade control lever (14). Blade control lever (14) is connected to pilot valve (2) by a mechanical linkage.

The mechanical movement of blade control lever (14) causes a pilot signal to be sent from pilot valve (2) to main control valve (3). As a result, blade lift control spool (4) or blade tilt control spool (5) will move to the left or the right. The lift cylinders or the tilt cylinders will then move.

Dual Tilt Operation

Toggle switch (13) controls the function of dual tilt control valve (11). When the top of the switch is depressed, the machine will operate in dual tilt mode. The solenoid in the dual tilt control valve is de-energized. Both spools are centered.

When the machine is in dual tilt mode, the tilt cylinders will move in opposite directions. If blade control lever (14) is moved to the right, the left tilt cylinder will extend. Oil from the rod end of the left tilt cylinder will return to the dual tilt control valve. The oil is then directed to the rod end of the right tilt cylinder. This causes the right tilt cylinder to retract. Oil from the head end of the right tilt cylinder will be directed back to the hydraulic tank.

If the TILT LEFT position is selected, the direction of movement of each cylinder will be the opposite.

Single Tilt Operation

If the bottom of toggle switch (13) is depressed, the machine will operate in single tilt mode. The pilot operated spool in dual tilt control valve (11) will shift to the left.

In single tilt mode, oil flow to the right tilt cylinder is blocked. If the TILT LEFT position is selected, the left tilt cylinder will retract. If the TILT RIGHT position is selected, the left tilt cylinder will extend. The trapped oil in the right tilt cylinder will act as a brace in both cases.

Tip Operation

A trigger switch on blade control lever (14) controls the tip function of the machine. When the trigger switch is depressed, the blade can be tipped. When the tip function is selected, the pilot operated spool in the dual tilt control valve will shift to the right.

While the trigger switch is depressed, both tilt cylinders will move in the same direction. If the TIP FORWARD position is selected, the left tilt cylinder will extend. Oil from the rod end of the lift tilt cylinder will enter dual tilt control valve (11) and the oil will be directed to the head end of the right tilt cylinder. This will cause the right tilt cylinder to extend. Oil from the rod end of the right tilt cylinder will be directed to the hydraulic tank.

If the TIP BACK position is selected, the direction of movement of each cylinder will be the opposite.

Blade Tilt Control

Note: The descriptions that follow describe the operation of the machine in dual tilt mode. Refer to “Single Tilt Operation” or “Tip Operation” for descriptions of the other operating modes.

TILT RIGHT Position



Tilt Right – Move blade control lever (14) to the right in order to lower the blade to the right.

When the TILT RIGHT position is selected with blade control lever (14), pilot oil flows to the right end of blade tilt control spool (5). The spool shifts to the left. Oil flows to the head end of the left tilt cylinder. The left tilt cylinder extends. Oil from the rod end of the left tilt cylinder is directed to the rod end of the right tilt cylinder. The right tilt cylinder retracts. Oil from the head end of the right tilt cylinder is directed to the hydraulic tank.

TILT HOLD Position



Tilt Hold – Release blade control lever (14). The control lever will return to the HOLD position. Blade movement will stop.

When blade control lever (14) is in the HOLD position, pilot oil is not directed to the main control valve. Pilot oil that is entering the pilot valve (2) is directed back to the hydraulic tank.

TILT LEFT Position



Tilt Left – Move blade control lever (14) to the left in order to lower the blade to the left.

When the TILT LEFT position is selected with blade control lever (14), pilot oil flows to the left end of blade tilt control spool (5). The spool shifts to the right. Oil flows to the dual tilt control valve (11). The oil is directed to the head end of the right tilt cylinder. The right tilt cylinder extends. Oil from the rod end of the right tilt cylinder is directed to the rod end of the left tilt cylinder. The left tilt cylinder retracts. Oil from the head end of the left tilt cylinder is directed to the hydraulic tank.

Blade Lift Control

RAISE Position



Raise – Pull back on blade control lever (14) in order to raise the blade.

When the RAISE position is selected with blade control lever (14), pilot oil flows to the left end of blade lift control spool (4). The spool shifts to the right. Oil is directed to the rod end of the lift cylinders. Oil from the head end of the lift cylinders is directed to the hydraulic tank.

HOLD Position



Hold – Release blade control lever (14). The control lever will return to the HOLD position. Blade movement will stop.

When blade control lever (14) is in the HOLD position, pilot oil is not directed to the main control valve. Pilot oil that is entering the pilot valve (2) is directed back to the hydraulic tank.

LOWER Position



Lower – Push blade control lever (14) forward in order to lower the blade.

When the LOWER position is selected with blade control lever (14), pilot oil flows to the right end of blade lift control spool (4). The spool shifts to the left. Oil is directed to the head end of the lift cylinders. Oil from the rod end of the lift cylinders is directed to the hydraulic tank.

FLOAT Position



Float – Push blade control lever (14) all the way forward into the detent. The blade will lower to the ground. The blade will follow the contour of the ground as the machine moves.

When the FLOAT position is selected with blade control lever (14), pilot oil flows to the right end of blade lift control spool (4). The spool shifts all the way to the left. Both ends of each cylinder are open to the hydraulic tank. The cylinder can move in and out as the blade follows the contour of the ground.

i02416568

Gear Pump (Pilot, Brake)

SMCS Code: 4014-GT; 5073-P&B

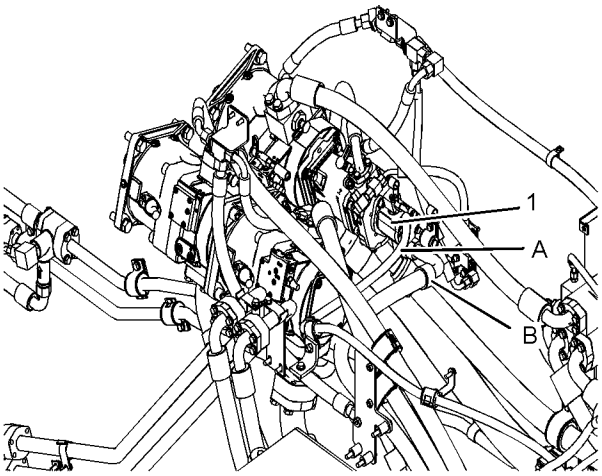


Illustration 8 g01207836

(A) Outlet (high pressure)
(B) Inlet (low pressure)
(1) Pilot/brake pump

Pilot/brake pump (1) is a fixed displacement external gear pump. The pump supplies flow to the hydraulic brake system and pilot flow for the implement system. When the pump is viewed from the drive end, the pump shaft rotates in a counterclockwise direction.

Pilot/brake pump (1) is mounted on the fan pump on the left hand pump drive. The pumps are located behind the cab under the floorplate.

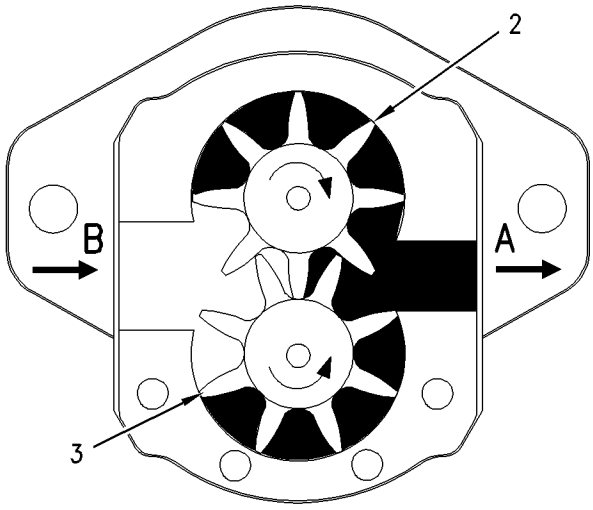


Illustration 9 g00850745

Fixed Displacement External Gear Pump

(2) Drive gear
(3) Idler gear
(A) Outlet (High pressure)
(B) Inlet (Low pressure)

A gear pump carries oil from inlet port (B) to outlet port (A) in the spaces between the gear teeth.

The drive shaft turns drive gear (2). The drive gear forces idler gear (3) to rotate. When the gear teeth separate, a partial vacuum is formed. Oil fills the spaces between the teeth in inlet port (B). The gears carry oil around the circumference of the pump to outlet port (A). A seal is formed by the gear teeth against the pump housing. Oil is forced out of the spaces between the gear teeth as the gear teeth mesh together at outlet port (A). Oil will not return to inlet port (B) because the meshing of the gears will fill the spaces between the gear teeth.

The flow rate of oil that is supplied by the pump is controlled by the rate of rotation of the shaft.

i02441611

Accumulator (Pilot)

SMCS Code: 5077-PS

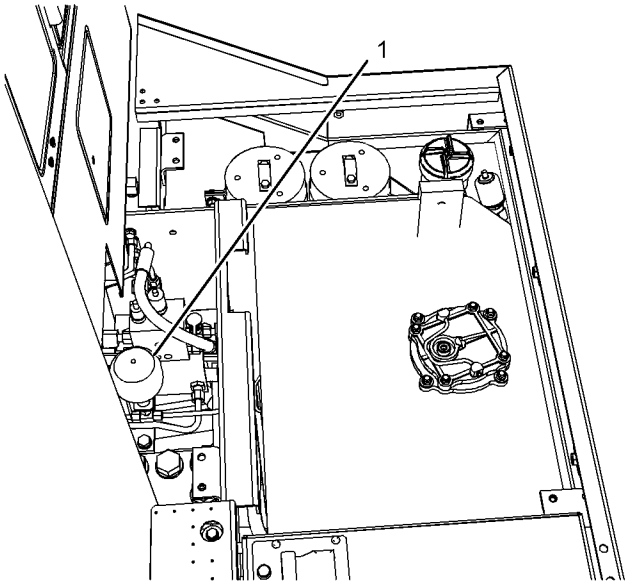


Illustration 10 g01220063

(1) Accumulator for the Pilot Hydraulic System

The accumulator for the pilot hydraulic system is located next to the hydraulic tank on the right side of the machine.

The combination valve supplies the accumulator with oil. The oil from the combination valve charges the accumulator.

When the control lever is in the HOLD position, the accumulator maintains a constant oil pressure in the pilot hydraulic system. When the control lever is moved, the constant oil pressure enables the implements to respond quickly.

Reference: For more information on the pilot accumulator, refer to the Service Manual module Specifications, “Accumulator (Pilot)” for the machine that is being serviced.

i02441356

Pilot Valve

SMCS Code: 5059

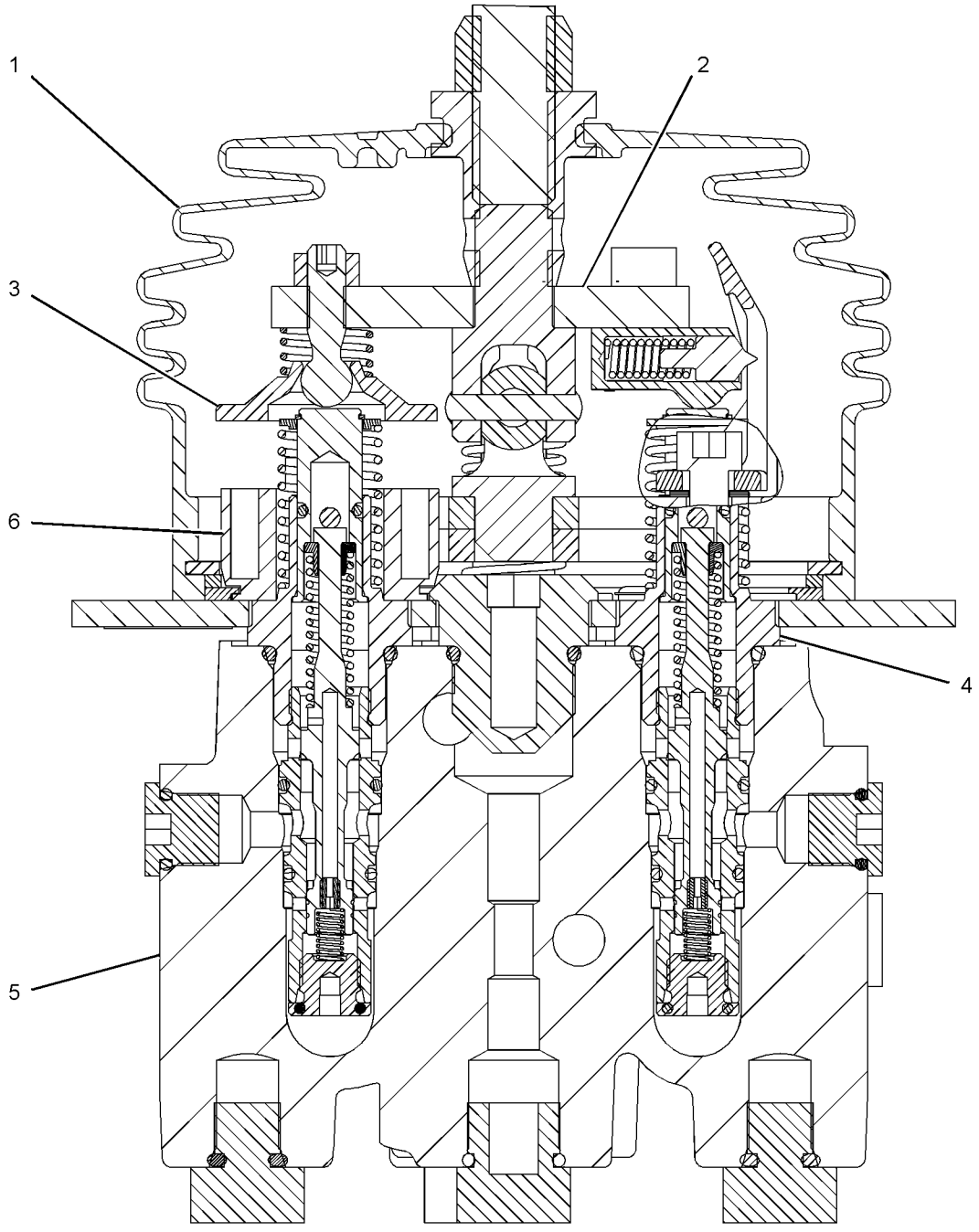


Illustration 11 g01219928

Pilot valve (left side view)

(1) Boot. (2) Lever assembly. (3) Detent plate. (4) Cartridge assembly. (5) Body. (6) Detent coil.

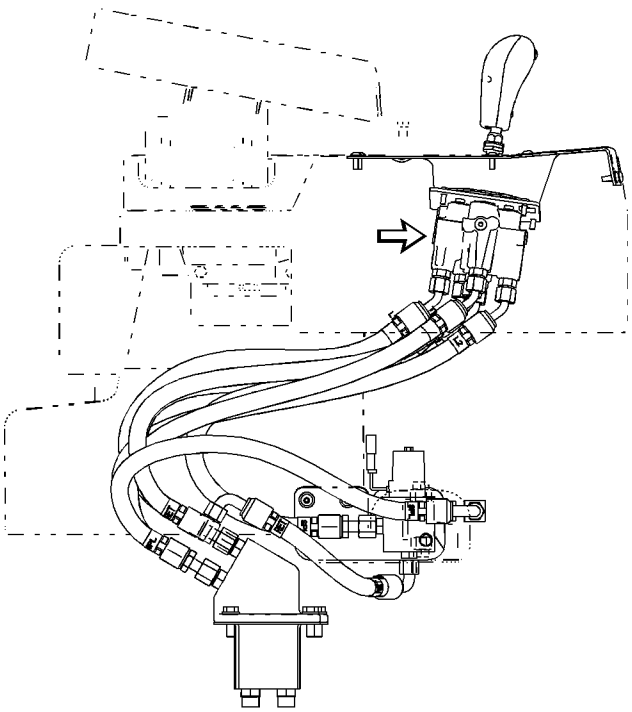


Illustration 12 g01206274

Right side view of cab

Location of pilot valve

The pilot valve controls the pilot pressure to the main control valve. The main control valve controls the flow of oil to the lift cylinders and tilt cylinders.

In the pilot hydraulic system, oil is supplied by the pilot/brake pump. The oil is directed to the combination valve. Once pilot pressure is obtained, the oil is directed back to the tank. The pilot oil is directed to the pilot accumulator in order to charge the accumulator. Pilot oil is then directed to the solenoid valve (hydraulic lockout) for the pilot valve. The pilot oil is then directed to the pilot valve.

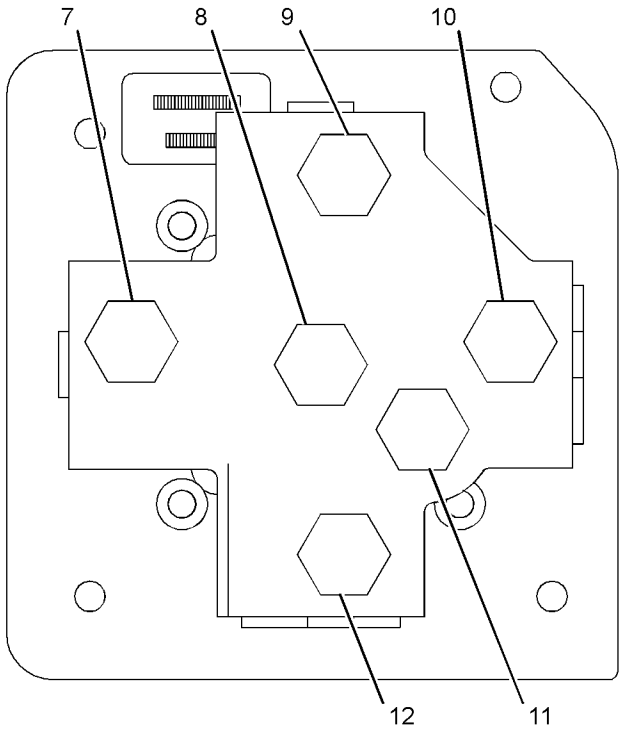


Illustration 13 g01206279

Base of pilot valve

(7) Control port for TILT RIGHT position. (8) Tank port. (9) Control port for LOWER position or FLOAT position. (10) Control port for TILT LEFT position. (11) Pilot supply port. (12) Control port for RAISE position.

The pilot oil enters the implement joystick at the pilot pressure inlet (11). Illustration 13 shows the position of the pilot pressure inlet, the connector for the return line, and the connectors of the lines which go to the end caps of the main relief valve.

The blade control lever controls the pilot oil. The blade control lever is connected to lever assembly (2) by a rod. When the blade control lever is moved, the lever assembly will push down on the top of cartridge assembly (4). The spool in cartridge assembly (4) controls the flow of oil to the control ports in the base of the valve.

The joystick control is equipped with detent coil (6). When you start the engine, the detent coil is energized by electricity. Only the FLOAT position has a detent coil.

When the joystick control is rotated to 90 percent of lever travel, the retainer on the lever assembly contacts detent coil (6). Detent coil (6) will hold the retainer. The joystick will be held in position until the kickout switch interrupts the flow of current to the detent coil. The detent coil de-energizes and lever assembly can return to the HOLD position.

When you push the joystick control into the FLOAT position, the pilot oil pressure increases to maximum pilot system pressure. The increase in pilot oil pressure causes the lift spool in the main control valve to shift into the FLOAT position. Hydraulic oil in the rod end of the lift cylinder and the head end of the lift cylinder drains to the tank. The lift arms lower to the ground.

The flow of pilot oil through the system is controlled by the cartridge assembly. The movement of each spool in the main control valve is determined by the individual cartridge assembly. The location of the cartridge assembly is shown in Illustration 11 . The following sections explain the operation of the cartridge assembly.

The Cartridge in the HOLD Position

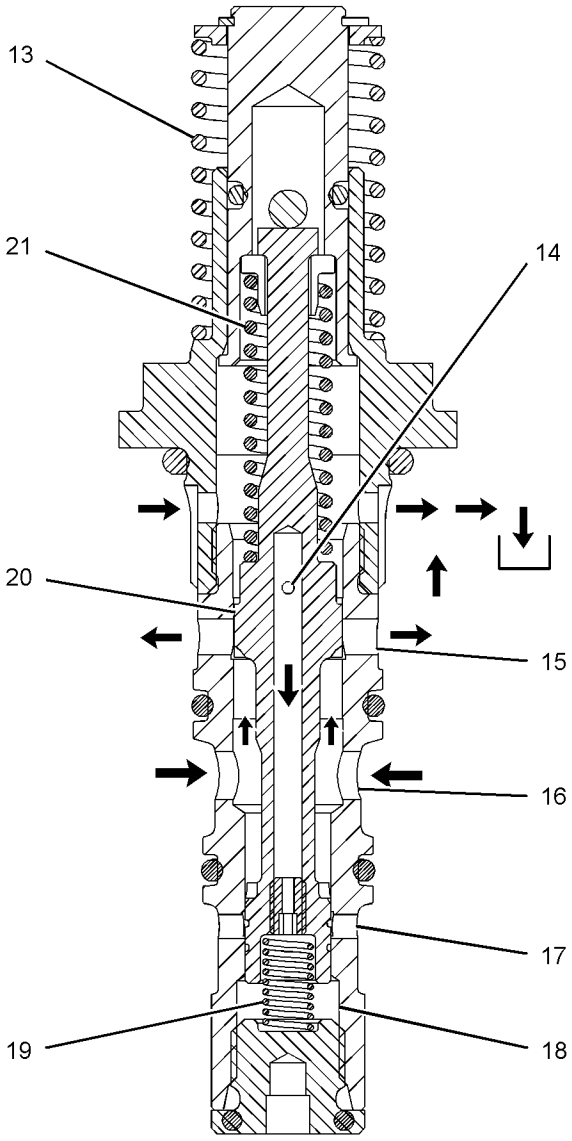


Illustration 14 g01206295

Cartridge assembly

(13) Spring. (14) Hole. (15) Port. (16) Port. (17) Port. (18) Chamber. (19) Spring. (20) Spool. (21) Spring.

When the cartridge assembly is in the HOLD position, centering spring (13), spring (21), and spring (19) keep lever assembly (2) in the HOLD position.

Pilot pressure oil flows into the pilot valve through the port at the bottom of the valve. The pilot oil flows through the pilot oil passage. The passage takes the oil to port (17) of the cartridge assembly.

The position of spool (20) blocks port (17). The pilot oil is prevented from flowing into ports (15) and (16). The internal passages are open to return port (15). This drains the pilot lines from the main control valve to return port (15). Return port (15) provides a path back to the hydraulic oil tank. Illustration 14 shows the flow of pilot oil through the cartridge assembly in the HOLD position.

Spring (19) will help to push up the spool. In the HOLD position, oil flows through hole (14) and through the center of spool (20). The oil flows into chamber (18). The oil is held in the chamber until the spool is moved.

The Cartridge with an Activated Spool

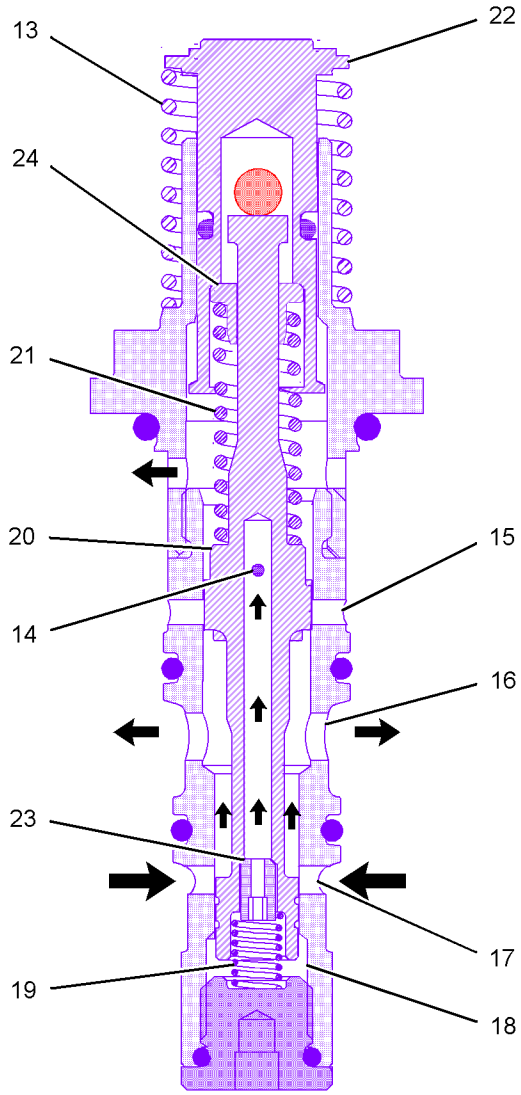


Illustration 15 g01206390

Cartridge assembly

(13) Spring. (14) Hole. (15) Port. (16) Port. (17) Port. (18) Chamber. (19) Spring. (20) Spool. (21) Spring. (22) Plunger. (23) Orifice. (24) Retainer.

In order to move a work tool, the flow of oil in the main control valve must be routed to a cylinder. This is accomplished by sending pilot oil from the pilot valve to the end cap of the main control valve. When the blade control lever is moved, lever assembly (2) causes plunger (22) to move downward. As plunger (22) moves downward, the force on retainer (24) overcomes spring (21).

As spring (21) compresses, spool (20) moves against spring (19). This moves spool (20) which closes port (15) to the hydraulic oil tank. At the same time, pilot oil supply port (17) opens. The pilot oil flows from pilot oil supply port (17) around spool (20) and into port (16). The oil pressure at port (16) to the control port also increases.

As plunger (22) continues to move down, pressure at port (16) to the control port increases. The spool in the main control valve starts to move. High pressure oil is sent to the end of the appropriate cylinder.

Once the pilot control lever is shifted, the pilot valve becomes a pressure reducing valve. The pilot valve will maintain a downstream pressure. The pressure is equal to the spring forces above the spool.

At the same time as spool (20) is moving in the downward direction, pressure of the oil in chamber (18) increases. The trapped oil is forced through orifice (23). This helps to dampen the valve. The combination of the oil in chamber (18) and spring (19) increases the stability of the valve.

Cartridge in Ball Lock

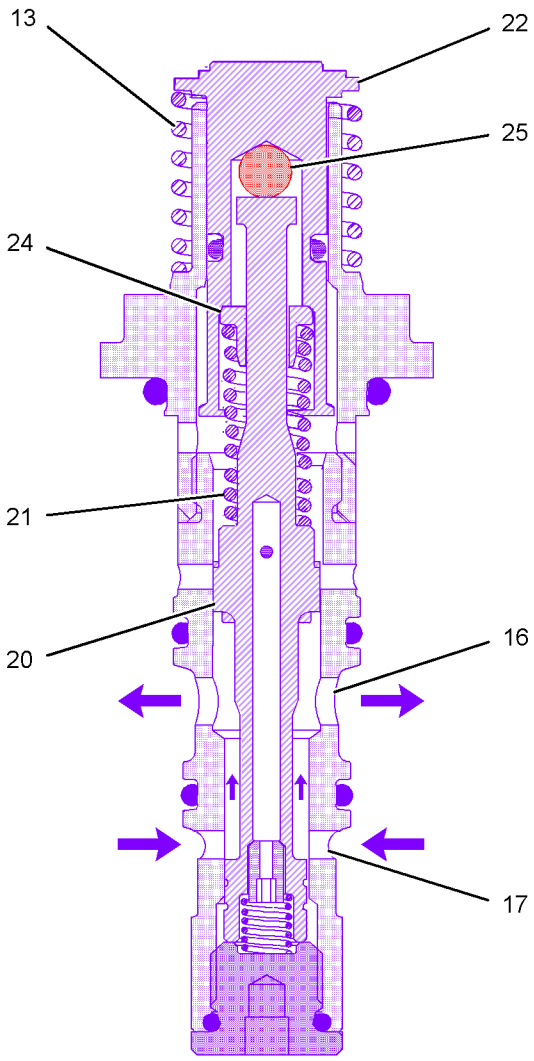


Illustration 16 g01206406

Cartridge assembly

(13) Spring. (16) Port. (17) Port. (20) Spool. (21) Spring. (22) Plunger. (24) Retainer. (25) Ball.

At approximately 85 percent of lever travel, ball (25) contacts both plunger (22) and spool (20). The opposing force of the spring (21) will no longer have an effect on the pilot pressure. This will equalize the oil pressure between port (16) and pilot supply passage (17).

i02441369

Main Hydraulic System

SMCS Code: 5050

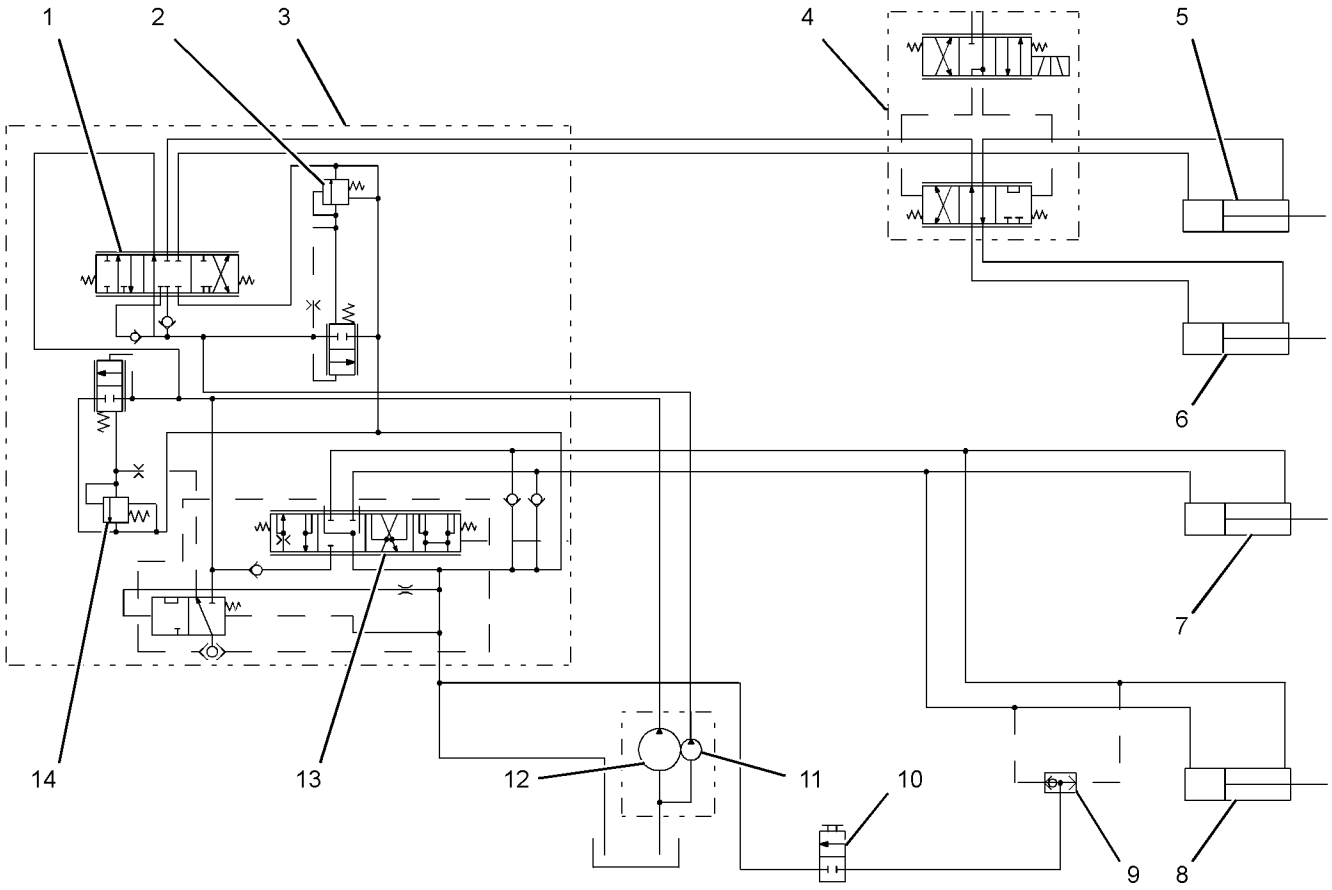


Illustration 17 g01204269

Main Hydraulic System

(1) Blade tilt control spool
(2) Tilt relief valve
(3) Main control valve
(4) Dual tilt control valve
(5) Left tilt cylinder
(6) Right tilt cylinder
(7) Left lift cylinder
(8) Right lift cylinder
(9) Ball resolver
(10) Manual lowering control
(11) Implement pump (small section)
(12) Implement pump (large section)
(13) Blade lift control spool
(14) Lift/lower relief valve

The main hydraulic system consists of the following components: Main control valve (3), Left tilt cylinder (5), Right tilt cylinder (6), Left lift cylinder (7) and Right lift cylinder (8) Manual lowering control (10), Small pump section (11) and Large pump section (12).

The operator of the machine controls the main hydraulic system through the use of a pilot hydraulic system. Pilot oil from the pilot control valve in the cab is sent to the ends of blade tilt control spool (1) and blade lift control spool (13). This pilot oil shifts the spools. The spools then direct the flow of oil to the lift cylinders and the tilt cylinders.

Lift Operation

Blade lift control spool (13) has four positions: RAISE, HOLD, LOWER and FLOAT.

RAISE Position



Raise – Pull back on the blade control lever in order to raise the blade.

When the RAISE position is selected with the blade control lever, pilot oil flows to the left end of blade lift control spool (13). Blade lift control spool (13) shifts to the right. Oil is directed to the rod end of lift cylinders (7,8). Lift cylinders (7,8) retract. Oil from the head end of the lift cylinders flows to the main control valve. The return oil is directed to the hydraulic tank.

HOLD Position



Hold – Release the blade control lever . The control lever will return to the HOLD position. Blade movement will stop.

When the blade control lever is in the HOLD position, pilot oil is not directed to the main control valve. Springs on either end of blade lift control spool (13) return the spool to the HOLD position. The oil that is entering main control valve (3) will pass through unloading valves. The oil will then return to the hydraulic tank.

LOWER Position



Lower – Push the blade control lever forward in order to lower the blade.

When the LOWER position is selected with the blade control lever, pilot oil flows to the right end of blade lift control spool (13). The spool shifts to the left. Oil is directed to the head end of lift cylinders (7,8). Lift cylinders (7,8) extend. Oil from the rod end of the lift cylinders flows to main control valve (3). The return oil is directed to the hydraulic tank.

FLOAT Position



Float – Push the blade control lever all the way forward into the detent. The blade will lower to the ground. The blade will follow the contour of the ground as the machine moves.

When the FLOAT position is selected with the blade control lever, pilot oil flows to the right end of blade lift control spool (13). The spool shifts all the way to the left. Both ends of each cylinder are open to the hydraulic tank. The cylinder can move in and out as the blade follows the contour of the ground.

Dual Tilt Operation

Blade tilt control spool (1) has three positions: TILT RIGHT, HOLD and TILT LEFT.

DUAL TILT RIGHT Position



Tilt Right – Move the blade control lever to the right in order to lower the blade to the right.

When the DUAL TILT RIGHT position is selected with the blade control lever , pilot oil flows to the right end of blade tilt control spool (1). Blade tilt control spool (1) shifts to the left. Oil flows to the head end of left tilt cylinder (5). Left tilt cylinder (5) extends. Oil from the rod end of the left tilt cylinder flows to dual tilt control valve (4). The oil is directed to the rod end of right tilt cylinder (6). The right tilt cylinder retracts. Oil from the head end of the right tilt cylinder flows through dual tilt control valve (4). The oil is directed to main control valve (3). The oil is then directed to the hydraulic tank.

TILT HOLD Position



Tilt Hold – Release the blade control lever. The control lever will return to the HOLD position. Blade movement will stop.

When the blade control lever is in the HOLD position, pilot oil is not directed to the main control valve. Springs on either end of blade tilt control spool (1) return the spool to the HOLD position. The oil that is entering main control valve (3) will pass through unloading valves. The oil will then return to the hydraulic tank.

DUAL TILT LEFT Position



Tilt Left – Move the blade control lever to the left in order to lower the blade to the left.

When the DUAL TILT LEFT position is selected with the blade control lever , pilot oil flows to the left end of blade tilt control spool (1). Blade tilt control spool (1) shifts to the right. Oil flows to dual tilt control valve (4). The oil is directed to the head end of right tilt cylinder (6). Right tilt cylinder (6) extends. Oil from the rod end of the right tilt cylinder flows to dual tilt control valve (4). The oil is directed to the rod end of left tilt cylinder (5). The left tilt cylinder retracts. Oil from the head end of the left tilt cylinder flows to main control valve (3). The oil is then directed to the hydraulic tank.

Reference: For more information on the operation of the main control valve, refer to the Service Manual System Operation, “Main Control Valve” for the machine that is being serviced.

Reference: For more information on the operation of the pilot hydraulic system, refer to the Service Manual System Operation, “Pilot Hydraulic System” for the machine that is being serviced.

i01648888

Vane Pump (Implement)

SMCS Code: 5055-II; 5084-VA

The implement pump is located under the cab on the right side of the machine. The pump is mounted to the pump drive on the flywheel end of the engine.

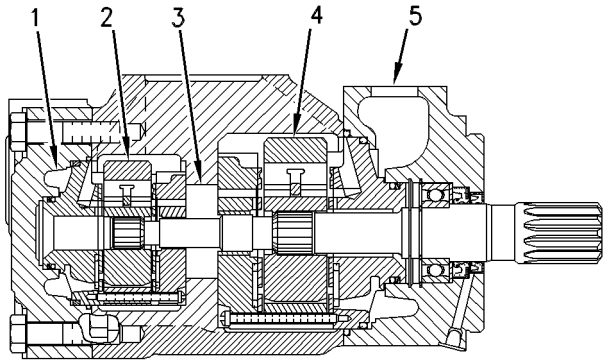


Illustration 18 g00340192

Section View of the Implement Pump

(1) Outlet for the small section of the implement pump. (2) Small section of the implement pump. (3) Inlet for the implement pump. (4) Large section of the implement pump. (5) Outlet for the large section of the implement pump.

The implement pump is a two-section vane pump. The implement pump draws oil from the hydraulic oil tank through inlet (3).

Implement pump section (2) supplies the oil that is needed to operate the tilt function of the bulldozer blade. The oil exits the small section of the implement pump through outlet (1).

Implement pump section (4) supplies the oil that is needed to operate the lift function of the bulldozer blade. The oil exits the large section of the implement pump through outlet (5).

Note: The large section and the small section of the implement pump operate similarly. An explanation of the operation of a typical vane pump follows.

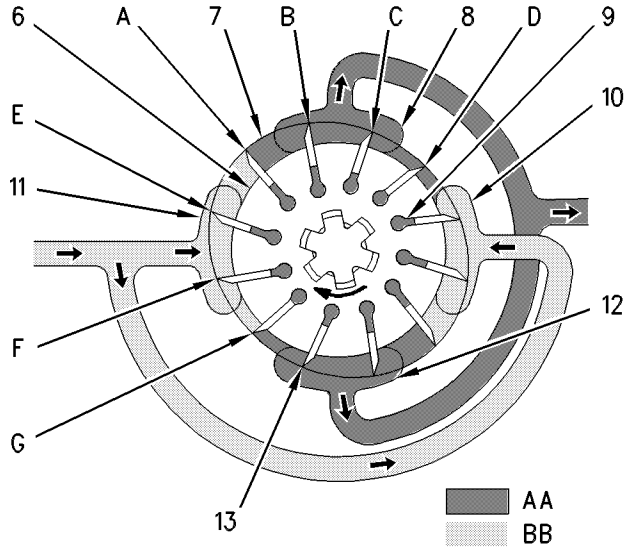


Illustration 19 g00275070

Schematic of the Carriage Assembly for a Typical Vane Pump

(6) Rotor. (7) Cam ring. (8) Outlet. (9) Passage. (10) Inlet. (11) Inlet. (12) Outlet. (13) Vane.

Callouts (A) through callout (G) represent various locations of the vanes. (AA) Pressure oil. (BB) Supply oil.

The components of the carriage assembly for a typical vane pump include a plate, an adapter, seal packs, rotor (6), cam ring (7) and vanes (13).

Vanes (13) are pushed outward by centrifugal force. Pressure oil in passages (9) pushes the vanes outward along the contour of the cam ring (7). Both ends of the vanes are connected by these passages. The oil in these passages keeps the pressure equal on both ends of the vanes. Also, the oil behind the vanes is allowed to escape as the vanes are pushed inward.

As rotor (6) turns clockwise, the vanes in positions (G) and (F) move outward along the contour of the cam ring. As the chamber area between the vanes increases, the oil pressure drops and a vacuum is created in the chamber. This pressure difference causes oil to flow from the hydraulic oil tank and through inlet (11). The oil fills the space between positions (F) and (A).

Oil between the vanes at positions (F) and (E) will be trapped when the vanes pass the end of inlet (11). As rotor (6) continues to turn, the vanes are pushed inward by the contour of cam ring (7). The chamber area between the vanes now decreases. The pressure of the oil increases.

Pressurized oil between the vanes at positions (A) and (B) is pushed into outlet (8). The oil continues to be pushed through the outlet between positions (B) and (C). When the vane at position (B) passes the end of outlet (8), the cycle is complete.

Note: The oil that enters through inlet (10) flows through the cartridge assembly and through outlet (12) similarly.

Reference: For information on the specifications of the implement pump, refer to the Service Manual module Specifications, “Vane Pump (Implement)” for the machine that is being serviced.

Reference: For more information about vane pumps, refer to Special Instruction, SMHS7047.

i02441375

Main Control Valve

SMCS Code: 5051-MV

Blade Lift Control Spool

The spools of the main control valve are shifted by pilot oil. The flow of pilot oil to the end of the control valve spools is controlled by the pilot valve.

HOLD Position

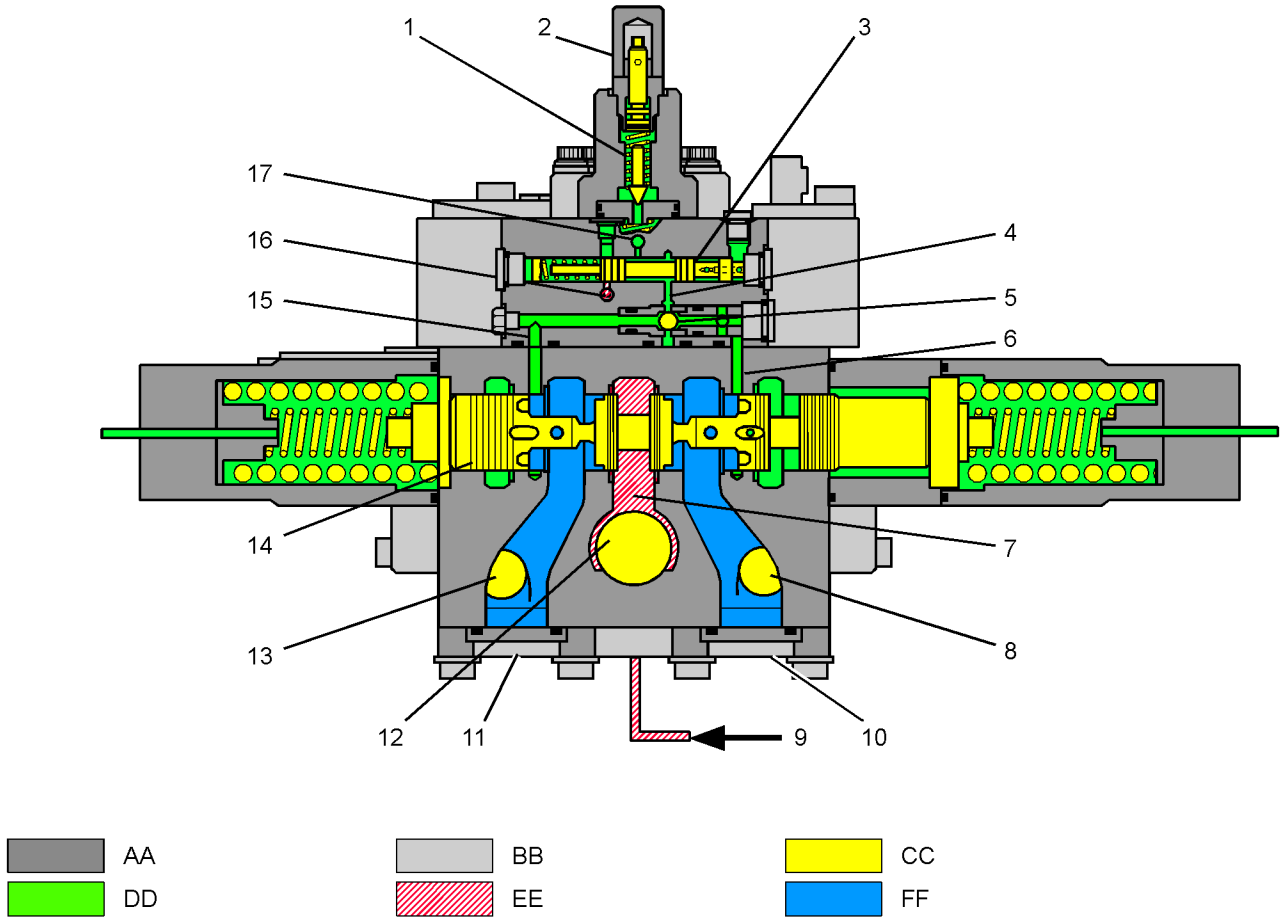


Illustration 20 g01203257

Main Control Valve in HOLD position

(1) Spring
(2) Lift/lower relief valve
(3) Shuttle valve
(4) Passage
(5) Resolver valve
(6) Passage
(7) Inlet (Lift section)
(8) Makeup valve for lift cylinder
(9) Inlet (Tilt section)
(10) Head end passage
(11) Rod end passage
(12) Load check valve
(13) Makeup valve for lift cylinder
(14) Blade lift control spool
(15) Passage
(16) Supply from lift section
(17) Passage
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(EE) First pressure reduction
(FF) Trapped oil

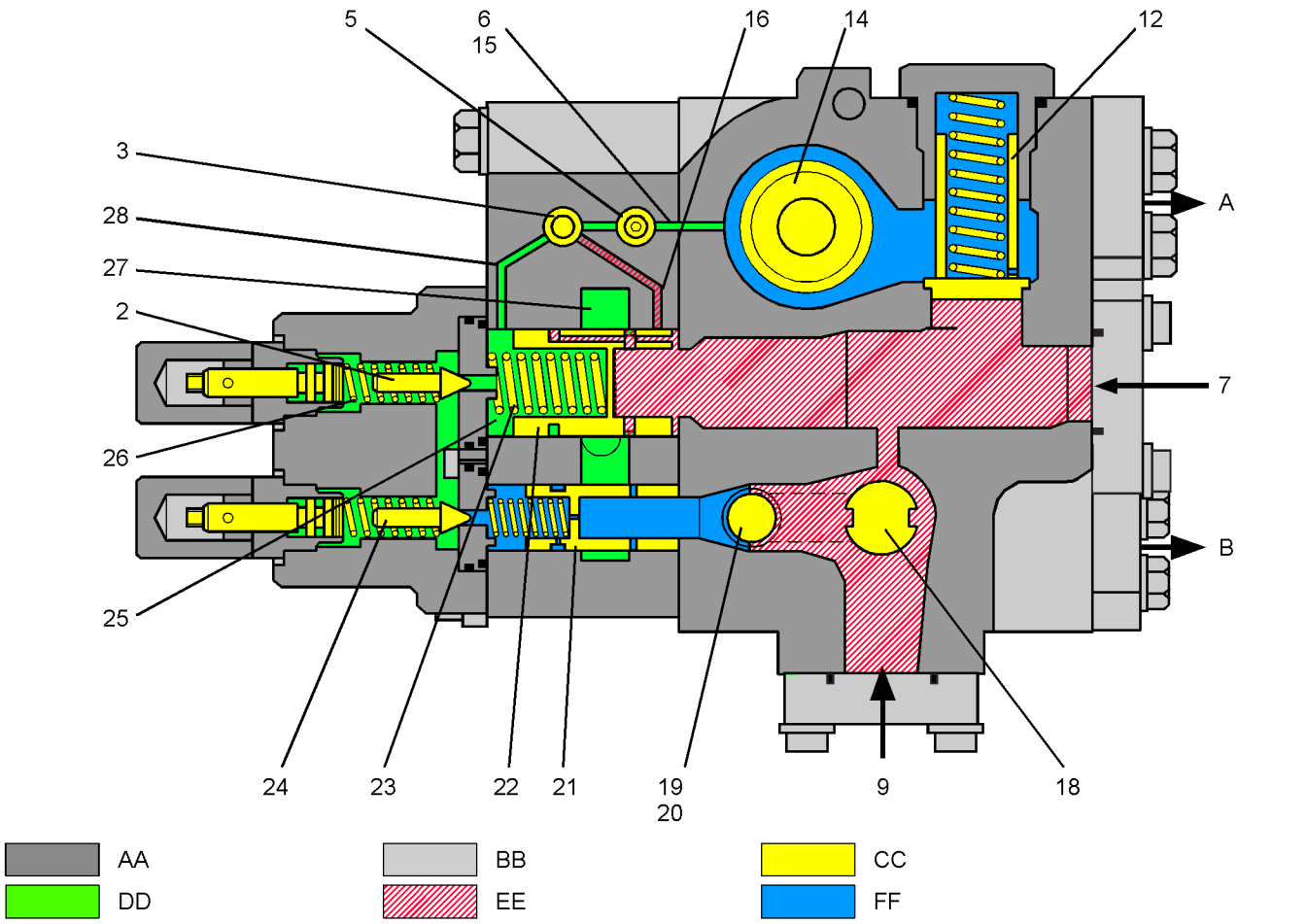


Illustration 21 g01203259

Main Control Valve in HOLD position (side view)

(2) Lift/lower relief valve
(3) Shuttle valve
(5) Resolver valve
(6) Passage
(7) Inlet (Lift section)
(9) Inlet (Tilt section)
(12) Load check valve
(14) Blade lift control spool
(15) Passage
(16) Supply from lift section
(18) Blade tilt control spool
(19) Load check valve
(20) Load check valve
(21) Unloading valve
(22) Unloading valve
(23) Spring
(24) Tilt relief valve
(25) Spring chamber
(26) Spring
(27) Tank passage
(28) Passage
(A) Supply to lift cylinders
(B) Supply to tilt cylinders
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(EE) First pressure reduction
(FF) Trapped oil

When the valve is in the HOLD position, output from the implement pump is sent to the main control valve. Oil enters the valve at the inlet for lift section (7) and the inlet for tilt section (9). Oil in the tilt section flows around the center section of blade tilt control spool (18). This oil then combines with the oil in the lift section. The combined oil then flows to the unloading valve for lift (22) and to the relief valve for lift (2). The oil is blocked at that location.

RAISE Position

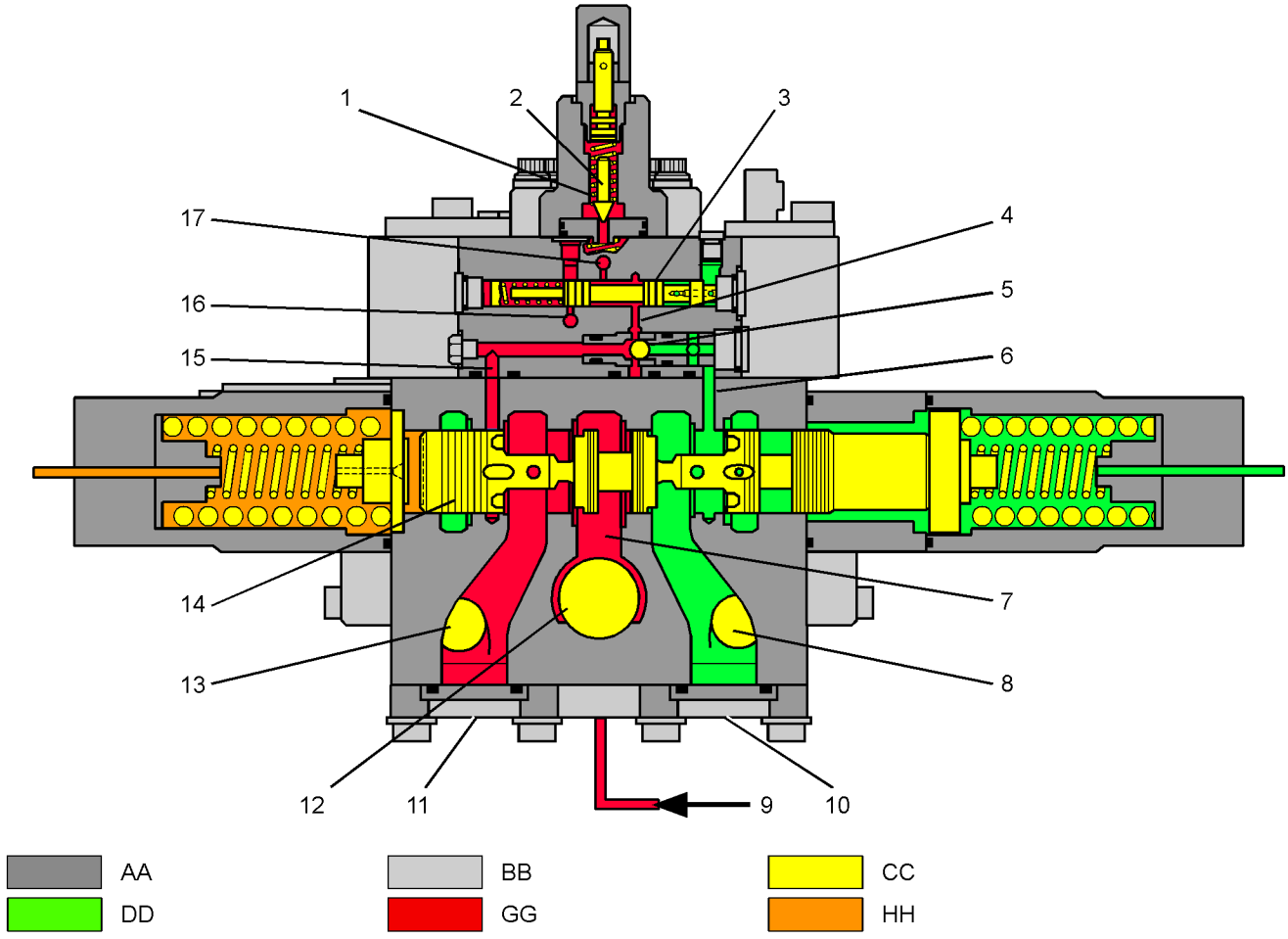


Illustration 22 g01203262

Main Control Valve in RAISE position

(1) Spring
(2) Lift/lower relief valve
(3) Shuttle valve
(4) Passage
(5) Resolver valve
(6) Passage
(7) Inlet (Lift section)
(8) Makeup valve for lift cylinder
(9) Inlet (Tilt section)
(10) Head end passage
(11) Rod end passage
(12) Load check valve
(13) Makeup valve for lift cylinder
(14) Blade lift control spool
(15) Passage
(16) Supply from lift section
(17) Passage
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(GG) High pressure
(HH) Pilot pressure

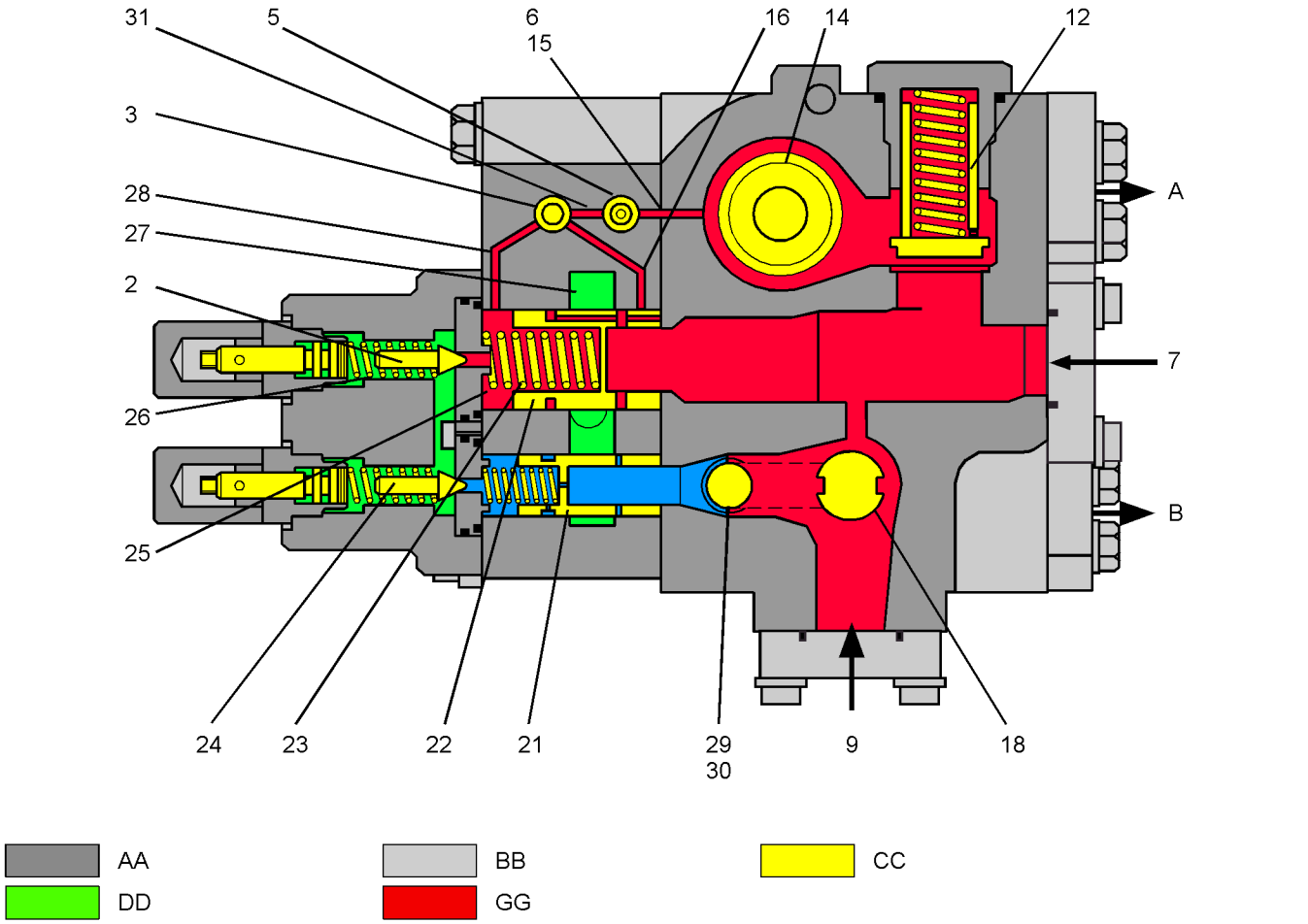


Illustration 23 g01203263

Main Control Valve in RAISE position (side view)

(2) Lift/lower relief valve
(3) Shuttle valve
(5) Resolver valve
(6) Passage
(7) Inlet (Lift section)
(9) Inlet (Tilt section)
(12) Load check valve
(14) Blade lift control spool
(15) Passage
(16) Supply from lift section
(18) Blade tilt control spool
(21) Unloading valve
(22) Unloading valve
(23) Spring
(24) Tilt relief valve
(25) Spring chamber
(26) Spring
(27) Tank passage
(28) Passage
(29) Load check valve
(30) Load check valve
(31) Passage
(A) Supply to lift cylinders
(B) Supply to tilt cylinders
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(GG) High pressure

When the operator moves the blade control lever from the HOLD position to the RAISE position, pilot oil is directed to the left end of blade lift control spool (14). Pilot oil shifts blade lift control spool (14) to the right. This opens the pump inlet passage in the main control valve to the rod end passage to the lift cylinders. High pressure oil from the lift section and the tilt section will combine. The high pressure oil will combine if the tilt section of the valve is not activated. The combined high pressure oil will enter the control valve and open load check valve (12). High pressure oil then flows around blade lift control spool (14). The high pressure oil then flows into rod end passage (11). The high pressure oil then travels to the rod end of the lift cylinders. The high pressure oil will then raise the blade at a rate relative to the amount of movement of the blade control lever. As the blade is raised, return oil from the head end of the lift cylinders enters head end passage (10) of the main control valve. The oil then flows around blade lift control spool (14) and into tank passage (27). The oil is then directed back to the hydraulic tank.

At the same time, high pressure oil flows through the machined slots on the left side of blade lift control spool (14) and into passage (15). The high pressure oil shifts the resolver ball in signal resolver (5) to the right. The high pressure oil enters passage (31). There high pressure oil is directed to shuttle valve (3). The high pressure oil flows around the center stem of shuttle valve (3) and into passage (17). Passage (17) leads to spring chamber (25). Spring chamber (25) is between the relief valve for the lift (2) and unloading valve (22) for the lift cylinder. The high pressure oil plus the force of spring (23) keeps unloading valve (22) for the lift closed. Maximum oil pressure is now available to move the lift cylinders.

The relief valve for the lift (2) protects the system from unusually high pressures that may be introduced into the system due to the load on the lift cylinders. The force of spring (1) holds the relief valve for the lift (2) closed until the pressure exceeds the value of spring (1). The relief valve for the lift (2) opens in order to relieve the excessive pressure.

LOWER Position

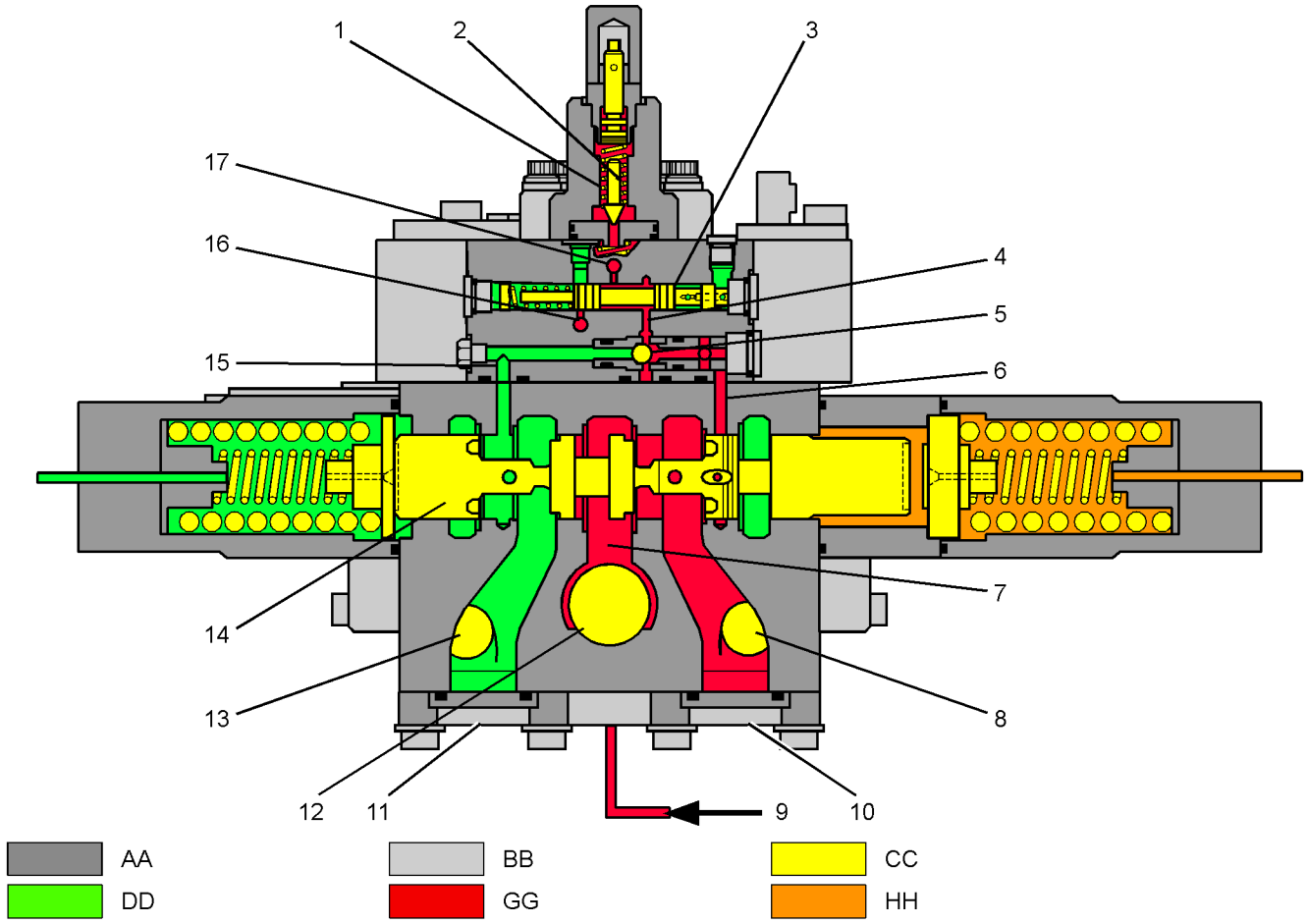


Illustration 24 g01203265

Main Control Valve in LOWER position

(1) Spring
(2) Lift/lower relief valve
(3) Shuttle valve
(4) Passage
(5) Resolver valve
(6) Passage
(7) Inlet (Lift section)
(8) Makeup valve for lift cylinder
(9) Inlet (Tilt section)
(10) Head end passage
(11) Rod end passage
(12) Load check valve
(13) Makeup valve for lift cylinder
(14) Blade lift control spool
(15) Passage
(16) Supply from lift section
(17) Passage
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(GG) High pressure
(HH) Pilot pressure

When the operator moves the blade control lever from the HOLD position to the LOWER position, pilot oil is directed to the right end of blade lift control spool (14). Pilot oil shifts blade lift control spool (14) to the left. This will open the pump inlet passage in the main control valve to the head end passage to the lift cylinders. If the tilt valve for the blade is not activated, high pressure oil from the lift section and the tilt section combine. The high pressure oil enters the control valve. The high pressure oil will open load check valve (12). High pressure oil then flows around blade lift control spool (14). The high pressure oil then flows into head end passage (10). The high pressure oil then flows to the head end of the lift cylinders. The high pressure will lower the blade at a rate relative to the amount of movement of the blade control lever. As the blade is lowered, return oil from the rod end of the lift cylinders enters rod end passage (11) of the main control valve. The oil then flows around blade lift control spool (14) and into tank passage (27). The oil is then directed back to the hydraulic tank.

At the same time, high pressure oil flows through the machined slots on the right side of blade lift control spool (14) and into passage (6). The high pressure oil shifts the resolver ball in signal resolver (5) to the left. The high pressure oil enters passage (4). The high pressure oil is directed to shuttle valve (3). The high pressure oil flows around the center stem of shuttle valve (3) and into passage (17). Passage (17) leads to spring chamber (25). Spring chamber (25) is between the relief valve for the lift (2) and unloading valve (22) for the lift cylinder. The high pressure oil plus the force of spring (23) keeps unloading valve (22) for the lift closed. Maximum oil pressure is now available to move the lift cylinders.

The relief valve for the lift (2) protects the system from unusually high pressures that may be introduced into the system due to the load on the lift cylinders. The force of spring (1) holds the relief valve for the lift (2) closed until the pressure exceeds the value of spring (1). The relief valve for the lift (2) opens in order to relieve the excessive pressure.

FLOAT Position

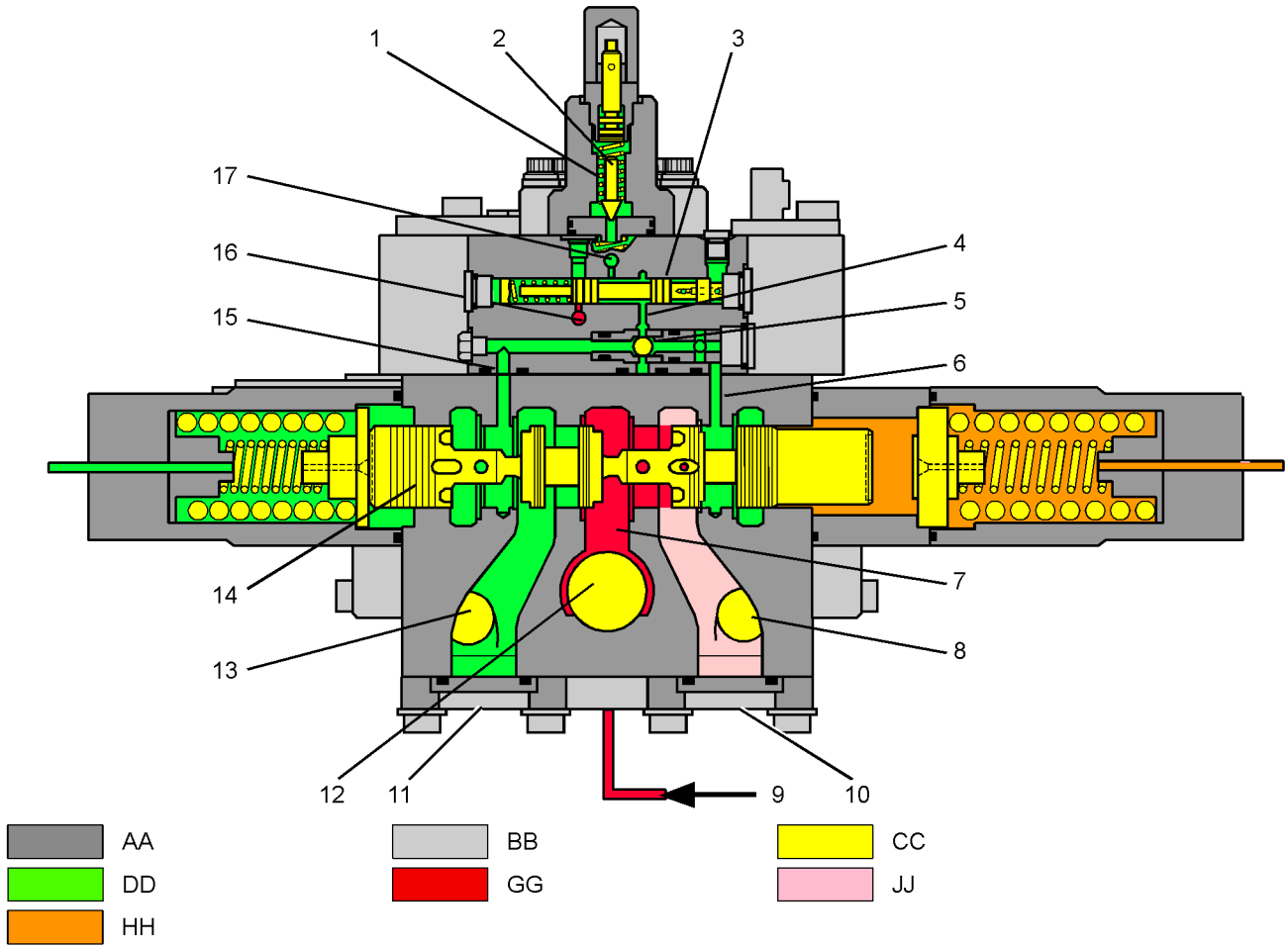


Illustration 25 g01203266

Main Control Valve in FLOAT position

(1) Spring
(2) Lift/lower relief valve
(3) Shuttle valve
(4) Passage
(5) Resolver valve
(6) Passage
(7) Inlet (Lift section)
(8) Makeup valve for lift cylinder
(9) Inlet (Tilt section)
(10) Head end passage
(11) Rod end passage
(12) Load check valve
(13) Makeup valve for lift cylinder
(14) Blade lift control spool
(15) Passage
(16) Supply from lift section
(17) Passage
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(GG) High pressure
(HH) Pilot pressure
(JJ) Third pressure reduction

When the operator moves the blade control lever from the HOLD position to the FLOAT position, pilot oil is directed to the right end of blade lift control spool (14). Pilot oil shifts blade lift control spool (14) all the way to the left. Blade lift control spool (14) now blocks the pump inlet passage in the main control valve to the rod end passage (11). Blade lift control spool (14) almost blocks the pump inlet passage in the main control valve to the head end of the lift cylinders. Only a slight amount of oil flows into the head end passage. In this position, rod end passage (11) is open to tank passage (27) and head end passage (10) is open to tank passage (27). As the tractor moves, the blade follows the contour of the ground. The lift cylinders will move according to the contour of the ground. As the lift cylinders move, hydraulic oil is drawn from the hydraulic tank and hydraulic oil is directed back to the hydraulic tank.

Passages (6) and (15) are also open to the tank, so no pressure signal is sent to the ball for signal resolver (5) or shuttle valve (3). Therefore, no high pressure oil is sent to spring chamber (25) between unloading valve (22) and relief valve (2). This causes unloading valve (22) to open against the force of spring (23). The hydraulic oil that is passing through unloading valve (22) then flows back to the hydraulic tank.

Blade Tilt Control Spool

HOLD Position

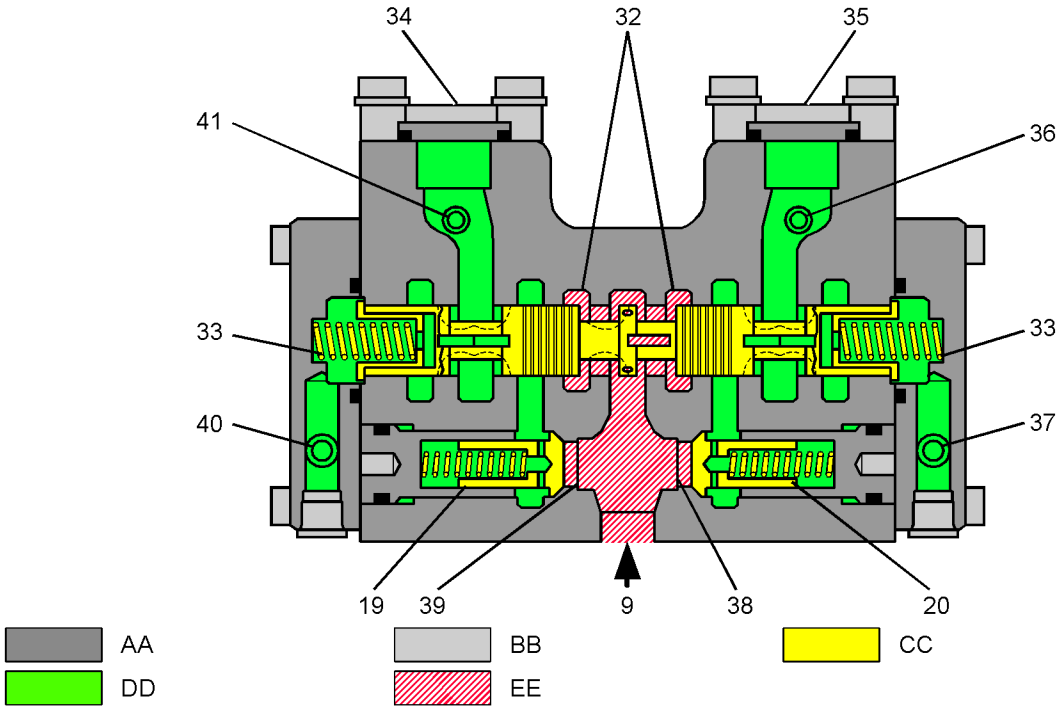


Illustration 26 g01203267

Tilt Control Valve in HOLD position

(9) Inlet (Tilt section)
(19) Load check valve
(20) Load check valve
(32) Passages to blade lift control spool
(33) Centering spring
(34) Supply to head end of tilt cylinder
(35) Supply to rod end of tilt cylinder
(36) Passage
(37) Port
(38) Passage
(39) Passage
(40) Port
(41) Passage
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(EE) First pressure reduction

When the blade tilt control valve is in the HOLD position, blade tilt control spool (18) is held in the center position by centering springs (33). In the center position, blade tilt control spool (18) blocks pump supply oil from entering the passages to the tilt cylinders. The oil in the passages is trapped and the blade does not move. The tilt spool is an open center spool, which allows the oil to flow around the center of the spool into passages (32) to blade lift control spool (14) when the tilt spool is in the HOLD position. The oil from the tilt section combines with oil from the lift section.

TILT LEFT Position

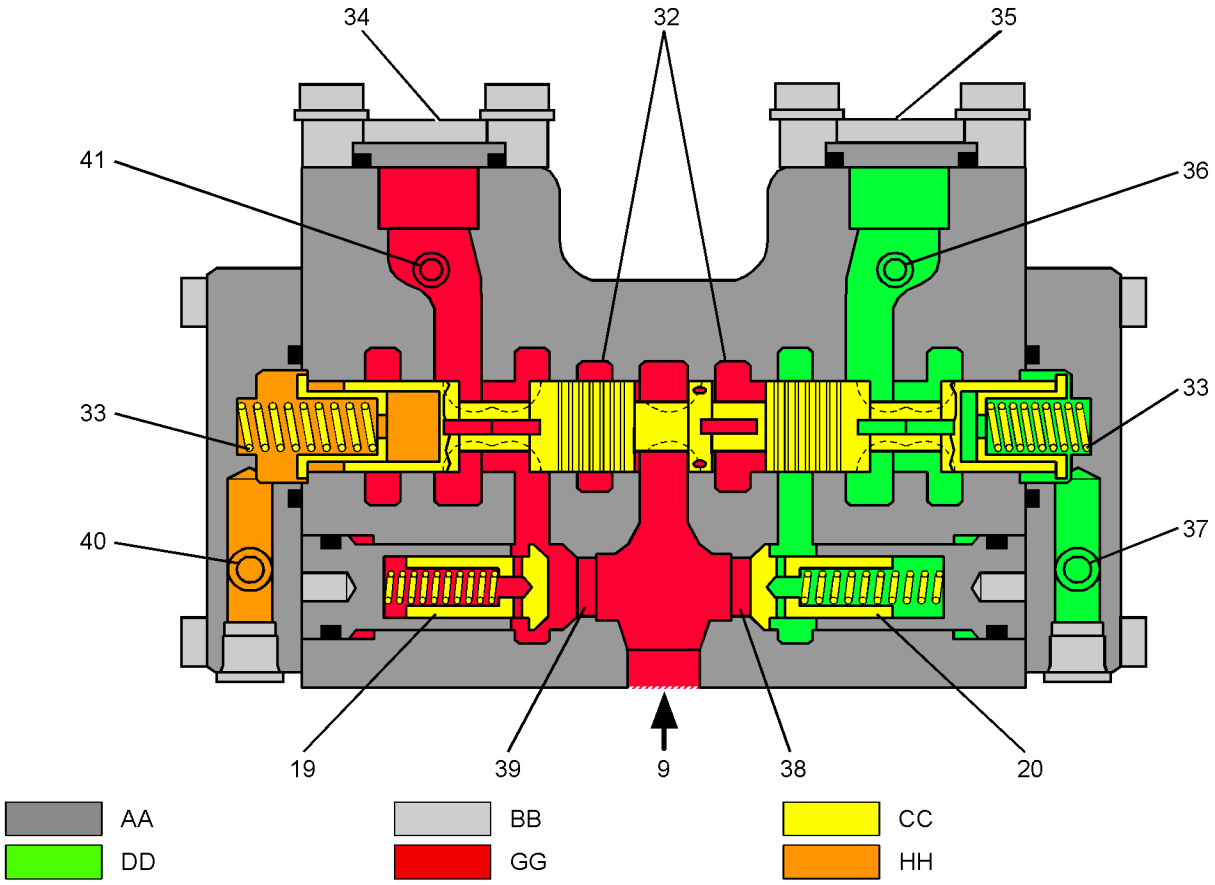


Illustration 27 g01203268

Tilt Control Valve in TILT LEFT position

(9) Inlet (Tilt section)
(19) Load check valve
(20) Load check valve
(32) Passages to blade lift control spool
(33) Centering spring
(34) Supply to head end of tilt cylinder
(35) Supply to rod end of tilt cylinder
(36) Passage
(37) Port
(38) Passage
(39) Passage
(40) Port
(41) Passage
(AA) Cutaway section
(BB) Component surface
(CC) Activated components
(DD) Tank pressure
(GG) High pressure
(HH) Pilot pressure

When the operator moves the blade control lever to the TILT LEFT position, pilot oil is directed to port (40) at the left end of blade tilt control spool (18). The pressure of the pilot oil shifts the tilt spool (18) to the right.

At the same time, high pressure oil from the tilt section flows into passage (39). Load check valve (19) opens. High pressure oil flows past blade tilt control spool (18) to the head end passage (34).

TILT RIGHT Position

The operation of the tilt control valve in the TILT RIGHT position is similar to the operation of the tilt control valve in the TILT LEFT position.

When the operator moves the blade control lever to the TILT RIGHT position, pilot oil is directed to port (37) at the right end of blade tilt control spool (18). The pressure of the pilot oil shifts the tilt spool (18) to the left.

At the same time, high pressure oil from the tilt section flows into passage (38). Load check valve (20) opens. High pressure oil flows past blade tilt control spool (18) to the rod end passage (35).

i02441393

Tilt Control Valve (Dual)

SMCS Code: 5051-T2

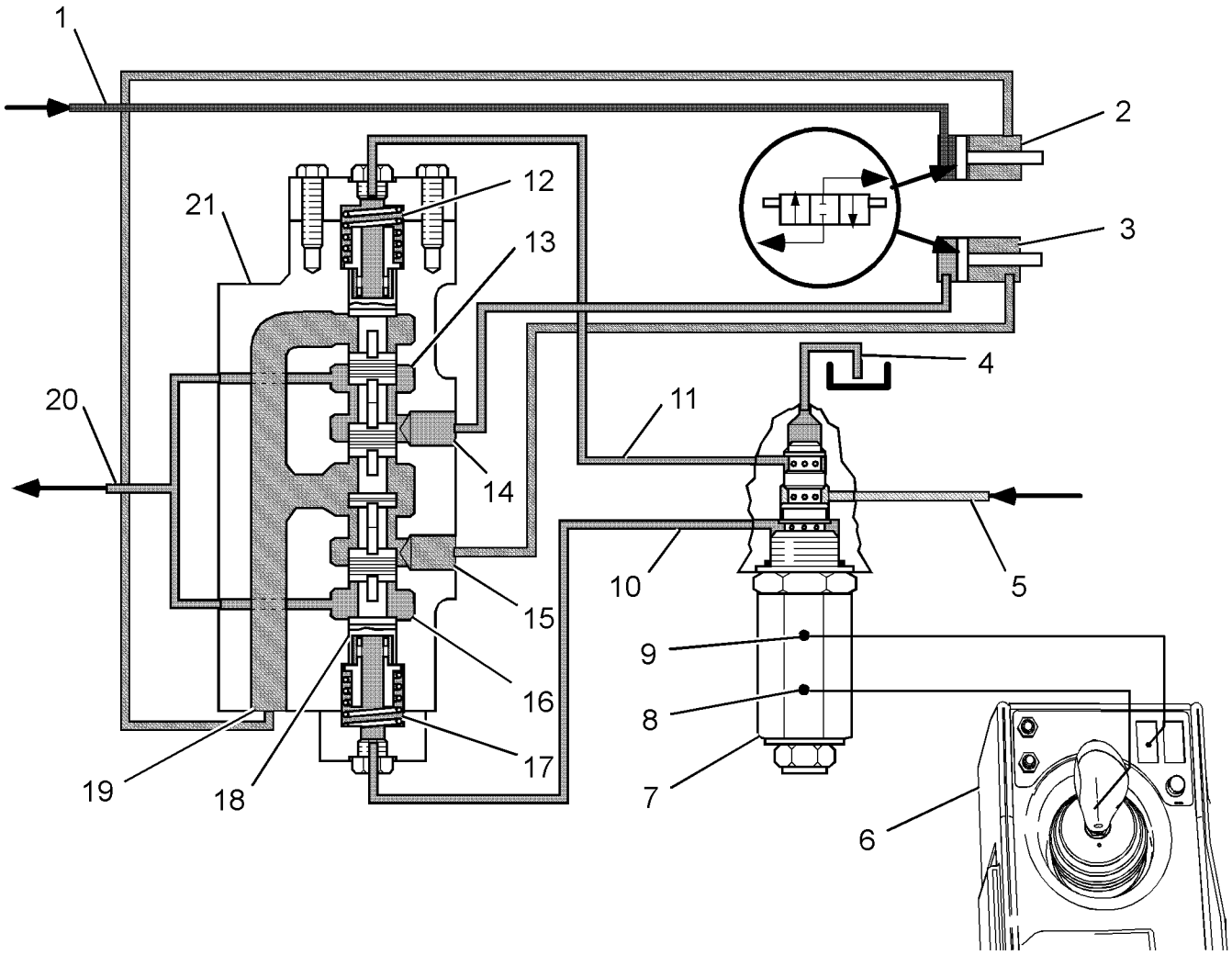


Illustration 28 g01196255

Schematic of Dual Tilt Control Valve in Dual Tilt position

(1) Line from the bulldozer tilt control valve
(2) Dual tilt cylinder (left)
(3) Dual tilt cylinder (right)
(4) Passage to tank for solenoid valve
(5) Passage for pilot oil to the solenoid valve
(6) Dozer blade control
(7) Solenoid valve
(8) Coil for tip operation of the cylinders
(9) Coil for single tilt operation of the cylinders
(10) Passage for pilot oil
(11) Passage for pilot oil
(12) Chamber for pilot oil
(13) Chamber for pump oil from the bulldozer tilt control valve
(14) Port to head end of right dual tilt cylinder
(15) Port to rod end of right dual tilt cylinder
(16) Chamber for pump oil from the bulldozer tilt control valve
(17) Chamber for pilot oil
(18) Stem in dual tilt control valve
(19) Port to rod end of left dual tilt cylinder
(20) Line from the bulldozer tilt control valve
(21) Dual tilt control valve

Dual tilt control valve (21) gives the hydraulic circuit for the tilt cylinder three different types of operation: DUAL TILT, SINGLE TILT and TIP. The control valve is installed in the non-engine end frame. The valve is activated by pilot oil pressure from the blade control lever for the dozer. Solenoid valve (7) directs the pilot oil to the ends of stem (18). Dozer blade control (6) controls the operation of the solenoid valve with a toggle switch for SINGLE TILT operation and a trigger switch for TIP operation.

Dual Tilt Operation

When solenoid valve (7) is not energized by dozer blade control (6), dual tilt control valve (21) is in the DUAL TILT position. Tilt cylinders (2) and (3) will move in opposite directions.

When the bulldozer control lever is moved to the TILT RIGHT position, pump oil from the bulldozer tilt control valve is sent through line (1) to the head end of left tilt cylinder (2). As cylinder (2) extends, oil from the rod end flows to port (19) of the dual tilt control valve. The oil then flows around stem (18) through port (15) to the rod end of right tilt cylinder (3). As cylinder (3) retracts, oil from the head end of the cylinder flows to port (14) of the dual tilt control valve. The oil then flows around stem (18) to chamber (13). Then, the oil flows to the tank through line (20) and through the bulldozer tilt control valve. The action of the two dual tilt cylinders causes the bulldozer to tilt to the right. When the control lever is released, oil is blocked to the cylinders and the bulldozer will stay tilted to the right until the control lever is moved again.

To tilt the bulldozer to the left, the bulldozer control lever is moved to the TILT LEFT position. Pump oil from the bulldozer tilt control valve is sent through line (20) to chambers (13) and (16). Since oil to chamber (16) is blocked, the oil flows to chamber (13) and around stem (18) to port (14). Oil then flows to the head end of right tilt cylinder (3). As the cylinder extends, oil from the rod end of cylinder (3) flows to port (15). Oil at port (15) flows around stem (18) to port (19). Then, the oil flows to the rod end of left tilt cylinder (2). As the cylinder retracts, oil from the head end of cylinder (2) flows to the tank through line (1) and the bulldozer tilt control valve. The action of the two dual tilt cylinders causes the bulldozer to tilt to the left. When the control lever is released, oil is blocked to the cylinders and the bulldozer will stay tilted to the left until the control lever is moved again.

Single Tilt Operation

When the toggle switch on dozer blade control (6) is moved to the ON position, coil (9) is energized. Pilot oil from the implement control valve in passage (5) flows through the solenoid valve to passage (11). Oil through passage (11) flows to chamber (12). The oil moves stem (18) downward to the SINGLE TILT position. The stem blocks oil in right tilt cylinder (3), and the stem allows the cylinder to act as a brace. Left tilt cylinder (2) now acts as a single tilt cylinder.

When the bulldozer control lever is moved to the TILT RIGHT position, pump oil from the bulldozer tilt control valve is sent through line (1) to the head end of left tilt cylinder (2). As cylinder (2) extends, oil from the rod end flows to port (19) of the dual tilt control valve. The oil then flows around stem (18) to chamber (13). Then, the oil flows back to the tank through line (20) and the bulldozer tilt control valve. The action of cylinder (2) causes the bulldozer to tilt to the right. When the control lever is released, oil is blocked to cylinder (2) and the bulldozer will stay tilted to the right until the control lever is moved again.

To tilt the bulldozer to the left, the bulldozer control lever is moved to the TILT LEFT position. Pump oil from the bulldozer tilt control valve is sent through line (20) to chambers (13) and (16). Since oil to chamber (16) is blocked, the oil flows to chamber (13) and around stem (18) to port (19). Oil then flows to the rod end of left tilt cylinder (2). As cylinder (2) retracts, oil from the head end flows to the tank through line (1) and the bulldozer tilt control valve. The action of cylinder (2) causes the bulldozer to tilt left. When the control lever is released, oil is blocked to cylinder (2) and the bulldozer will stay tilted to the left until the control lever is moved again.

Tip Operation

When the trigger lever on dozer blade control (6) is held backward, and the toggle switch is in the OFF position, coil (8) is energized. If the toggle switch on the control panel (6) is in the ON position and the trigger lever is pulled, coil (8) will be energized and coil (9) will be de-energized. The tip operation of the bulldozer has priority over either the dual tilt function or the single tilt function. When coil (8) is energized, pilot oil from the implement control valve in passage (5) flows through the solenoid valve to passage (10). Oil flows through passage (10) to chamber (17) and the oil moves stem (18) upward to the TIP position. Oil in chamber (12) flows through passage (11) to the solenoid valve. Then, the oil flows to the tank through passage (4). When dual tilt control valve (21) is in the TIP position, the dual tilt cylinders move in the same direction in order to tip the bulldozer forward or backward.

In order to move the bulldozer forward, the bulldozer control lever is moved to the right or TIP FORWARD position. Pump oil from the bulldozer tilt control valve is sent through line (1) to the head end of left tilt cylinder (2). As the cylinder extends, the oil from the rod end of cylinder (2) flows to port (19) of dual tilt control valve (21). Then, the oil flows around stem (18) to port (14). Then, the oil flows to the head end of right tilt cylinder (3). As cylinder (3) extends, rod end oil from the cylinder flows to port (15) and into chamber (16) of the control valve. Then, the oil flows to the tank through line (20) and the bulldozer tilt control valve. The action of the cylinders causes the bulldozer to tip forward. When the control lever is released, the bulldozer will stay tipped forward until the trigger lever is held and the control lever is moved again.

When the trigger lever is held and the bulldozer control lever is moved to the left or TIP BACK position, pump oil from the bulldozer control valve is sent through line (20). The oil flows to chambers (13) and (16). Since oil to chamber (13) is blocked, the oil flows to chamber (16) and around stem (18) to port (15). Oil then flows to the rod end of right tilt cylinder (3). As cylinder (3) retracts, head end oil from the cylinder flows to port (14). The oil then flows around stem (18) to port (19) and onto the rod end of left tilt cylinder (2). As the cylinder retracts, head end oil from cylinder (2) flows to the tank through line (1) and the bulldozer tilt control valve. The action of the cylinders causes the bulldozer to tip backward. When the control lever is released, the bulldozer will stay tipped backward until the trigger lever is held and the control lever is moved again.

i02441600

Hydraulic Fan System

SMCS Code: 1386; 1387

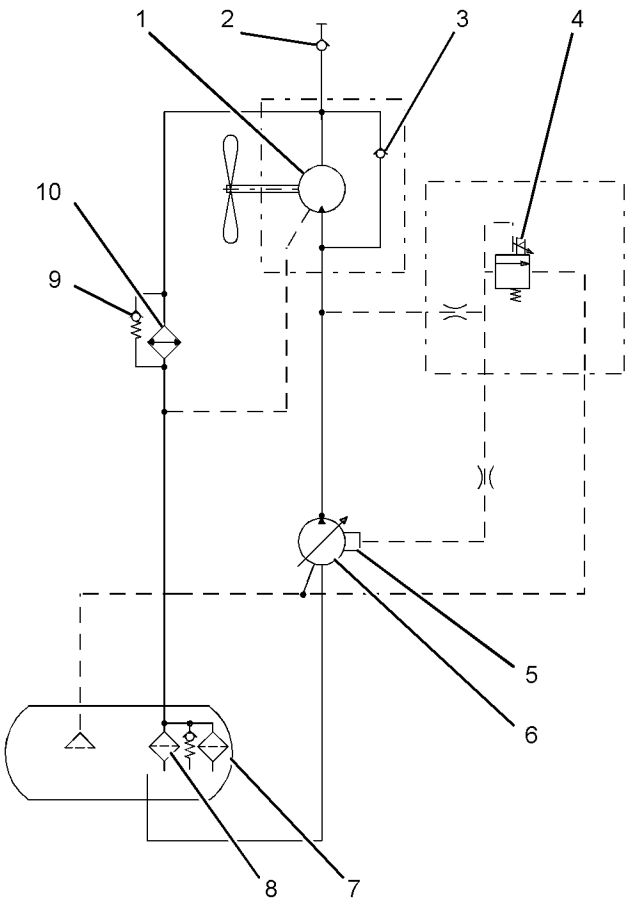


Illustration 29 g01202915

Schematic for the Hydraulic Fan System

(1) Hydraulic fan motor. (2) Fluid sampling port. (3) Makeup valve. (4) Valve. (5) Pressure and flow compensator. (6) Hydraulic fan pump. (7) Hydraulic tank. (8) Filter group. (9) Check valve (hydraulic oil cooler bypass). (10) Hydraulic oil cooler.

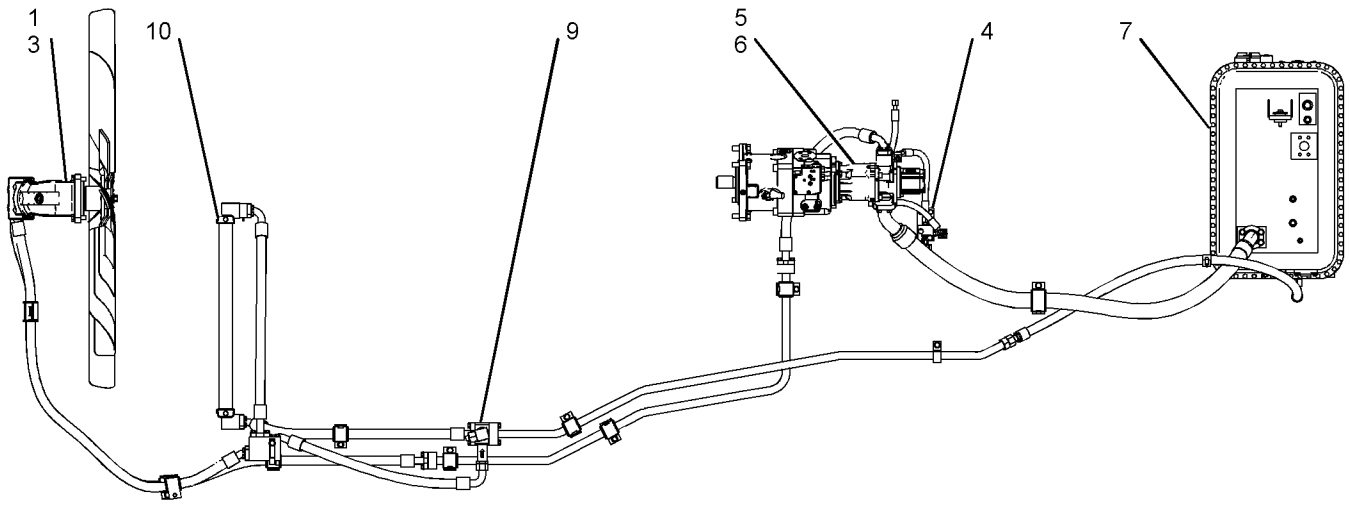


Illustration 30 g01202916

Hydraulic Fan System (Right Side View)

The hydraulic fan system is used to cool the following components: the engine, the hydraulic oil, the transmission oil and the air conditioning system.

The hydraulic fan system is made up of the following components: piston pump (6), hydraulic tank (7), valve (4), hydraulic motor (1), hydraulic oil cooler (10), bypass valve (9), makeup valve (3) and filter (8).

The hydraulic fan pump is a variable displacement piston pump. The pump is mounted on the steering pump. The pump is located under the cover behind the cab. If the machine is equipped with the high ambient temperature cooling arrangement, the output of the hydraulic pump will increase. The pump pulls oil from hydraulic tank (7). Pressurized hydraulic oil from the pump is sent to the hydraulic motor (1).

Hydraulic motor (1) is a fixed displacement bent axis motor. The speed of the motor depends on the amount of oil flow from the pump. The oil flows out of the motor and through the hydraulic oil cooler.

The hydraulic fan system is equipped with a makeup valve (3) that is attached to the motor. The makeup valve will eliminate cavitation of the motor as the fan slows. The fan slows when flow of oil in the hydraulic fan system is reduced or the flow of oil stops.

When the machine is running, valve (4) is controlled by the ECM. When the temperature of the engine coolant is high, the ECM will cause the valve to open. Valve (4) will send a hydraulic oil signal to the pressure and flow compensator (5). The pressure and flow compensator valve is attached to the hydraulic fan pump. The compensator will move the piston in pump (6) that controls the angle of the swashplate. The angle of the swashplate controls the flow of oil to the motor.

The return oil from motor (1) is sent to hydraulic oil cooler (10). When the engine is first started and the hydraulic oil is cold, the oil does not easily flow through cooler (10). The pressure of the hydraulic oil overcomes the check valve (hydraulic oil cooler bypass) (9). The check valve is set to open at a pressure of 345 ± 45 kPa (50 ± 7 psi). As the temperature of the oil increases, the resistance of the oil through the hydraulic oil cooler decreases and the check valve will close. When the check valve closes all the oil will pass through the hydraulic oil cooler. The oil flows back to the hydraulic tank. Return oil will pass through filter (8) inside the tank in order to remove any contamination that may be in the hydraulic fan system.

i02441607

Piston Pump (Hydraulic Fan)

SMCS Code: 1387-QP; 5070-HFN

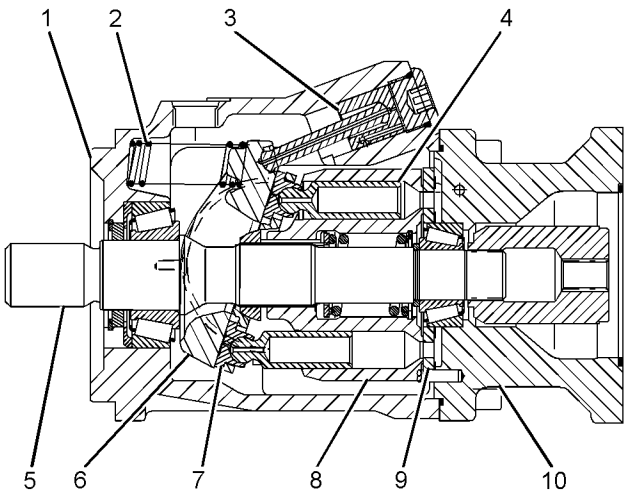


Illustration 31 g01199752

Piston Pump (Hydraulic Fan)

(1) Housing. (2) Spring. (3) Control piston. (4) Piston. (5) Drive shaft. (6) Swashplate. (7) Retraction plate. (8) Cylinder barrel. (9) Plate. (10) Head.

The axial piston type pump is used to supply oil flow to the hydraulic fan motor. The outward movement of pistons (4) pulls oil from the hydraulic tank. The inward movement of the pistons pushes oil out of the discharge port of the pump. The hydraulic oil is then forced to the hydraulic motor in order to rotate the fan.

When the engine is in operation and drive shaft (5) is rotating, the components that rotate are cylinder barrel (8), pistons (4), and retraction plate (7). There are nine piston assemblies in the barrel assembly. The components of the pump that remain are fastened to pump housing (1).

When drive shaft (5) rotates,hydraulic oil from the tank is pulled into pump head (10) through the inlet passage. The oil then flows from the inlet passage through inlet passages in plate (9). Oil is then pulled into the openings of cylinder barrel (8). Oil then fills the piston chamber. As the rotating group rotates, the piston chamber rotates over the passage in plate (9). The hydraulic oil is then forced out of the pump discharge port by the pistons.

Each piston (4) inside cylinder barrel (8) is held against swashplate (6) by retraction plate (7). Swashplate (6) can be at any angle between the maximum displacement angle and the zero displacement angle.

As shaft (5) rotates, pistons (4) follow the angle of swashplate (6). The angle of the swashplate controls the movement of the pistons in cylinder barrel (8).

The angle of swashplate (6) determines the amount of oil that is drawn into each cylinder barrel (8). As cylinder barrel (8) rotates, the swashplate angle pushes pistons (4) back into cylinder barrel (8). Pistons (4) will then push oil out of cylinder barrel (8). The oil then flows through the outlet passages of plate (9).

Swashplate (6) can be at any angle between the zero displacement angle and the maximum displacement angle. The zero displacement angle is perpendicular with drive shaft (5). When swashplate (6) is at the zero displacement angle, pistons (4) do not move in and out of rotating cylinder barrel (8). Therefore, no oil is drawn into the pump and no oil is pushed out of the pump. The pump has zero displacement and zero flow.

When swashplate (6) is at the maximum displacement angle, pistons (4) move in and out of cylinder barrel (8). The movement of pistons (4) allows the maximum amount of oil to be drawn in to cylinder barrel (8), and the pump will produce the maximum flow.

The swashplate angle is controlled by control piston (3). The movement of the control piston (3) is regulated by oil pressure from the pressure and flow compensator valve.

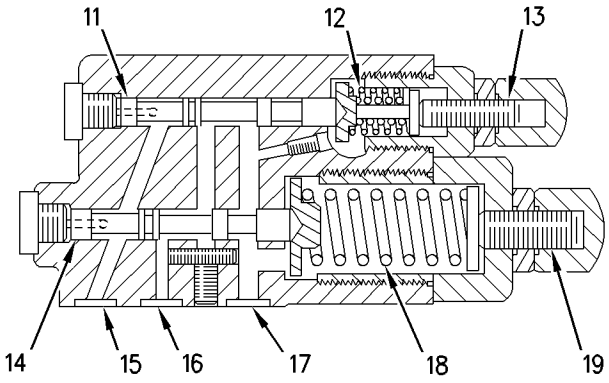


Illustration 32 g00796639

Pressure and Flow Compensator Valve

(11) Flow compensator spool. (12) Spring. (13) Adjustment screw. (14) Pressure cutoff spool. (15) Passage for the discharge of the pump. (16) Passage to destroke piston. (17) Drain to tank. (18) Spring. (19) Adjustment screw.

The pressure and flow compensator valve is attached to the piston pump. The compensator valve receives a signal from the load sensing port.

The pressure and flow compensator valve maintains the correct pressure and correct oil flow. The flow and pressure of the pump are maintained by the regulation of the pressure that is sent to control piston (3).

The control piston (3) and spring (2) work together in order to adjust the angle of swashplate (6). The pressure compensator valve limits circuit pressure.

To decrease the displacement of the pump, the oil that is behind control piston (3) must increase in pressure. The signal pressure and the force of spring (12) are less than the pump pressure in port passage (15). Flow compensator spool (11) is moved right. The oil that is behind control piston (3) can not flow to the case drain. Pump oil in port passage (15) now flows to port passage (16), and into control piston (3).

The force that is generated by the pump pressure behind control piston (3) is now greater than the force of spring (2). The angle of swashplate (6) decreases. When the angle of swashplate (6) decreases, the output of the pump decreases. The pressure in port passage (15) becomes less than the combined force in the cavity and of spring (12). Flow compensator spool (11) moves left into the metering position.

If the signal pressure does not change, flow compensator spool (11) will remain in the metering position. When flow compensator spool (11) is in the metering position, the fan circuit is equalized.

To increase the displacement of the pump, the oil that is behind control piston (3) must be drained. Draining the cavity will allow the angle of swashplate (6) to increase. The signal pressure and the force of spring (12) move flow compensator spool (11) to the left which allows the oil behind control piston (3) to be drained. The force of spring (2) is now greater than the force behind control piston (3) and the angle of swashplate is increased. When the angle of the swashplate increases, the output of the pump increases.

The output increases until the outlet pressure to port (15) is high enough to move spool (11) to the right. Oil then flows through port (16) to control piston (3). The pressure of this oil overcomes the force of spring (2) and the pressure forces swashplate (6) to rotate. This causes a decrease in the swashplate angle, output, and pressure to port (15).

When the pressure to port (15) is lower than the combined force of the signal pressure and spring (2), spool (11) moves to the left draining oil behind control piston (3). The oil drains to the case and the output increases. This movement of spool (11) (increasing and decreasing output) is known as metering.

Metering maintains a pump pressure that is 2100 ± 100 kPa (300 ± 15 psi) greater than signal pressure. The difference between pump outlet pressure and signal pressure is called margin pressure.

Reference: For specifications of the hydraulic fan pump, refer to the hydraulic system Specifications, “Piston Pump (Hydraulic Fan)” for the machine that is being serviced.

i02435042

Piston Motor (Hydraulic Fan)

SMCS Code: 1386-QP; 5058-HFN

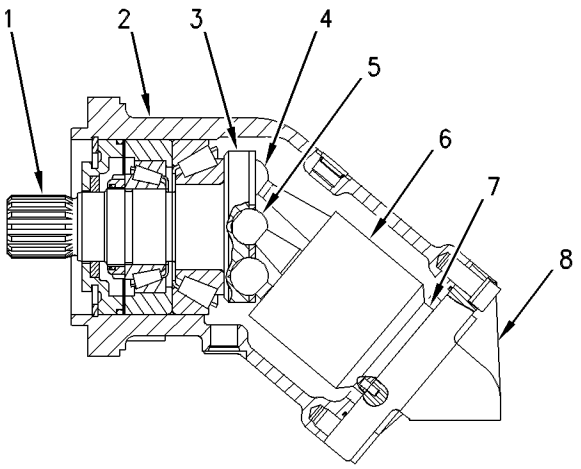


Illustration 33 g00333218

Fan motor

(1) Shaft. (2) Case. (3) Retainer plate. (4) Pistons (seven). (5) Pin (pivot). (6) Barrel. (7) Port plate. (8) Head.

The fan motor is a bent axis type motor. The motor is also a piston type motor. The motor has a fixed displacement of oil volume per revolution. The fan drive motor is mounted on a frame in front of the radiator.

The components of the motor that rotate are shaft (1), retainer plate (3), pistons (4) and barrel (6). The parts that do not turn are head (8), case (2), and port plate (7).

When the drive shaft turns, the drive shaft turns the fan blade at the same speed.

Any internal leakage drains back to the hydraulic tank through the drain passage.

The fan motor turns the fan at a speed in order to match the cooling system requirements. When the requirements of the cooling system are met, the power demand on the engine is decreased.

i02405748

Oil Coolers and Cooling System Operation

SMCS Code: 1350; 1353; 1374; 1375; 1378

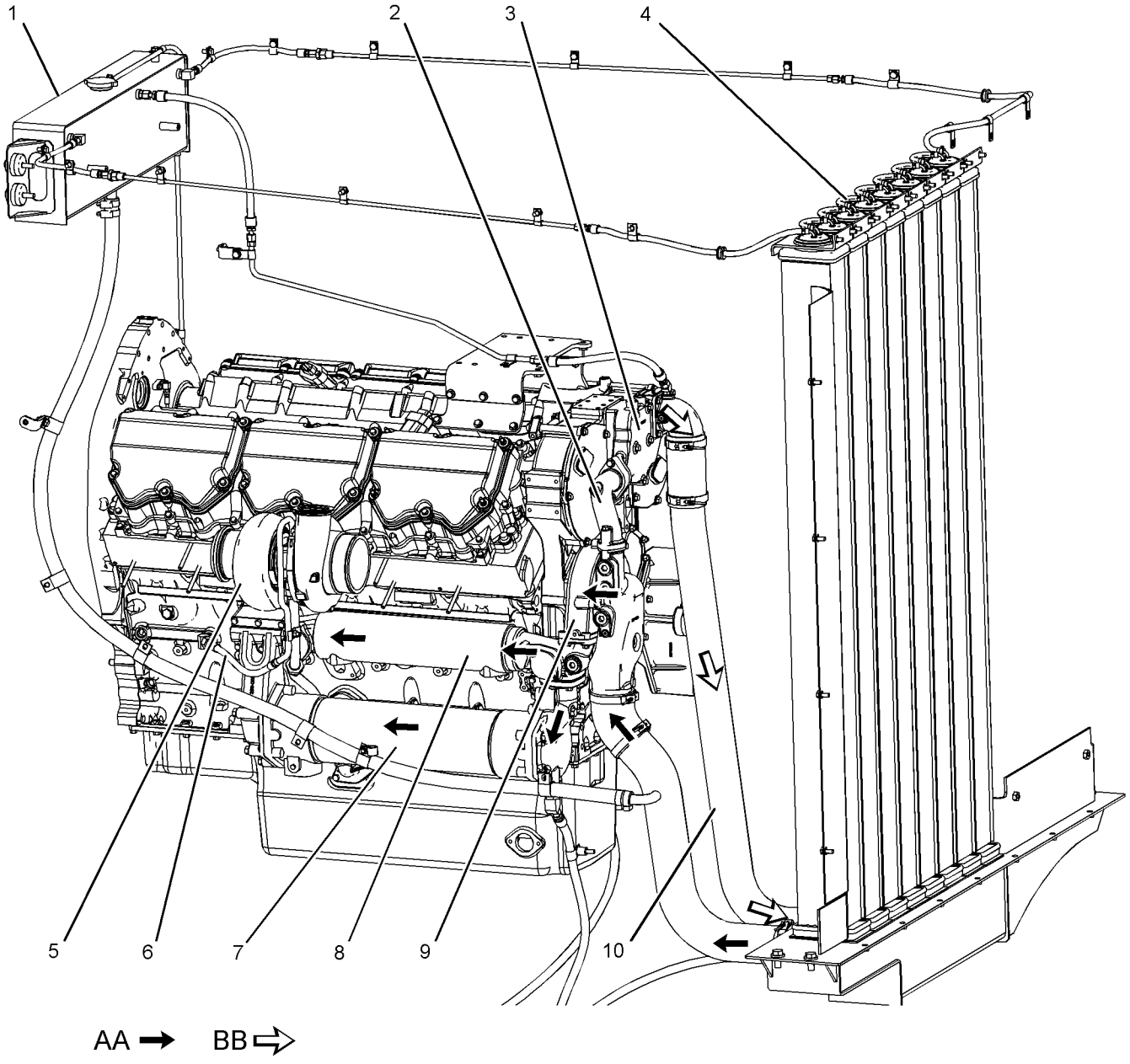


Illustration 34 g01201765

Cooling System

(1) Radiator top tank
(2) Bypass
(3) Water regulator
(4) Radiator cores
(5) Turbocharger
(6) Turbocharger Oil Lines Gp
(7) Transmission oil cooler
(8) Engine oil cooler
(9) Water pump
(10) Inlet tube (radiator)
(AA) Unregulated coolant
(BB) Regulated coolant

Water pump (9) draws coolant directly from radiator (4). The coolant is pumped through the engine oil cooler (8) and the transmission oil cooler (7). From these oil coolers, coolant flows through the engine block.

The coolant goes around the cylinder liners, through the water directors and into the cylinder heads. The water directors send the flow of coolant around the valves and the passages for exhaust gases in the cylinder heads. The coolant then goes to the front of the cylinder heads and into water regulator housing (3). When the coolant is inside of housing (3), two water temperature regulators control the direction of coolant flow within housing (3).

When the coolant temperature is below 81 °C (178 °F), water temperature regulator (3) will be closed. The path for the coolant return to radiator (4) is blocked. The coolant flows through regulator housing (3). Then, the coolant is fed back to the inlet of water pump (9).

As the coolant temperature reaches 82° ± 1°C (180° ± 2°F), water temperature regulator (3) starts to open. Coolant begins to flow to tube (10). When the coolant temperature reaches 92 °C (198 °F), the coolant is at normal operating temperature. Water temperature regulator (3) is fully open and the flow of coolant to bypass (2) is blocked. The path for the coolant to radiator (4) through the tube (10) is open. The temperature of the returned coolant will be reduced as the coolant flows through radiator (4).

Note: Water temperature regulator (3) is an important part of the cooling system. Water temperature regulator (3) divides the coolant flow between radiator (4) and bypass (2). Normal operating temperature is maintained. If the water temperature regulator is not installed in the system, the flow of coolant is not regulated. Most of the coolant will go through the bypass (2) and bypass radiator assembly (4). The engine, the transmission, and the hydraulic oil may overheat during high ambient temperatures.

Coolant for the Turbocharger

Turbocharger (5) has one inlet and one outlet. Turbocharger Oil Lines Gp (6) is connected to the turbocharger at these ports. Pressurized engine oil flows from the crankcase of the engine into turbocharger (5) through Turbocharger Oil Lines Gp (6). This engine oil is used for lubrication of the bearings in the turbocharger and for cooling of the turbocharger. The oil then drains through Turbocharger Oil Lines Gp (6) into the oil pan on the bottom of the engine.

Radiator Assembly

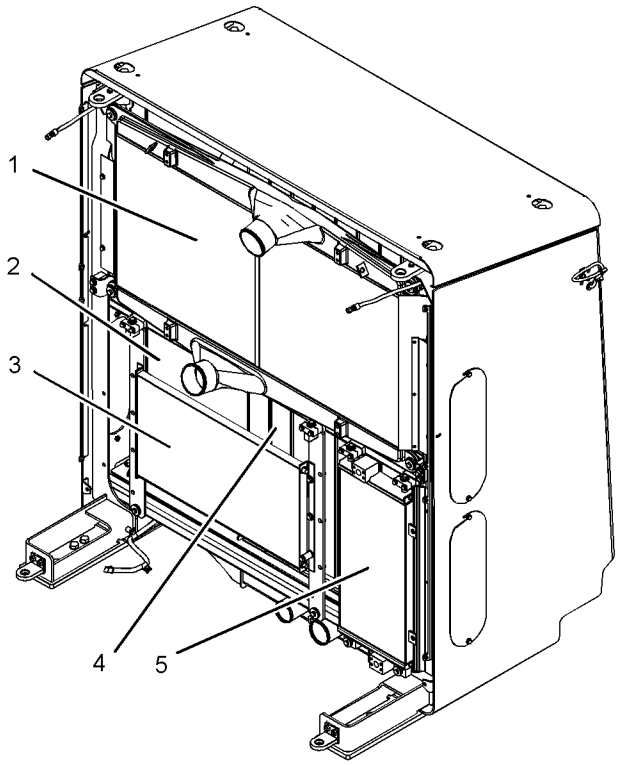


Illustration 35 g01201927

Radiator Assembly (Front View)

(1) Aftercooler
(2) Hydraulic oil cooler
(3) refrigerant condenser
(4) Radiator
(5) Hydraulic oil cooler for the steering system and the hydraulic fan system

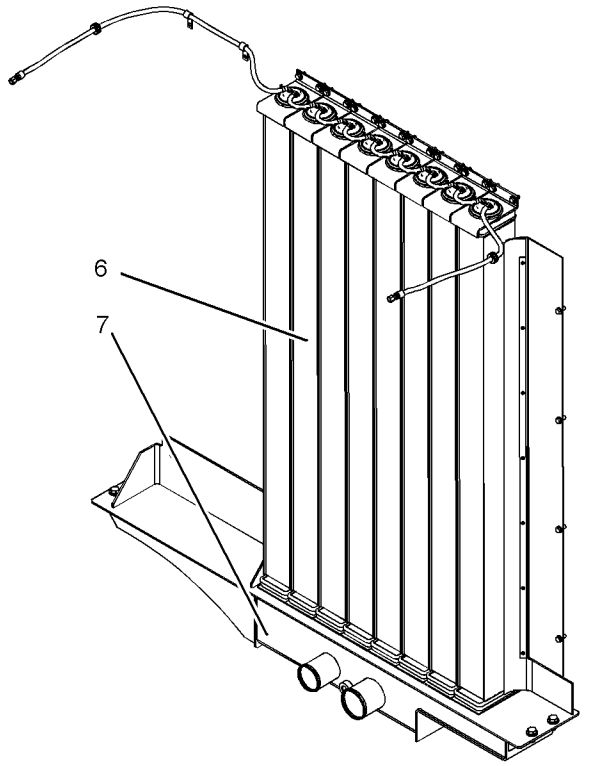


Illustration 36 g01201957

Radiator Cores (Front View)

(6) Radiator Cores
(7) Radiator bottom tank

The radiator assembly is the source of coolant for the cooling system. The radiator is made up of the following two sections: Radiator bottom tank (7) and Radiator core assemblies (6).

Also, the radiator assembly includes the air aftercooler (1), refrigerant condenser (3), radiator core assemblies (4), hydraulic oil cooler (2), and the hydraulic oil cooler for the steering system and the hydraulic fan system (5).

Reference: For additional information about the refrigerant condenser, refer to the Service Manual module Systems Operation, SENR5664, “Air Conditioning and Heating R-134a All Caterpillar Machines ”.

Reference: For additional information about cooling the hydraulic system, refer to the Service Manual module Systems Operation, “Hydraulic Fan System” for the machine that is being serviced.

The radiator bottom tank is divided into two sections. The rear section accepts the return coolant from the water regulator housing. The return coolant flows into the rear section of the bottom tank.

Radiator core (6) is made up of one row of eight tubes in the front and one row of eight tubes in the rear with a connection between the paths at the top of each core. As the coolant flows into the rear section of the bottom tank, the coolant is pushed up the core through the row of eight tubes in the rear. As the coolant gets to the top of the core, the coolant flows through the crossover tubes. Then, the coolant flows through the row of eight tubes in the front of the radiator core assembly. Then, the coolant flows into the front section of the bottom tank.

As the coolant flows through the radiator cores in both directions and the air is pulled around the radiator core, the temperature of the coolant is reduced.

Transmission Oil Cooler

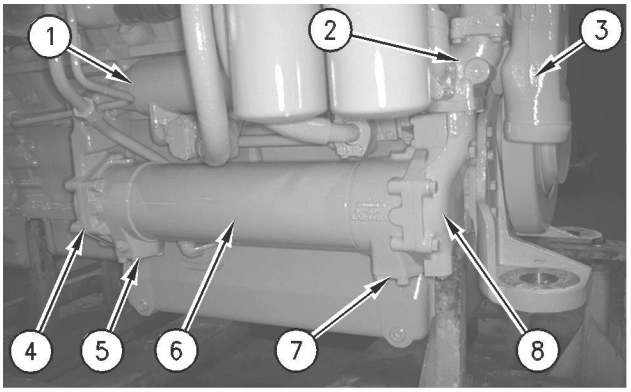


Illustration 37 g00379759

Rear Left Side of the Machine

(1) Engine oil cooler. (2) Bonnet. (3) Water pump. (4) Bonnet. (5) Oil inlet. (6) Transmission oil cooler. (7) Oil outlet. (8) Bonnet.

Engine coolant from water pump (3) flows through bonnets (2) and (8) to oil cooler (6). The coolant flows through long tubes inside the oil cooler to bonnet (4). The coolant then flows through bonnet (4) to the engine cylinder block.

Transmission oil with high temperatures and hydraulic system oil with high temperatures flow from the torque converter outlet to the oil cooler. This oil flows through oil cooler inlet (5) to the inside of the cooler. In this procedure, heat is removed from the oil and the heat is transferred to the coolant in the tubes. The engine coolant is then cooled by the cooling system of the engine.

After the oil flows around the tubes, the oil flows to the other end of the oil cooler. The oil then flows out of the oil cooler through oil cooler outlet (8). This oil has a lower temperature than the inlet oil. The oil now flows through a line in order to lubricate the planetary group.

Air to Air Aftercooler

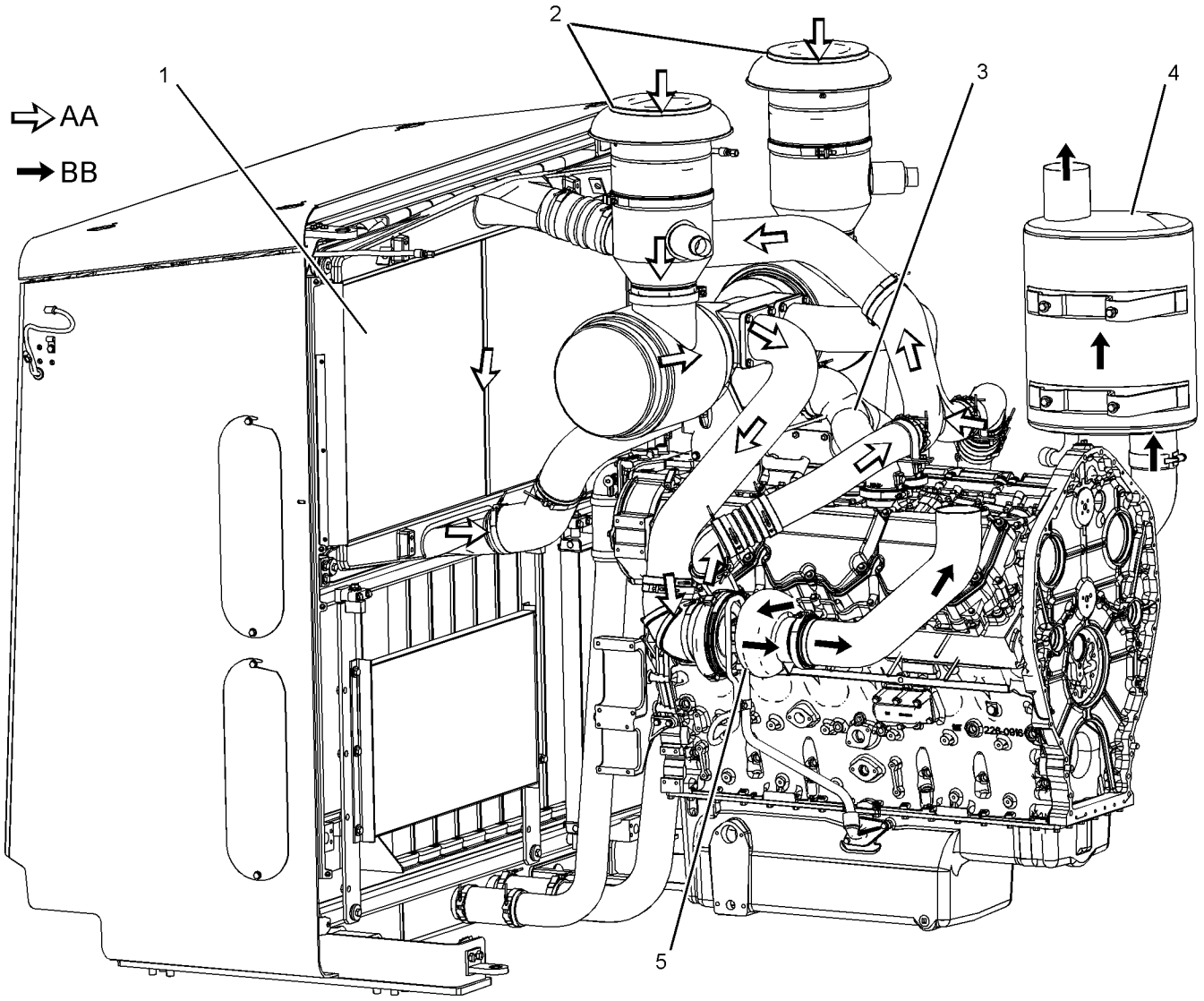


Illustration 38 g01202027

Air to Air Aftercooler

(1) Aftercooler
(2) Air cleaners
(3) Cooled air enters the air intake manifold on top of the engine.
(4) Muffler
(5) Turbocharger
(AA) Inlet air
(BB) Exhaust gases

The air-to-air aftercooler system (ATAAC system) provides cooled air to air intake manifold (3) on top of the engine. Air is drawn in through air cleaners (2) and into turbocharger (5). The air is sent through the tube into aftercooler core (1). From core (1), the air flows into the air intake manifold (3) on the top of the engine. The air flow from the inlet port into the cylinders is controlled by inlet valves. Each cylinder has inlet valves and exhaust valves in the cylinder head. The inlet valves open when the piston moves downward on the inlet stroke. When the inlet valves open, cooled compressed air from the inlet port within the inlet manifold is pulled into the cylinder. The inlet valves close when the piston begins to move up on the compression stroke. The air in the cylinder is compressed and the fuel is injected into the cylinder when the piston is near the top of the compression stroke. Combustion begins when the fuel mixes with the air. The force of combustion pushes the piston downward on the power stroke. The exhaust valves open and the exhaust gases are pushed through the exhaust port.

Exhaust gases from the exhaust manifold flow into the turbine side of the turbocharger (5). The high pressure exhaust gases cause the turbocharger turbine wheel to rotate. The turbine wheel is connected to the shaft that drives the compressor wheel. Exhaust gases from turbocharger (5) pass through the exhaust outlet , through a muffler (4), and through an exhaust stack.

The efficiency of the engine will increase due to the cooler inlet air. This helps to provide lowered fuel consumption and increased horsepower output. The air circulates through the intake manifold and flows back to turbocharger (5). From turbocharger (5), the air flows out of the system through muffler (4).

Reference: For additional information about the turbocharger, refer to the Service Manual module Systems Operation, Testing and Adjusting, “Air Inlet and Exhaust System” for the engine that is being serviced.

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RENR8837-04 (en-us)
August 2018

Testing and Adjusting

844H Wheel Dozer
Hydraulic System

BTW 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Testing And Adjusting Section

Troubleshooting

i02410117

Machine Preparation for Troubleshooting

SMCS Code: 5050-035

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

1. Park the machine on a smooth, level surface. Move away from other operating machines and away from personnel. Lower the blade to the ground. Stop the engine.
2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.
3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

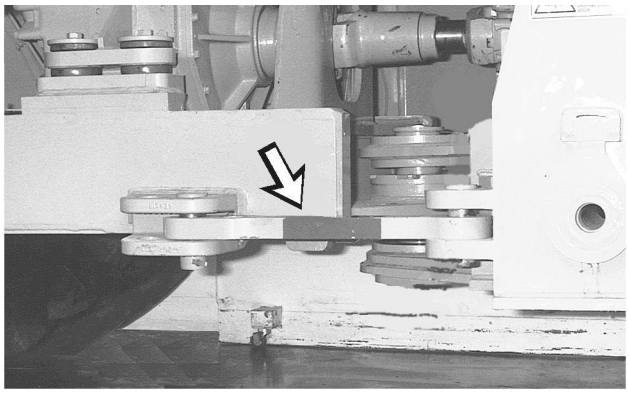


Illustration 1 g00852083
Steering frame lock in the LOCKED position

4. Install steering frame lock in the LOCKED position so the machine can not articulate.
5. Depress the brake pedal repeatedly. This will relieve any pressure that may be present in the brake hydraulic system.
6. Move the blade control lever through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the blade control lever in the HOLD position.
7. Move the steering control several times in both directions in order to relieve the pressure in the steering system.

8. This machine is equipped with two hydraulic tanks. Press the plunger on the breaker relief valve on each hydraulic tank. This will relieve any pressure in each tank.

i02410231

Visual Inspection

SMCS Code: 5050-035

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the systems is one of the first steps when you are troubleshooting a problem. Before any tests are performed, visually inspect the systems for oil leaks and for damaged parts.

1. When possible, talk to the operator. Ask about the symptoms of the problem: machine performance, noises, smells and frequency of the problem.

2. Prepare the machine for troubleshooting. Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced.

3. Check the display of the monitoring system for the following machine conditions: alert indicators, warnings and service codes.

4. Be aware of the work environment. An extreme work environment can greatly affect the symptoms of a machine.

5. Check the hydraulic oil levels in the sight gauges on both of the tanks. The 844H Wheel Dozer and 990H Wheel Loader have two separate hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. The tank for the hydraulic fan system and the steering system is located on the left side of the cab under the floorplate. The sight gauges can be seen from the ground on either side of the machine.

6. Look for air in the hydraulic tank oil immediately after the engine is stopped. Use a clear container to obtain a sample of the oil. Look for air bubbles in the oil in the container.

7. Remove the hydraulic oil filter and cut the filter open with a filter cutter. Look for particles in the filter elements. A magnet will separate the ferrous particles such as iron and steel from the nonferrous particles such as brass, aluminum and rubber.

8. Check all hydraulic hose and connections. Look for damage, tightness of fasteners, and leaks.

9. Inspect all of the hydraulic cylinders for damage and leaks.

10. Inspect all of the control linkages for components that are bent, broken, or damaged.

i02410242

Hydraulic System Troubleshooting

SMCS Code: 5050-035

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Note: This machine is equipped with a pilot hydraulic system.

This section provides probable causes to a known problem. Since there may be several probable causes, specific inspections or specific instrument tests may be recommended. These inspections and tests will help to identify the cause that is most probable.

The following is a list of some pertinent terms and the definitions of those terms.

Collapse – The sudden drop of a cylinder during normal operation

Drift – Slow motion of the implement cylinders while the blade control lever is in the HOLD position.

Droop – Hydraulic cylinders move initially in the direction that is opposite of the direction that is commanded by the operator. The cylinders then move in the correct direction.

Possible problem list for the hydraulic system

The implement pump makes noise and the cylinder rods do not move evenly. There are also air bubbles in the oil.

Probable causes

1. The viscosity of the oil is incorrect.

2. The main relief valve opens at low oil pressure.

3. There is a loose connection of the suction line on the inlet side of the implement pump.

4. The implement pump has too much wear.

The oil temperature is too high.

Probable causes

1. The machine is being operated above the intended capacity or in ambient temperatures that are too high for the machine's design.

2. The viscosity of the oil is incorrect.

3. The setting of one or both of the implement relief valves is too low.

4. The implement pump has too much wear.

5. There is a restriction in an hydraulic oil passage.

6. There is a leak in one or more circuits.

7. The hydraulic oil level is low.

8. The hydraulic oil is contaminated.

9. The air flow through the hydraulic oil cooler is too low.

10. The oil flow through the hydraulic oil cooler is too low.

11. There is air in the hydraulic oil.

Note: A problem with air in the hydraulic oil must be corrected before the hydraulic system will operate at normal temperatures. There are two conditions that cause air to be in the hydraulic oil:

- Return oil is flowing into the hydraulic oil tank above the level of oil that is in the tank.
- There are leaks in the oil suction line between the implement pump and the hydraulic oil tank.

12. The hydraulic oil temperature sensor is faulty.

The output of the implement pump is low.

Probable causes

1. The oil level is low.

2. The viscosity of the oil is incorrect.

3. The implement pump has too much wear.

4. The setting of one or both of the implement relief valves is too low.

5. There is a restriction in the supply line.

6. The setting of the pilot relief valve is too low.

The oil pressure is low.

Probable causes

1. One or both of the implement relief valves opens at low oil pressure.

2. The implement pump has too much wear.

3. An O-ring seal in the system failed causing a leak in the system.

4. The main control valve and the valve spool have an excessive amount of wear.

5. The setting of the pilot relief valve is too low.

The blade moves while the implement control lever is in the HOLD position.

Probable causes

1. The main control valve and the valve spool have an excessive amount of wear.

2. A piston seal in a cylinder has an excessive amount of wear.

3. There is a leak in a connection between the control valve and the moving cylinder.

4. A check valve is not closing because of dirt or because of a worn seat.

5. The control valve is not centering correctly.

6. The control lever was not in the center position when the engine start key was turned to the ON position. There may be dirt or the return spring may be broken.

The blade droops when the implement control lever is moved from the HOLD position to the RAISE position.

Probable causes

1. The oil is too cold.

2. The piston seals and/or the lift cylinders are worn.

3. The load check valve is not closing because the return spring is weak or broken, or because there is dirt or debris in the check valve.

The hydraulic force is too low when the implement control lever is moved to the RAISE position or to the LOWER position.

Probable causes

1. The machine is being operated incorrectly.

2. The main control valve is contaminated or damaged.

3. The pilot control valve is contaminated or damaged.

4. The makeup valve is sticking.

5. The setting of the pilot relief valve is too low.

6. The relief valve setting for the lift circuit is too low.

All implement functions are sluggish.

Probable causes

1. The oil level is low.

2. The implement pump is worn or damaged.

3. The main relief valve setting is too low.

4. The oil in the hydraulic system is contaminated.

The implement functions are erratic or intermittent.

Probable causes

1. The oil level is low.

2. There is air in the hydraulic oil.

Note: A problem with air in the hydraulic oil must be corrected before the hydraulic system will operate at normal temperatures. There are two conditions that cause air to be in the hydraulic oil:

- Return oil is flowing into the hydraulic oil tank above the level of oil that is in the tank.

- There are leaks in the oil suction line between the hydraulic pump and the tank.

3. The pump has too much wear.
4. The main control valve is contaminated or damaged.
5. The load check valve is not closing because the spring is weak or broken, or because there is dirt or debris in the check valve.

There is too much lift cylinder drift.

Probable causes

1. The piston seals and/or the lift cylinders are worn.
2. The components of the main control valve are worn or damaged.
3. The load check valve is not closing because the spring is weak or broken or because there is dirt or debris in the check valve.

The hydraulic force is too low when the tilt control lever is moved to the TILT RIGHT position or to the TILT LEFT position.

Probable causes

1. The machine is being operated incorrectly.
2. The line relief setting for the tilt circuit is too low.
3. The piston seals and/or the tilt cylinders are worn.
4. The main control valve is contaminated or damaged.
5. The pilot control valve is contaminated or damaged.
6. The relief valve setting for the tilt circuit is too low.
7. The setting of the pilot relief valve is too low.

The lift cylinders collapse during the lift operation.

Probable causes

1. The piston seals and/or the lift cylinders are worn.
2. The main control valve is contaminated or damaged.
3. The makeup valve is sticking.
4. The load check valve is not closing because the spring is weak or broken, or because there is dirt or debris in the check valve.

There is low power to the implements.

Probable causes

1. The machine is operating above the intended capacity.
2. The engine power is too low.
3. The implement pump has too much wear.
4. The relief valve settings of the lift circuit and tilt circuit are too low.
5. The piston seals and/or the cylinders are worn.
6. The load check valve is damaged or contaminated.

There is too much tilt cylinder drift.

Probable causes

1. The setting of the line relief valve is too low.
2. The piston seals and/or the tilt cylinder is worn.
3. The components of the main control valve are worn or damaged.
4. The load check valve is contaminated or damaged.

The tilt cylinder collapses during the tilt operation.

Probable causes

1. The line relief setting for the tilt circuit is too low.
2. The piston seals and/or the tilt cylinder is worn.
3. There is dirt or debris in the main control valve.
4. The main control valve spool and mating surfaces may be worn or damaged.
5. The makeup valve is sticking.

The blade droops during the tilt function.

Probable causes

1. The oil is too cold.
2. The piston seals and/or the lift cylinder is worn.
3. The load check valve is not closing because the spring is weak or broken, or because there is dirt or debris in the check valve.

One implement function is sluggish or nonfunctional.

Probable causes

1. The setting of the line relief valve is too low.
2. The pilot supply to an implement function is blocked or leaking.
3. The main control valve spool and the mating surfaces are worn or damaged.

The implements are not functioning.

Probable causes

1. The pilot pump is worn or damaged.

2. The implement pump has too much wear.

3. The pressure setting of one of the relief valves is too low.

4. One of the relief valves is stuck open.

Testing and Adjusting

i02411423

System Pressure - Release

SMCS Code: 5050-553-PX

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

⚠ WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

In order to prevent possible injury, perform the following procedure before testing and adjusting any of the machine hydraulic systems.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Note: The 844H Wheel Dozer and 990H Wheel Loader are equipped with two hydraulic tanks. The tank for the implement system and the brake system is located outside the cab on the right side of the machine under the floorplate. The tank for the hydraulic fan system and the steering system is located on the left side of the cab under the floorplate. If maintenance is performed on any of the hydraulic systems, the hydraulic pressure should be released from both of the hydraulic tanks.

Reference: Refer to the Service Manual module Testing and Adjusting, “Machine Preparation for Troubleshooting” for the machine that is being serviced before performing the following procedure.

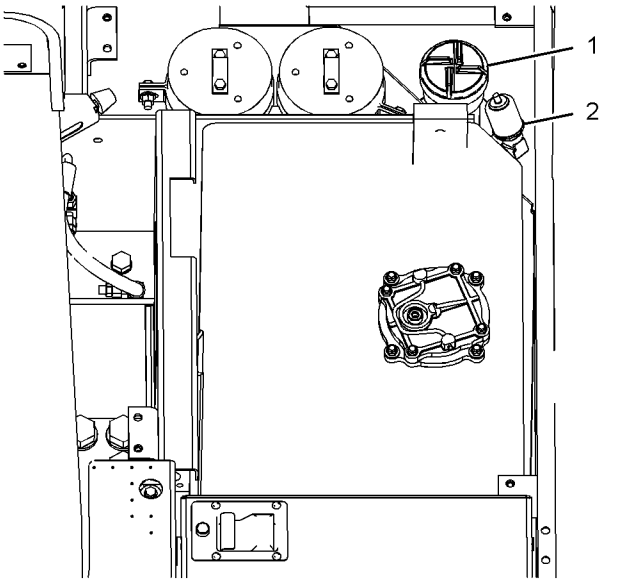


Illustration 2 g01205402

Brake and Implement Hydraulic Tank

(1) Filler cap
(2) Breaker relief valve

To manually purge the pressure that is in the hydraulic tanks, the following procedure should be done.

1. Park the machine on a smooth, level surface. Engage the parking brake. Turn the ignition key to the OFF position.
2. In order to release the pressure in the accumulators, apply the brakes repeatedly.
3. Move the implement control levers through the full range of travel. This will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the HOLD position. Place the tilt control lever in the HOLD position.
4. Move the STIC steering control lever several times through the full range of motion in order to relieve the pressure in the steering system.

5. In order to purge the pressure that is in the hydraulic oil tanks, press the plunger on breaker relief valve (2) on each tank.

i02410011

Hydraulic Oil Contamination - Test

SMCS Code: 5050-008

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine.

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Table 1

Required Tools		
Part Number	**Description**	**Quantity**
169-7372	Fluid Sampling Bottle	1
177-9343	Fluid Sampling Cap and Probe Gp	1

The hydraulic oil in this system is SAE 10. If the hydraulic oil becomes contaminated, premature component failure could result. Contaminated hydraulic oil can also contribute to overheating.

Use the following procedure in order to sample the hydraulic oil.

1. Start the engine and run the engine at high idle. Allow the oil temperature to reach the normal operating temperature.

2. Actuate all cylinders through a minimum of ten full cycles.

3. Lower the work tools to the ground.

4. Stop the engine.

5. Release the pressure in the hydraulic system.

Reference: For additional information about the release of hydraulic oil pressure, refer to the Service Manual module Testing and Adjusting, “System Pressure - Release” for the machine that is being serviced.

6. Make sure that all of the control levers are in the HOLD position.

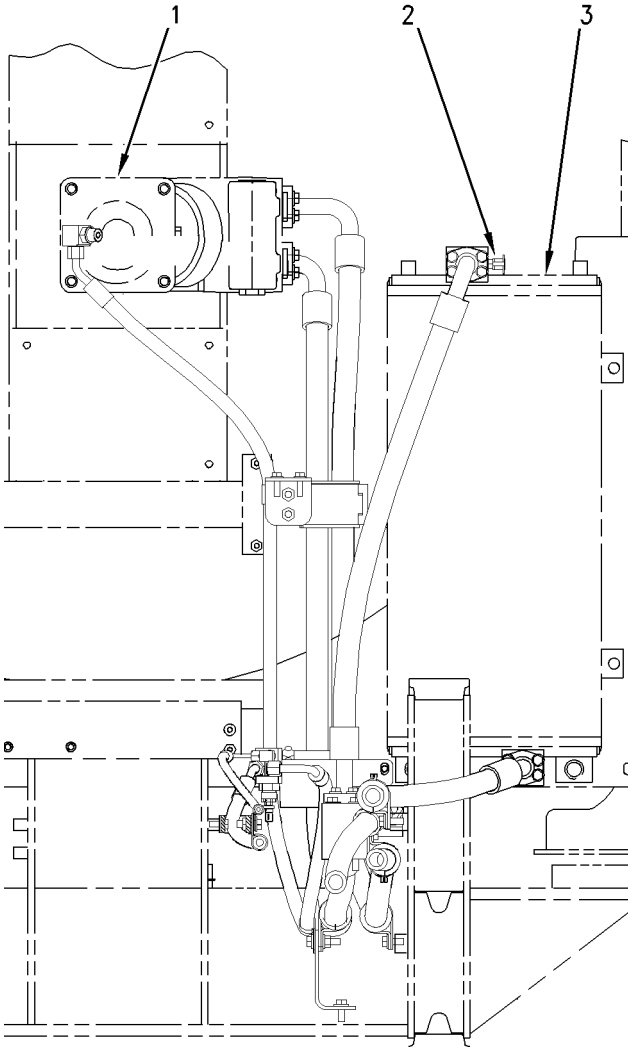


Illustration 3 g00857123

Location of Fluid Sampling Valve for the Steering and Hydraulic Fan System

(1) Fan motor. (2) Fluid sampling port. (3) Hydraulic oil cooler.

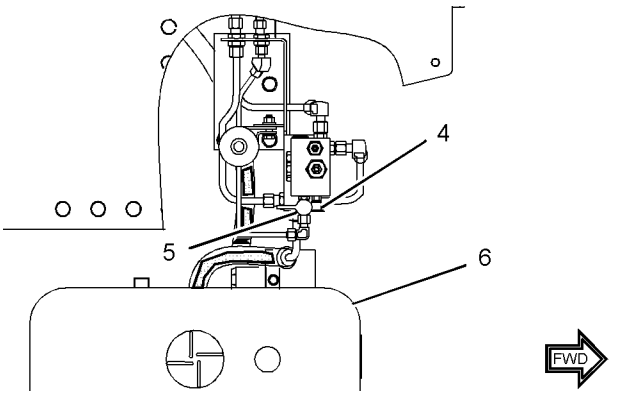


Illustration 4 g01217047

Location of Fluid Sampling Valve for the Brake and Implement System (Top View)

(4) Fluid Sampling Valve. (5) Pressure Tap. (6) Hydraulic Tank.

Note: Fluid sampling valve (4) for the brake and the implement system is under the right side cab platform. Fluid sampling valve (2) for the steering and the hydraulic fan system is at the top of hydraulic oil cooler (3).

7. Purge fluid sampling port (2). Insert an 8T-9208 Probe Assembly into the hydraulic oil sampling port.

Note: Use approximately 150 mm (6 inch) length of tube on the end of the probe. Drain approximately 100 mL (4 fl oz) of oil into a container for disposal. This will clean out the sampling port so that a good oil sample may be obtained.

8. Start the engine and allow the engine to run at low idle.

Note: Do not operate the hydraulic controls.

9. Use a clean tube to draw a 50 mL (2 fl oz) oil sample from the fluid sampling valve. Use an 8T-9190 Fluid Sampling Bottle in order to take the hydraulic oil sample.

10. The recommended level of cleanliness for the hydraulic system is ISO Code 18/15. Refer to Table 2 for the maximum allowable particle count.

Table 2

Hydraulic Oil Contamination		
ISO Code	**Particle Size (Microns)**	**Maximum Number of Particles Per 1 mL Sample**
18	5	2500
15	15	320

Note: The concentration of the particles by size should be monitored over a series of samples. This information can be used in order to spot abnormal wear before a failure occurs. A spectrographic analysis of the samples can be used in order to identify the composition of the particles. The analysis of the oil sample may be used in order to identify the components that are failing.

i02444651

Hydraulic System Air - Purge

SMCS Code: 5050-542-AI

⚠ WARNING

Personal injury or death can result from sudden movement of the lift cylinders or the tilt cylinders. Do not stand under the work tool when you are testing or adjusting the lift cylinders or the tilt cylinders.

Do not stand under the lift arms when you are testing or adjusting the lift cylinders or the tilt cylinders.

If the hydraulic tank has been drained or a pilot line has been removed, air may have entered the pilot system. Air in the pilot system will not always flow into the main system. Air in the pilot system should be removed before the machine is put back into operation. Air in the pilot system may cause the blade to fall.

Air in the pilot system can be purged through the main relief valve and through the combination relief valve. The following procedure will purge air from the pilot system.

Machine Preparation

1. Park the machine on a smooth, level surface. Move away from other operating machines and away from personnel. Lower the bucket to the ground. Stop the engine.
2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.
3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

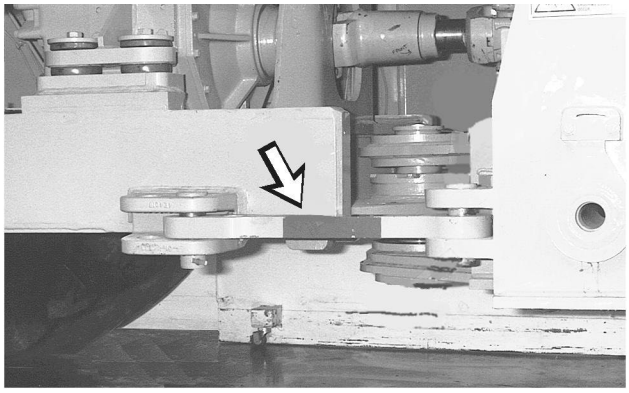


Illustration 5 g00849168
Steering frame lock in the LOCKED position

4. Install steering frame lock in the LOCKED position so the machine can not articulate.
5. Make sure that the direction control switch is in the NEUTRAL position.

Test Procedure

1. Start the engine and run the engine at high idle.
2. Place the bucket control lever in the full LOWER position. The front wheels will raise off the ground which will cause the main relief valve to open. Place the bucket control lever in the FLOAT position. The front wheels will be lowered to the ground. Repeat this procedure at least six times.
3. Move the bucket control lever in order to raise the blade. Position the blade approximately 300 mm (12 inch) off the ground. Turn the engine start switch to the OFF position.
4. Measure the drift of the bucket. The bucket should not drift more than 13 mm (0.5 inch). If the bucket does not drift more than 13 mm (0.5 inch), proceed to Step 5. If the bucket drifts more than 13 mm (0.5 inch) perform Step 2 and Step 3 again.
5. Start the engine and run the engine at high idle. Raise the bucket to the lift kickout. Run the engine at low idle. Place the bucket control lever in the FLOAT position. Lower the bucket to approximately 300 mm (12 inch) off the ground. Place the bucket control lever in the HOLD position. Turn the engine start switch to the OFF position.

Note: When the bucket control lever is in the FLOAT position the bucket will drop rapidly and the machine will bounce when the bucket control lever is placed in the HOLD position.

6. Measure the drift of the bucket. The bucket should not drift more than 13 mm (0.5 inch). If the bucket drift is within specifications, proceed to Step 7. If the bucket drifts more than 13 mm (0.5 inch), perform Step 2 through Step 6 again.

7. Start the engine and run the engine at high idle. With the bucket flat on the ground, place the bucket control lever in the full LOWER position. Raise the front wheels off the ground. This will cause the relief valve to open. Place the bucket control lever in the HOLD position. Turn the engine start switch to the OFF position. After ten seconds, start the engine and run the engine at low idle. The wheels should not drift toward the ground. If the wheels do not drift toward the ground the air has been removed from the system. If the wheels drift toward the ground there is still air in the system. Run Step 2 through Step 7 until the wheels do not drift toward the ground.

i02442505

Pump Performance (Implement) - Test

SMCS Code: 5055-032-II; 5084-032-VA

The following procedure should be used in order to determine if there is a problem with the implement pump. Pump performance should be checked if the machine has slow implement movement or low digging power.

The amount of oil flow that is produced by a pump will increase with the speed of the pump. First verify that the pump is operating at the rated speed in order to test the performance of a pump.

Machine Preparation

1. Park the machine on a smooth, level surface. Move away from working machines and personnel. Lower the blade to the ground.

2. Allow only one operator on the machine. Keep all personnel away from the machine or in the view of the operator.

3. Engage the parking brake.

Performance Test

Torque Converter Stall Test

1. Shift the transmission to the NEUTRAL position.

2. Start the engine. Warm the transmission oil to normal operating temperature of approximately 74° to 85°C (165° to 185°F).

3. Fully depress the right side service brake pedal. Hold the brake pedal in the depressed position for the duration of the test.

4. Release the parking brake.

NOTICE
To make sure that the transmission oil does not overheat, do not keep the torque converter in a stall condition for more than 30 seconds. After the torque converter stall test, reduce engine speed to low idle, move the transmission control to neutral and increase the engine speed to approximately 1500 rpm to cool the oil.

5. Shift the transmission direction and speed control to THIRD SPEED FORWARD position and fully depress the accelerator pedal.

6. Allow the engine rpm to stabilize. Then, observe the tachometer. The correct torque converter stall speed is 1870 ± 65 rpm.

7. Reduce the engine speed to low idle. Shift the transmission to the NEUTRAL position.

8. Apply the parking brake and release the right side service brake pedal.

Allow the engine coolant and the transmission oil to cool. Wait for at least two minutes between tests in order to allow the transmission oil to cool.

If the torque converter stall speed is more than 1935 rpm, the engine power output could be too high or the torque converter could have excess slippage.

If the torque converter stall speed is less than 1805 rpm, the engine may not be developing full power. There may be a parasitic load on the engine.

Note: The stall speed should be corrected before the performance of the implement pump can be properly tested.

Reference: For more information on the torque converter stall test, refer to the Service Manual module Testing and Adjusting, “Torque Converter Stall and Implement Pump Double Stall - Test” for the machine that is being serviced.

Implement Cycle Time

The speed of the implements is affected by the amount of oil flow that is produced by the implement pump. Check the implement cycle times in order to determine if there may be a problem with the implement pump.

1. Perform the machine preparation for testing.

2. Warm the hydraulic oil to normal operating temperature of approximately 65° ± 3°C (150° ± 5°F).

3. Begin the test for the lift cycle time with the blade flat on the ground.

4. Increase the engine speed to high idle.

5. Pull the blade control lever back to the full RAISE position. Measure the lift cycle time. Record the lift cycle time.

6. Raise the blade to the full raised position.

7. Tilt the blade to the full TILT BACK position.

8. Move the control lever to the full TIP FORWARD position. Measure the tilt cycle time. Record the tilt cycle time.

9. Lower the blade and place the blade flat on the ground.

10. Reduce engine speed to low idle.

11. Stop the engine.

Table 3

Cycle Time for Lift Cylinders	Speed
RAISE from ground to lift kickouts	4.0 ± 0.2 seconds

Note: In order to perform the cycle time tests for the tilt circuit, the lift arms must be raised to the maximum height.

Table 4

Cycle Time for Tilt Cylinder	Speed
TIP FORWARD from full tilt back position to full dump position	5.0 ± 0.2 seconds

Compare the test results with the cycle times that are listed in Tables 3 and 4 . The implement pump should be working properly if the implement cycle times match the cycle times that are listed in Tables 3 and 4 .

If the cycle times are not correct for both the lift and tilt functions one of the following conditions are present:

- The main relief valve pressure setting is not within the specifications.
- The pump may have excessive wear.

The main relief pressure should be measured. If the main relief pressure is low, the cycle times should be retested after the main relief pressure has been corrected.

Reference: For more information on testing and adjusting the main relief valve, refer to the Service Manual module Testing and Adjusting, “Relief Valve (Main) - Test and Adjust” for the machine that is being serviced.

If the cycle time is slow for only one of the implement circuits, the circuit with slow cycle time should be tested for one of the following conditions:

- Low relief valve setting
- Leak in the circuit
- Control spool that is not shifting fully

Reference: For more information on troubleshooting the hydraulic system, refer to the Service Manual module Testing and Adjusting, “Hydraulic System Troubleshooting” for the machine that is being serviced.

i02619739

Torque Converter Stall and Implement Pump Double Stall - Test

SMCS Code: 3101-081-V8; 5055-081-V8; 5070-081-V8; 5073-081-V8; 5084-081-V8

The torque converter stall test and the double stall test for the implement pump help determine if the engine is producing the correct power output. These tests may be used in many diagnostic procedures.

Low stall speeds indicate a possible problem with engine performance. The stall speed should be corrected before the performance of the hydraulic system can be properly tested.

⚠ WARNING

Personal injury or death can result from machine movement.

When tests and adjustments are made to the transmission or the torque converter, the parking brake must be disengaged.

To prevent movement of the machine and personal injury perform the procedure that follows.

Machine Preparation

1. Move the machine to a smooth level location. Move away from working machines and personnel. Lower the blade to the ground.

2. Allow only one operator on the machine. Keep all personnel away from the machine or in the view of the operator.

3. Engage the parking brake.

Torque Converter Stall Test

1. Shift the transmission to the NEUTRAL position.

2. Start the engine. Warm the transmission oil to normal operating temperature of approximately 74° to 85°C (165° to 185° F).

3. Fully depress the right side service brake pedal. Hold the brake pedal in the depressed position for the duration of the test.

NOTICE
To make sure that the transmission oil does not overheat, do not keep the torque converter in a stall condition for more than 30 seconds. After the torque converter stall test, reduce engine speed to low idle, move the transmission control to neutral and increase the engine speed to approximately 1500 rpm to cool the oil.

4. Place the transmission control in the THIRD SPEED position.

5. Move the transmission direction switch to the FORWARD position.

6. Increase the engine speed to high idle.

7. Allow the engine speed to stabilize. Record the engine rpm.

8. Reduce the engine speed to low idle.

9. Shift the transmission to the NEUTRAL position.

The correct torque converter stall speed for the 844H Wheel Dozer in third speed forward is 1870 ± 65 rpm.

Double Stall Test for Implement Pump

1. Shift the transmission to the NEUTRAL position.

2. Start the engine. Warm the transmission oil to normal operating temperature of approximately 74° to 85°C (165° to 185° F).

3. Fully depress the right side service brake pedal. Hold the brake pedal in the depressed position for the duration of the test.

NOTICE
To make sure that the transmission oil does not overheat, do not keep the torque converter in a stall condition for more than 30 seconds. After the torque converter stall test, reduce engine speed to low idle, move the transmission control to neutral and increase the engine speed to approximately 1500 rpm to cool the oil.

4. Place the transmission control in the THIRD SPEED position.

5. Move the transmission direction switch to the FORWARD position.

6. Increase the engine speed to high idle.

7. Move the blade control lever to the full RAISE position in order to move the lift cylinder against the stops. Hold the blade control lever in the full RAISE position.

8. Allow the engine speed to stabilize. Record the engine rpm. Lower the blade to the full lower position. Return the blade control lever to the HOLD position.

9. Reduce the engine speed to low idle.

10. Shift the transmission to the NEUTRAL position.

The correct engine speed for the double stall test for the implement pump for the 844H Wheel Dozer in third speed forward is 1735 ± 75 rpm.

i02442508

Implement Cycle Time - Check

SMCS Code: 6000-535-VF

WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

The implement cycle time can be checked in order to verify a complaint about slow implement speed. This test will also help to determine whether all functions are slow or only one function is slow.

Before performing the following procedure, verify that the engine is developing adequate power by performing the torque converter stall test.

Reference: For more information about the torque converter stall test, refer to the Service Manual module Testing and Adjusting, “Torque Converter Stall and Implement Pump Double Stall - Test” for the machine that is being serviced.

Machine Preparation

1. Move the machine to a hard, level surface that is free of debris.

2. Permit only one operator on the machine. Keep all other personnel away from the machine.

3. Shift the transmission to neutral.

4. Warm the hydraulic oil to normal operating temperature. The hydraulic oil must be at a temperature of 65 ± 3°C (150 ± 5°F) in order to obtain accurate results.

Note: Run the machine at high idle in order to test cycle times.

Cycle Time (Tilt and Tip Cylinders)

Table 5

Tilt Cylinder Speed Test	Speed in Seconds
Single Tilt Mode	
Full tilt left to full tilt right	3.1 to 3.5 seconds
Full tilt right to full tilt left	2.4 to 2.8 seconds
Dual Tilt Mode	
Full tilt left to full tilt right	3.1 to 3.5 seconds
Full tilt right to full tilt left	2.9 to 3.3 seconds
Blade Tip Mode	
Full tip in to full tip out	6.1 to 6.5 seconds
Full tip out to full tip in	4.8 to 5.2 seconds

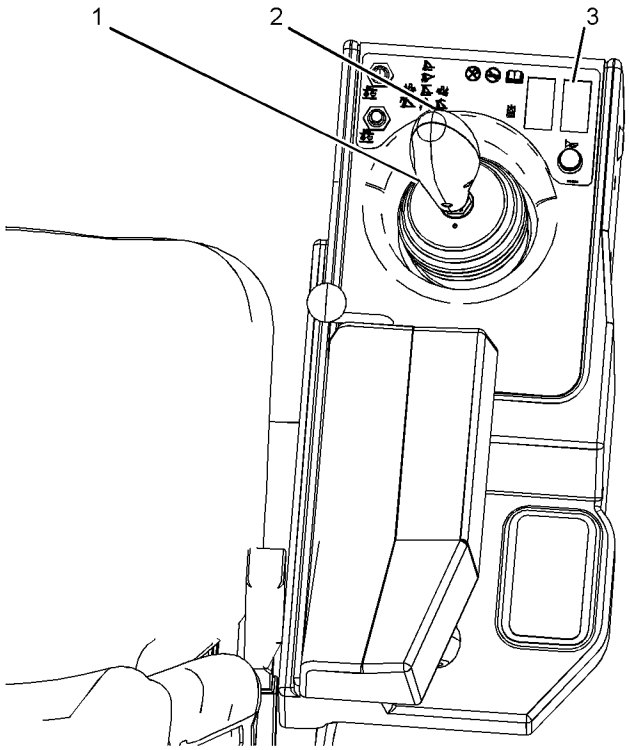


Illustration 6 g01216848

(1) Implement control lever. (2) Switch for Blade tip mode. (3) Tilt mode switch .

Single Tilt Mode

When the tilt mode switch (1) is moved to the FORWARD position, the solenoid valve is energized. The dual tilt control valve moves to the SINGLE TILT position. When tilt mode switch (1) is in the SINGLE TILT position, only one tilt cylinder moves.

Dual Tilt Mode

When tilt mode switch (1) is pressed into the BACKWARD, the solenoid valve is de-energized. The dual tilt control valve moves to the DUAL TILT position. The tilt cylinders move in opposite directions.

Blade Tip Mode

When the switch for the blade tip mode (2) is depressed, the blade can be tipped. If the switch for the blade tip mode (2) is not depressed, the blade cannot be tipped.

Cycle Time (Lift Cylinder)

Table 6

Lift Cylinder Speed Test	Speed in Seconds
Full ground to full up	3.8 to 4.2 seconds

Possible Causes for Incorrect Times

If the times are not correct, check the following conditions:

1. Check the pressure setting of the main relief valve.

Reference: For information on setting the pressure of the main relief valve, refer to the Service Manual module Testing and Adjusting, “Relief Valve (Main)” for the machine that is being serviced.

2. Check the pressure setting of the line relief valves.

Reference: For information on setting the line relief valves, refer to the Service Manual module Testing and Adjusting, “Relief Valve (Line) - Test and Adjust” for the machine that is being serviced.

3. Check the makeup valves in the lift control valve and in the tilt control valve.

4. Check the valve spools in the lift control valve and in the tilt control valve.

5. Check the piston seals in the cylinders.

6. Check pump efficiency.

7. Check the lift cylinders for leaks.

8. The makeup valves could have leaks.

9. The tilt spool of the main control valve could be worn or the lift spool of the main control valve could be worn.

i02442512

Lift Cylinder, Tilt and Tip Cylinder Drift - Check

SMCS Code: 5102-535-D9; 5104-535-D9; 5106-535-D9

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue, causing serious injury, and possible death.

Always use a board or cardboard when checking for a leak.

Do not check for pin hole leaks in pump or motor hoses during a steer stall condition.

If fluid is injected into your skin, it must be treated by a doctor familiar with this type of injury immediately.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To help prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic and steering system:

This procedure is used to verify a complaint about drift.

Excessive drift can be caused by a problem or a combination of problems.

Machine Preparation

1. Move the machine to a hard, level surface that is free of debris.

2. Permit only one operator on the machine. Keep all other personnel away from the machine.

3. Engage the parking brake.

4. Move the steering frame lock to the locked position in order to prevent the machine from articulating.

5. Raise the blade off the ground approximately 300 mm (12 inch). Place support blocks under the blade. Lower the blade onto the support blocks.

Lift Cylinder Drift Test

Circuit drift is caused by leakage past cylinder pistons, control valve spools, load check valves or makeup valves.

Table 7

Approximate Lift Cylinder Drift		
Oil Temperature	**Maximum Drift**	**Time**
38° to 49°C (100° to 121°F)	38 mm (1.5 inch)	5.0 minutes
50° to 65°C (122° to 149°F)	38 mm (1.5 inch)	2.7 minutes
66°C (150°F) or more	38 mm (1.5 inch)	1.7 minutes

Test 1

1. Start the engine.

2. Raise the blade off the ground.

3. Place the blade control lever in the HOLD position.

4. Stop the engine.

5. Watch the lift cylinder rods for movement. Record the movement. Refer to Table 7 in order to determine if the drift exceeds maximum allowable drift.

Test 2

1. Start the engine.

2. Raise the blade off the ground.

3. Stop the engine.

4. Hold the blade control lever in the RAISE position.

5. Watch the lift cylinder rods for movement. Record the movement. Refer to Table 7 in order to determine if the drift exceeds maximum allowable drift.

Tilt Cylinder Drift Test

Table 8

Approximate Tilt and Tip Cylinder Drift		
Oil Temperature	**Maximum Drift**	**Time**
38° to 49°C (100° to 121°F)	5 mm (0.2 inch)	5.0 minutes

(continued)

(Table 8, contd)

50° to 65°C (122° to 149°F)	5 mm (0.2 inch)	2.7 minutes
66°C (150°F) or more	5 mm (0.2 inch)	1.7 minutes

1. Set the blade flat on solid ground. Extend the tilt cylinder to one-half of total rod extension.
2. Raise the front wheels off the ground by lowering the right side of the blade (Tilt Right).
3. Place the blade control lever in the HOLD position.
4. Shut off the engine and monitor the tilt cylinder for movement. Record the movement. Refer to Table 8 in order to determine if the drift exceeds maximum allowable drift.
5. Set the blade flat on solid ground. Extend the tilt cylinder to one-half of total rod extension.
6. Raise the front wheels off the ground by lowering the left side of the blade (Tilt Left).
7. Place the blade control lever in the HOLD position.
8. Shut off the engine. Monitor the tilt cylinder for movement. Record the movement. Refer to Table 8 in order to determine if the drift exceeds maximum allowable drift.

i02412627

Pilot System Pressure - Test

SMCS Code: 5050-032-PS

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue, causing serious injury, and possible death.

Always use a board or cardboard when checking for a leak.

Do not check for pin hole leaks in pump or motor hoses during a steer stall condition.

If fluid is injected into your skin, it must be treated by a doctor familiar with this type of injury immediately.

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To help prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic and steering system:

The pilot oil system supplies oil to the pilot control valve. The pilot control valve allows pilot oil to shift the main control valve spools.

Table 9

Required Tools	
Part Number	**Description**
1U-5481	Pressure Gauge Group
1U-5482	Pressure Adapter Group

Machine Preparation

1. Park the machine on a smooth, level surface. Park the machine in an area away from working machines and personnel.
2. Allow only one operator on the machine. Keep all personnel away from the machine and in the view of the operator.
3. Engage the parking brake. Lower the blade to the ground. Shift the machine into neutral.

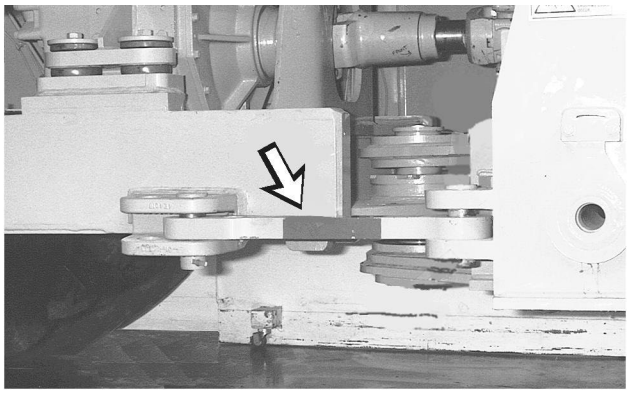


Illustration 7 g00849168

4. Install the steering frame lock.

5. Release the hydraulic pressure in the machine. Push down on the service brake pedal several times. This will release any hydraulic pressure in the accumulators. Move all the hydraulic control levers in order to release the pressure in the hydraulic system. In order to relieve any pressure in the hydraulic oil tank, press the plunger on the breaker relief valve.

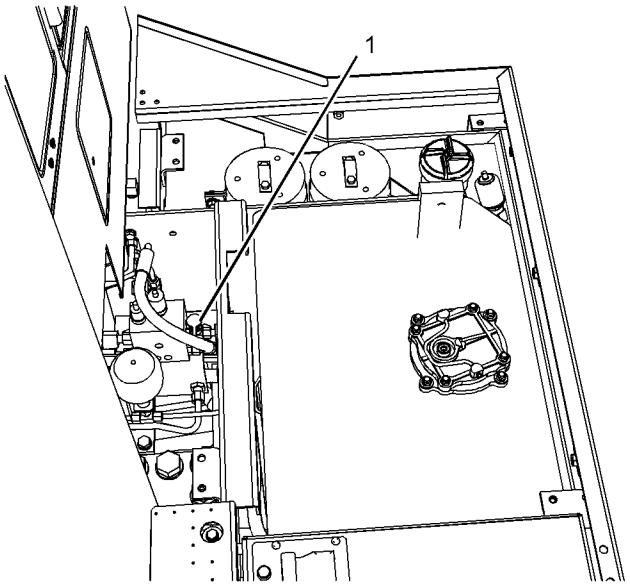


Illustration 8 g01205871

(1) Pressure tap for pilot pressure.

6. Install 1U-5481 Pressure Gauge Group and 1U-5482 Pressure Adapter Group to the pressure tap.

Note: The pressure tap is located next to the combination valve. The pressure tap is located on the right side of the machine. Access to the pressure tap can be gained by raising the cover on the platform over the hydraulic tank.

7. Engage the parking brake.

8. Shift the transmission to neutral.

Testing Procedure

1. Start the engine. Warm the hydraulic oil to a normal operating temperature of approximately 49 to 65°C (120 to 150°F).

2. Run the engine at low idle. Observe the pressure gauge.

3. The pilot oil pressure should be 2500 ± 70 kPa (365 ± 10 psi) at a flow of 19 L/min (5.0 US gpm).

4. If the pilot pressure is incorrect, the setting of the pilot relief valve may require adjustment.

5. Stop the engine. Repeat step 5 in order to release hydraulic pressure. Disconnect the test equipment.

Reference: For additional information on adjusting the pilot relief valve, refer to the Service Manual module Testing and Adjusting, “Relief Valve (Braking System Backup) - Test and Adjust” for the machine that is being serviced.

i02412654

Accumulator (Pilot) - Test and Charge

SMCS Code: 5077-045-PS; 5077-081-PS

Test Procedure

1. Start the engine. Run the engine at half speed for two minutes in order to increase the accumulator pressure.

2. Tilt the blade to the left and to the right several times.

3. If the movement of the blade is delayed, use the following procedure to charge the accumulator.

Charge Procedure

⚠ WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Table 10

Required Tools	
Part Number	**Description**
7S-5437	Nitrogen Charging Group

Stop the engine. Move the control lever to the tilt positions repeatedly until there is no pilot pressure.

To ensure that the nitrogen charge is correct, the accumulator piston must be at the bottom of the accumulator cylinder. Nitrogen gas pressure varies with the temperature. To obtain the most accurate nitrogen charge, the temperature of the accumulator must be identical to the air temperature around the accumulator.

If an accumulator has less than half of the required amount of precharge pressure, the accumulator should be charged, and then charged again after tilting the blade several times. This prevents trapping a quantity of oil in the accumulator which will give an inaccurate precharge reading.

However, the temperature of the accumulators could be higher than the air temperature around the accumulators. In this case, the temperature of the accumulator should be used instead of the surrounding air temperature.

Note: The pressures in the following table are for an ambient air temperature of 21°C (70°F). Adjust the pressure for other ambient conditions, as required.

Table 11

Accumulator Precharge Pressure/Temperature Relationship for the 690 kPa (100 psi) Accumulator	
Temperature	**Pressure**
−7°C (20°F)	806 kPa (117 psi)
−1°C (30°F)	825 kPa (119.6 psi)
4°C (40°F)	843 kPa (122.2 psi)
10°C (50°F)	860 kPa (124.8 psi)
16°C (60°F)	878 kPa (127.4 psi)
21°C (70°F)	900 kPa (130 psi)
27°C (80°F)	914 kPa (132.6 psi)
32°C (90°F)	932 kPa (135.2 psi)
38°C (100°F)	950 kPa (137.8 psi)
43°C (110°F)	968 kPa (140.4 psi)
49°C (120°F)	986 kPa (143 psi)

(continued)

(Table 11, contd)

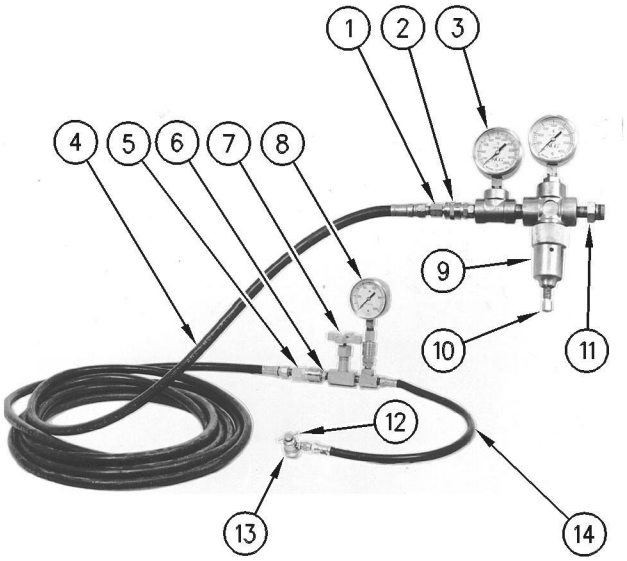


Illustration 9 g00107133

Nitrogen Charging Group

(1) Nipple. (2) Coupling assembly. (3) Pressure gauge. (4) Hose assembly. (5) Coupling assembly. (6) Nipple. (7) Valve. (8) Pressure gauge. (9) Regulator assembly. (10) Pressure regulating screw. (11) Chuck for the nitrogen cylinder valve. (12) Valve handle. (13) Chuck. (14) Hose assembly.

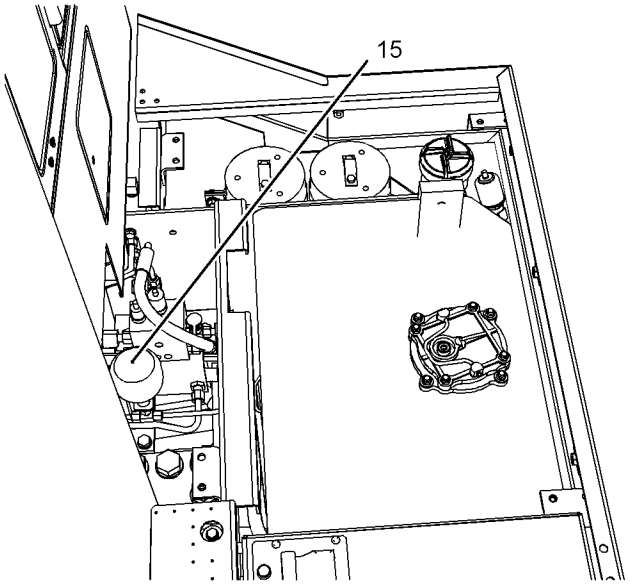


Illustration 10 g01205879

Location of Accumulator
(15) Cap.

Note: The accumulator for the pilot system is located underneath the operator's cab.

1. Tilt the blade to the left and to the right several times. This will release any pressure that may be in the accumulator.

2. Remove cap (15) from the accumulator.

3. Use a 1380 kPa (200 psi) pressure gauge (8) to check the nitrogen charge in the accumulator.

4. Install chuck (13) onto the nitrogen charging valve for the pilot accumulator.

5. Open valve (7) and charge line (14) to the correct precharge. Refer to Table 11 .

6. Turn valve handle (12) completely in the clockwise direction. Check the temperature of the air around the accumulator. The reading on the pressure gauge must be within the tolerances in Table 11 .

7. If the reading on the pressure gauge is too high, slowly open valve (7) in order to lower the pressure. If the reading on the pressure gauge is too low, use the following procedure to charge the accumulator:

a. Connect a hose from the nitrogen cylinder to valve (7).

b. Close valve (7) and open the valve on the nitrogen cylinder. Adjust screw (10) on regulator assembly (9) until pressure gauge (3) is at the correct charging pressure. Refer to Table 11 for the correct charging pressure.

c. Open valve (7) and charge the accumulator. Then, close valve (7). If pressure gauge (8) and pressure gauge (3) show the same reading and the readings do not change, the brake accumulator has the correct charge.

If the pressure reading on gauge (8) decreases, open valve (7) and allow more nitrogen to fill the accumulator.

Perform this procedure until pressure gauge (8) and pressure gauge (3) show the same reading. Make sure that neither reading changes when valve (7) is closed.

8. Close valve (7). Close the valve on the nitrogen cylinder.

9. Turn valve (12) on chuck (13) outward in the counterclockwise direction. Remove the test equipment.

i01649749

Main System Pressure - Test

SMCS Code: 5050-032-MV

WARNING

At operating temperature the implement hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible injury, release the pressure in the implement hydraulic system before hydraulic lines or components are disconnected or removed.

WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death. The rotating shaft is located under the implement and steering pumps.

Do not allow personnel into the pump bay area behind the cab when the engine is running.

This test verifies that the pressure of the main system is correct. If the pressure is not correct, the main relief valve may require adjustment.

Table 12

Required Tools	
Part Number	**Description**

(continued)

(Table 12, contd)

8T - 0860	Pressure Gauge
6V - 3989	Unvalved Nipple
8T - 5320	Hydraulic Test Group

Machine Preparation for Testing

1. Start the engine.

2. Lift the blade approximately 380 mm (15 inch) off the ground.

3. Stop the engine.

4. Slowly move the implement control lever toward the FLOAT position so that the blade moves slowly to the ground.

5. Move the control lever to the HOLD position.

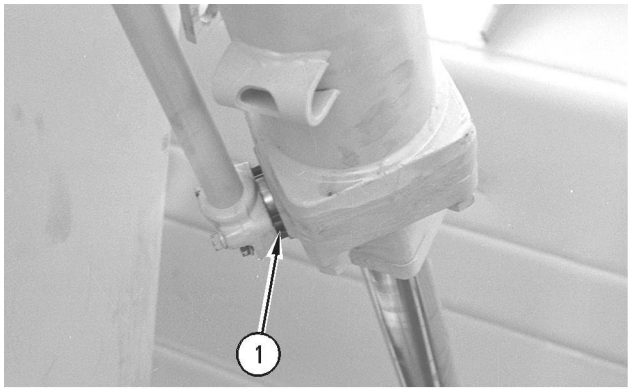


Illustration 11 g00394020

Rod End of Lift Cylinder

(1) Location of blocking plate assembly.

6. Disconnect the hydraulic oil line from the rod end of each lift cylinder (1).

7. Install two blocking plate assemblies from the 8T - 5320 Hydraulic Test Group in each hydraulic oil line at the rod end of each lift cylinder (1).

8. Attach an unvalved nipple to a 0 to 28000 kPa (0 to 4000 psi) pressure gauge. Attach a section of hydraulic line to the unvalved nipple.

9. Open the doors to the pump compartment.

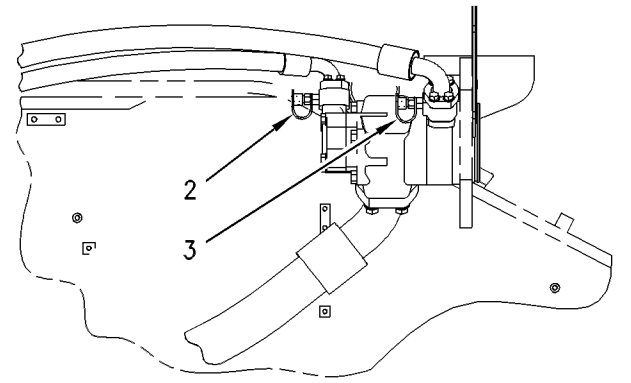


Illustration 12 g00394018

Location of Pressure Taps

(2) Pressure tap for the tilt relief valve. (3) Pressure tap for the main relief valve.

10. Attach the hydraulic line to pressure tap (3).

11. Close the doors to the pump compartment.

Testing Procedure

1. Start and run the engine at high idle.

2. Observe the test gauge and slowly move the control lever to the RAISE position.

3. The high reading on the gauge is the pressure setting of the main relief valve.

4. The pressure setting of the main relief valve should be 18650 ± 50 kPa (2700 ± 10 psi).

5. If the pressure setting of the main relief valve is not correct, the main relief valve may require adjustment.

Reference: For additional information about adjusting the main relief valve, refer to the Service Manual module Testing and Adjusting, “Main Relief Valve - Adjust” for the machine that is being serviced.

i02476330

Main Relief Valve - Adjust

SMCS Code: 5069-025

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

WARNING

At operating temperature the implement hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible injury, release the pressure in the implement hydraulic system before hydraulic lines or components are disconnected or removed.

WARNING

The drive shaft rotates between the torque converter and the transmission whenever the engine is running. Contact with the rotating shaft can result in personal injury or death. The rotating shaft is located under the implement and steering pumps.

Do not allow personnel into the pump bay area behind the cab when the engine is running.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Relief valve settings that are too low cause a decrease in the performance of the machine.

Opening pressures that are too high cause a decrease in the life of hoses and components.

The main relief valve relieves the lift circuit and the lower circuit of the machine.

Note: The tilt relief valve should be set correctly before attempting to set the main relief valve.

Machine Preparation

1. Move the machine to a hard, level surface that is free of debris.
2. Permit only one operator on the machine. Keep all other personnel away from the machine.
3. Lower the blade to the ground.
4. Engage the parking brake.
5. Move the steering frame lock to the locked position in order to prevent the machine from articulating.
6. Put blocks in front of the wheels and behind the wheels in order to prevent the machine from moving.

Testing Procedure

1. Stop the engine.
2. Move the implement control lever to the FLOAT position. Then move the control lever to the HOLD position.

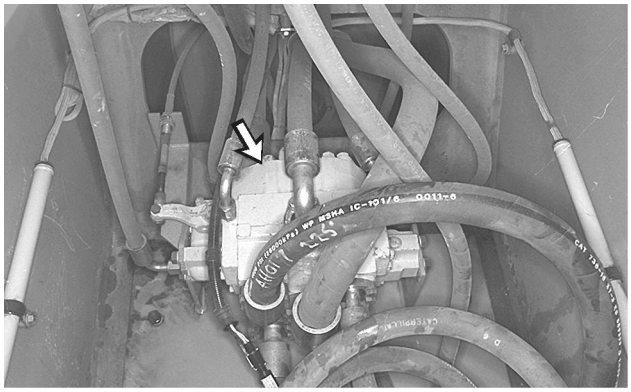


Illustration 13 g00391329
Main Control Valve Location (Typical Example)

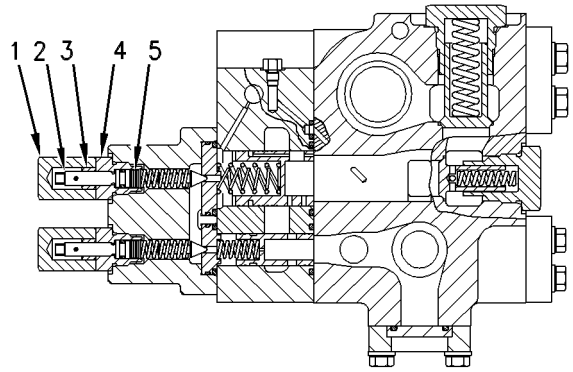


Illustration 14 g00391330
(1) Jam nut. (2) Adjustment screw. (3) Locknut. (4) Plug for the main relief valve. (5) Shims.

3. Remove jam nut (1) from the main control valve.

4. Loosen locknut (3).

5. Turn adjustment screw (2) clockwise in order to increase the pressure setting or turn adjustment screw (2) counterclockwise in order to decrease the pressure setting.

6. Tighten locknut (3).

7. Install jam nut (1).

8. The pressure setting of the main relief valve should be 18650 ± 50 kPa (2700 ± 10 psi).

Reference: For the correct procedure to check the pressure setting of the main relief valve, refer to the Service Manual module for Testing and Adjusting, “Main System Pressure - Test” for your machine.

9. If the pressure setting of the main relief valve is correct, install any access panels that may have been removed. Close any doors that may have been opened.

10. If the pressure setting of the main relief valve is not correct, shims can be added or removed.

11. Remove plug (4).

Note: A spring and a small valve can fall from the main control valve when plug (1) is removed.

12. Add shims to plug (4) in order to increase the pressure setting. Remove shims from plug (4) in order to decrease the pressure setting.

Table 13

Pressure Change With the Removal or Addition of One Shim		
Part Number	**Shim Thickness**	**Approximate Pressure Change**
3J-7470	1.22 mm (.048 inch)	2910 kPa (422 psi)
3J-7473	0.12 mm (.0047 inch)	285 kPa (41 psi)

13. Install plug (4).

Note: Make sure that the spring and the small valve are in the main control valve when plug (4) is replaced.

14. If the pressure setting of the main relief valve is correct, install any access panels that may have been removed. Close any doors that may have been opened.

i06603720

Relief Valve (Tilt, Tip Cylinder) - Test and Adjust

SMCS Code: 5104-081-PV; 5104-025-PV; 5106-081-PV; 5106-025-PV

This test verifies that the pressure of the tilt relief valve is correct. If the pressure is not correct, the tilt relief valve may require adjustment.

The tilt relief valve relieves the tilt circuit of the machine.

Table 14

Required Tools	
Part Number	**Description**
8T-0860	Pressure Gauge
6V-3989	Unvalved Nipple
8T-5320	Hydraulic Test Group

Machine Preparation

1. Park the machine on a smooth, level surface. Move away from other operating machines and away from personnel. Lower the blade to the ground. Stop the engine.

2. Permit only one operator on the machine. Keep all other personnel away from the machine or in sight of the operator.

3. Engage the parking brake. Put blocks in front of the wheels and behind the wheels.

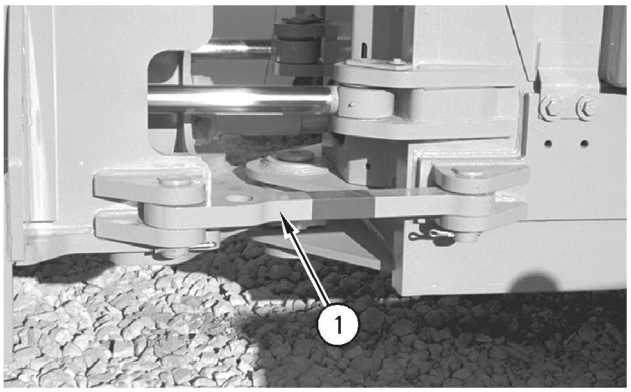


Illustration 15 g00710214

Steering Frame Lock

(1) Steering frame lock in the LOCKED position.

4. Install steering frame lock (1) in the LOCKED position so the machine cannot articulate.

5. Depress the brake pedal repeatedly. Depressing the pedal will relieve any pressure that may be present in the brake hydraulic system.

6. Move the implement control levers through the full range of travel. Moving the control levers will relieve any pressure that may be present in the implement hydraulic system. Place the lift control lever in the HOLD position. Place the tilt control lever in the HOLD position.

7. Turn the steering wheel several times in both directions to relieve the pressure in the steering system.

Note: If the machine is not equipped with a hydraulic tank breaker relief valve, the hydraulic tank cap may be removed slowly to relieve tank pressure.

Test Procedure

1. Install a blocking plate assembly from the 8T-5320 Hydraulic Test Group in one hydraulic oil line at the rod end of a tilt cylinder.

2. Attach an unvalved nipple to a 0 kPa to 40000 kPa (0 psi to 5800 psi) pressure gauge. Attach a section of hydraulic line to the unvalved nipple.

3. Open the doors to the pump compartment.

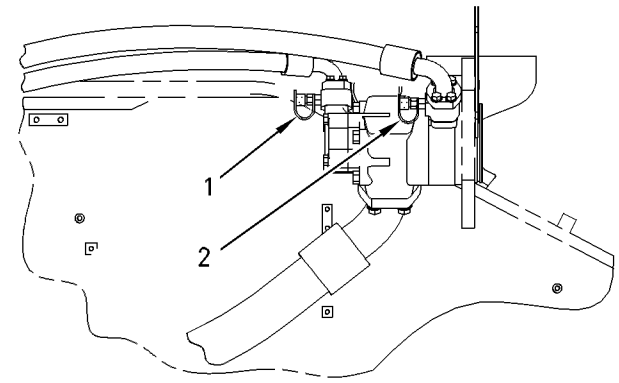


Illustration 16 g00394877

Location of Pressure Taps

(1) Pressure tap for the tilt relief valve. (2) Pressure tap for the main relief valve.

4. Attach the hydraulic line to pressure tap (1).

5. Close the doors to the pump compartment.

6. Start the engine.

7. Lift the blade approximately 380 mm (15 inch) off the ground.

8. Tilt the blade to the left as far as possible.

9. Operate the engine at high idle.

10. Observe the test gauge and move the control lever to the TILT LEFT position.

11. The high reading on the gauge is the pressure setting of the tilt relief valve.

12. The pressure setting of the tilt relief valve should be 20150 ± 150 kPa (2920 ± 20 psi).

13. If the pressure setting of the tilt relief valve is not correct, the tilt relief valve may require adjustment.

Adjustment Procedure

The opening pressure of the tilt relief valve for the implement hydraulic system may be incorrect.

Relief valve settings that are too low cause a decrease in the performance of the machine.

Opening pressures that are too high cause a decrease in the life of hoses and components.

Note: The tilt relief valve should be set correctly before attempting to set the main relief valve.

Note: The pressure setting of the tilt relief valve can be adjusted with an adjustment screw.

1. Stop the engine.

2. Slowly move the control lever toward the FLOAT position to allow the blade to slowly lower to the ground.

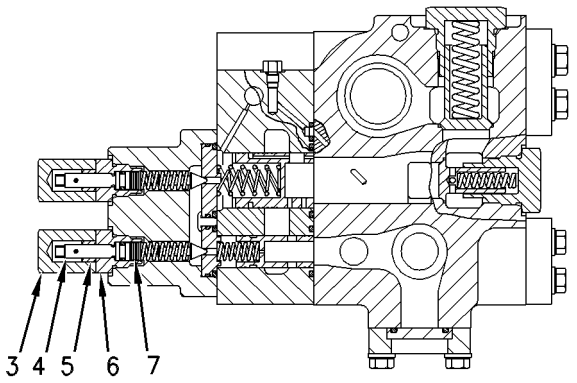


Illustration 17 g00394879

Main Control Valve (front non-engine end frame)

(3) Jam nut. (4) Adjustment screw. (5) Locknut. (6) Plug for the tilt relief valve. (7) Shims.

3. Remove jam nut (3) from the main control valve.

4. Loosen locknut (3).

5. Turn adjustment screw (4) clockwise to increase the pressure setting or turn adjustment screw (4) counterclockwise to decrease the pressure setting.

6. Tighten locknut (3).

7. Install jam nut (3).

8. The pressure setting of the tilt relief valve should be 20150 ± 150 kPa (2900 ± 20 psi).

9. If the pressure setting of the tilt relief valve is correct, remove the test equipment from pressure tap (1). Install any access panels that may have been removed. Close any doors that may have been opened.

10. If the pressure setting of the main relief valve is not correct, shims can be added or removed.

11. Remove plug (6).

Note: A spring and a small valve can fall from the main control valve when plug (6) is removed.

12. Add shims to plug (6) to increase the pressure setting. Remove shims from plug (6) to decrease the pressure setting.

Table 15

Pressure Change of Tilt Circuit Per Shim		
Part Number	**Shim Thickness**	**Approximate Pressure Change**
3J - 7470	1.22 mm (.048 inch)	2910 kPa (420 psi)
3J - 7473	0.12 mm (.0047 inch)	285 kPa (41 psi)

13. Install plug (6).

Note: Make sure that the spring and the small valve are in the main control valve when plug (6) is replaced.

14. If the pressure setting of the tilt relief valve is correct, install any access panels that may have been removed. Close any doors that may have been opened.

i04337469

Hydraulic Fan Speed - Test and Adjust

SMCS Code: 1386-025-VF; 1386-081-VF; 1387-081-PX; 1387-025-PX

⚠ WARNING

Rotating fan blades can result in personal injury or death.

Stop the engine and allow the fan to come to a complete stop before making any test or adjustment.

Before starting the engine, make sure all of the finger guards are installed and the guard door is closed. Do not allow any tools or test equipment to protrude or vibrate into the path of the rotating fan blades.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Sudden movement or accidental starting of the machine can cause personal injury or death to persons on or near the machine.

To prevent personal injury or death, perform the following:

Park the machine on a smooth, level surface.

Lower the work tool to the ground and engage the parking brake.

Stop the engine and remove the key.

Block the wheels and install the steering frame lock.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

This calibration procedure will set the signal limits for the hydraulic fan system. The signal limits are the maximum fan speed and the minimum fan speed. The calibration procedure for Testing and Adjusting the speed of the fan for the hydraulic fan system is completed through Caterpillar Electronic Technician (ET).

Table 16

Required Tools		
Part Number	**Description**	**Qty**
9U-7402[1]	Multitach Tool Gp	1
1U-6605	Reflective Tape	1

(1) The 1U-6602 Photo-Tachometer is also available.

Machine Preparation

1. Move the machine to a smooth horizontal location. Move away from working machines and personnel. Lower the work tools to the ground.
2. Only allow one operator on the machine. Keep all personnel away from the machine or in the view of the operator.
3. Engage the parking brake.

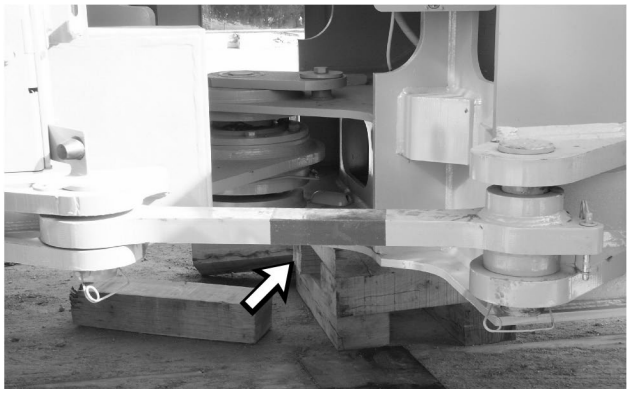


Illustration 18 g01450774

4. Place the steering frame lock in the LOCKED position.
5. Use the 9U-7402 Multitach Tool Gp in order to check the speed of the hydraulic fan. The multitach measures the speed of the hydraulic fan by using reflective tape and a photo pickup.

Reference: Special Instruction, NEHS0605, “Tool Operating Manual (9U-7400 Multitach II Group, 9U-7401 Multitach II, 9U-7402 Multitach Photo Group)”.

Note: If a piece of reflective tape is already visible on one of the fan blades, proceed to Step 6. If no reflective tape is visible on one of the fan blades, use the following procedure:

a. **Turn the engine start switch to the OFF position.**

b. Ensure that the engine start switch is in the OFF position.

c. Remove the rear grill.

d. Clean a small area on the surface of one fan blade near the edge. Position the 1U-6605 Reflective Tape so that the entire piece of tape is visible. Place the tape near the edge of the blade.

e. Install the rear grill.



Illustration 19 g01105419

Photo pickup and magnetic base on the fan guard (typical example)

6. Place photo pickup into the holder on the magnetic base. Tighten the screw. Attach the magnetic base to the fan guard assembly. Refer to Illustration 19 .

7. When the reflective tape and the photo pickup are in alignment, the LED indicator (red light) will come on. Position the photo pickup accordingly.

Note: When you start the engine, vibration of the machine may cause the photo pickup to become misaligned. Adjustment of the magnetic base may be necessary in order to realign the photo pickup.

Testing and Adjusting Fan Speed

Table 17

844H Hydraulic Fan Speeds (1)		
	844H Standard	844H High Ambient
Altitude	**Target Max Fan Speed**	**Target Max Fan Speed**
240 m (787 ft)	750 rpm	840 rpm

(continued)

(Table 17, contd)

500 m (1640 ft)	760 rpm	850 rpm
1000 m (3281 ft)	780 rpm	880 rpm
1500 m (4921 ft)	800 rpm	900 rpm
2000 m (6562 ft)	830 rpm	930 rpm
2500 m (8202 ft)	860 rpm	960 rpm
3000 m (9842 ft)	880 rpm	970 rpm
3500 m (11483 ft)	910 rpm	970 rpm
4000 m (13123 ft)	940 rpm	970 rpm
4500 m (14764 ft)	970 rpm	970 rpm
5000 m (16404 ft)	970 rpm	970 rpm

(1) The hydraulic fan speed is at high RPM. Calibration of the Hydraulic Fan System is done through Caterpillar Electronic Technician.

1. Connect Caterpillar ET to the machine. The ET connector is located on the control panel on the right side of the cab.

2. Turn the engine start switch to the ON position.

3. Open the ET software program.

4. When ET has started, start the engine. Run the engine at high idle. Warm the hydraulic oil to normal operating temperature.

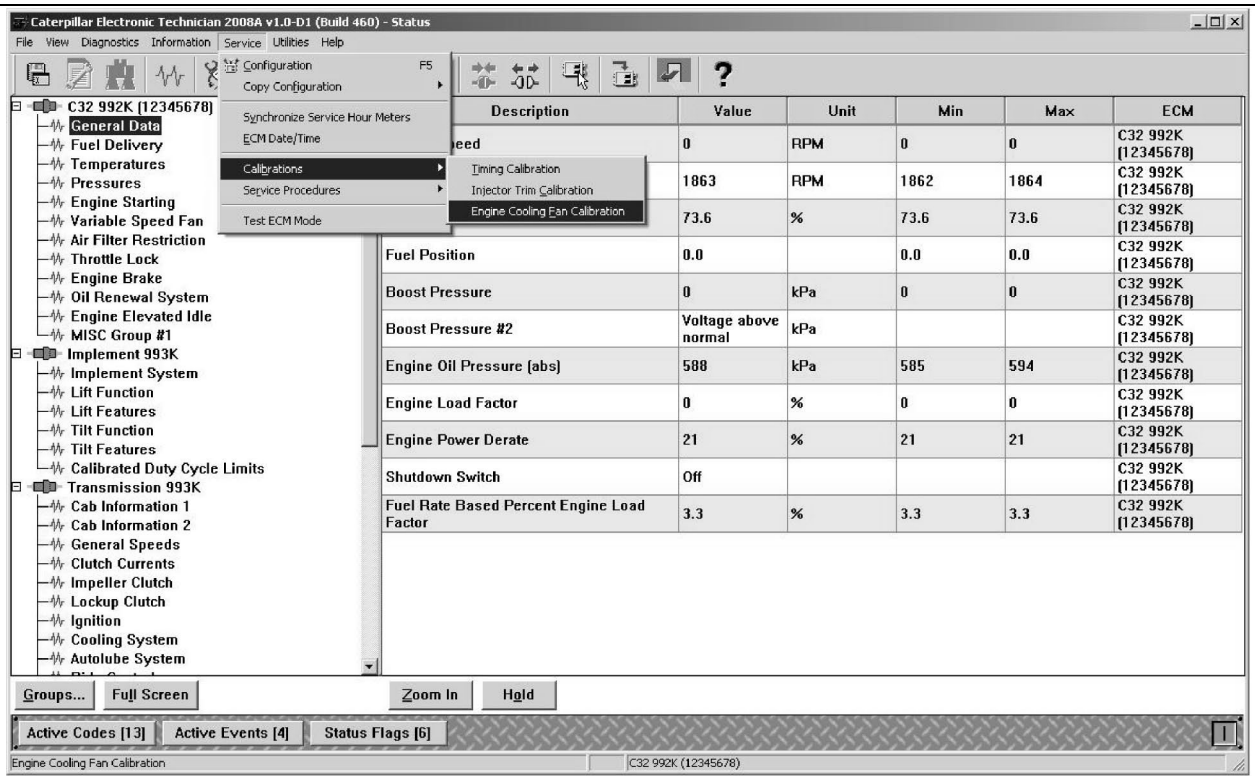


Illustration 20 g01450773

Typical Example

5. Select “General Data” under “C27 844H” . Select “Calibrations” from the “Service” menu. Select “Engine Cooling Fan Calibration” .

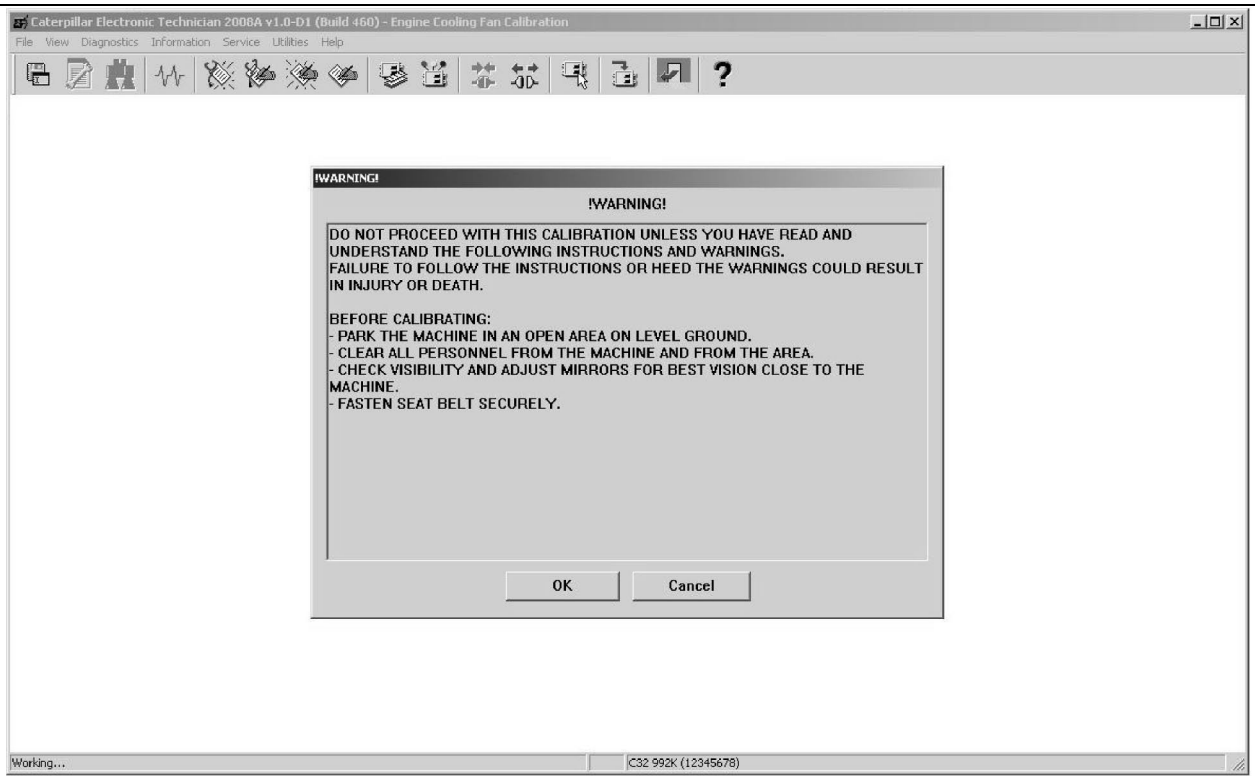


Illustration 21 g01450770

6. When the dialog box appears on the screen, read the information in the dialog box. In order to continue with the calibration procedure, select the “OK” button.

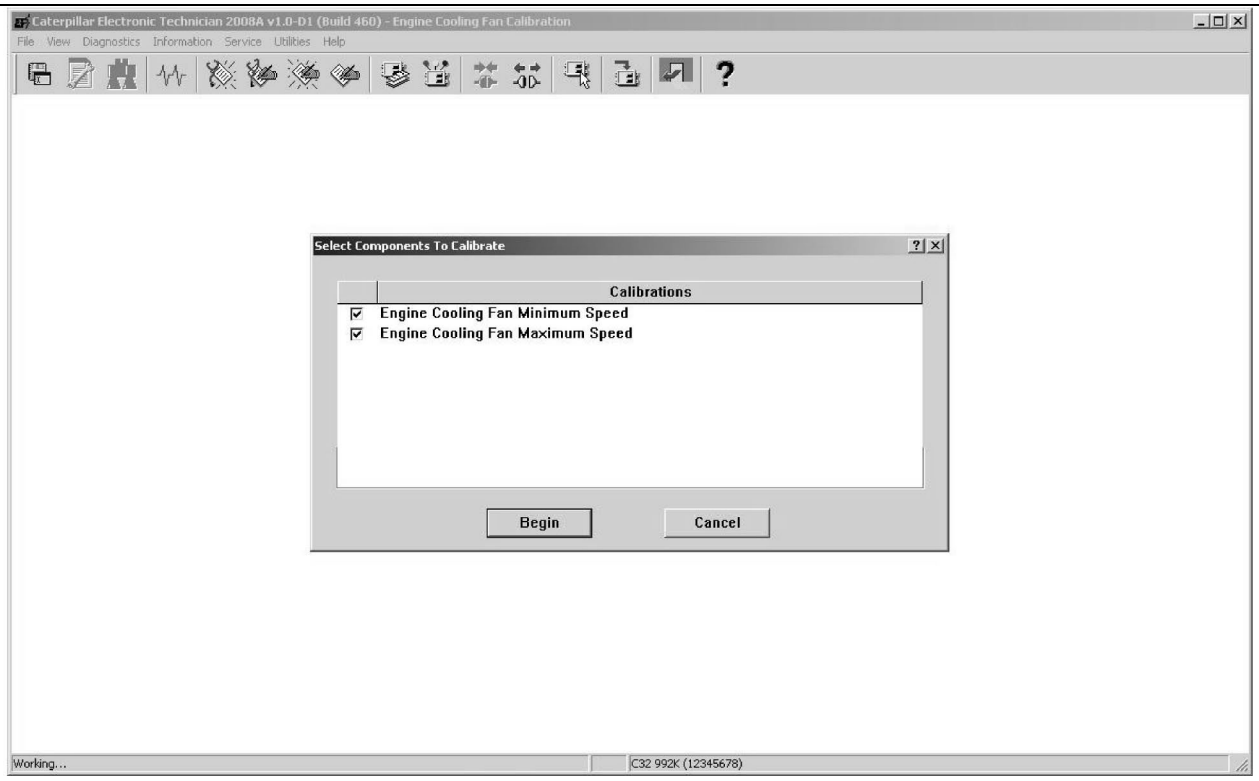


Illustration 22 g01450768

7. When the dialog box appears on the screen, two checked boxes appear. Select the “Begin” button in order to start the procedure. The calibration procedure for the minimum fan speed will appear first on the screen.

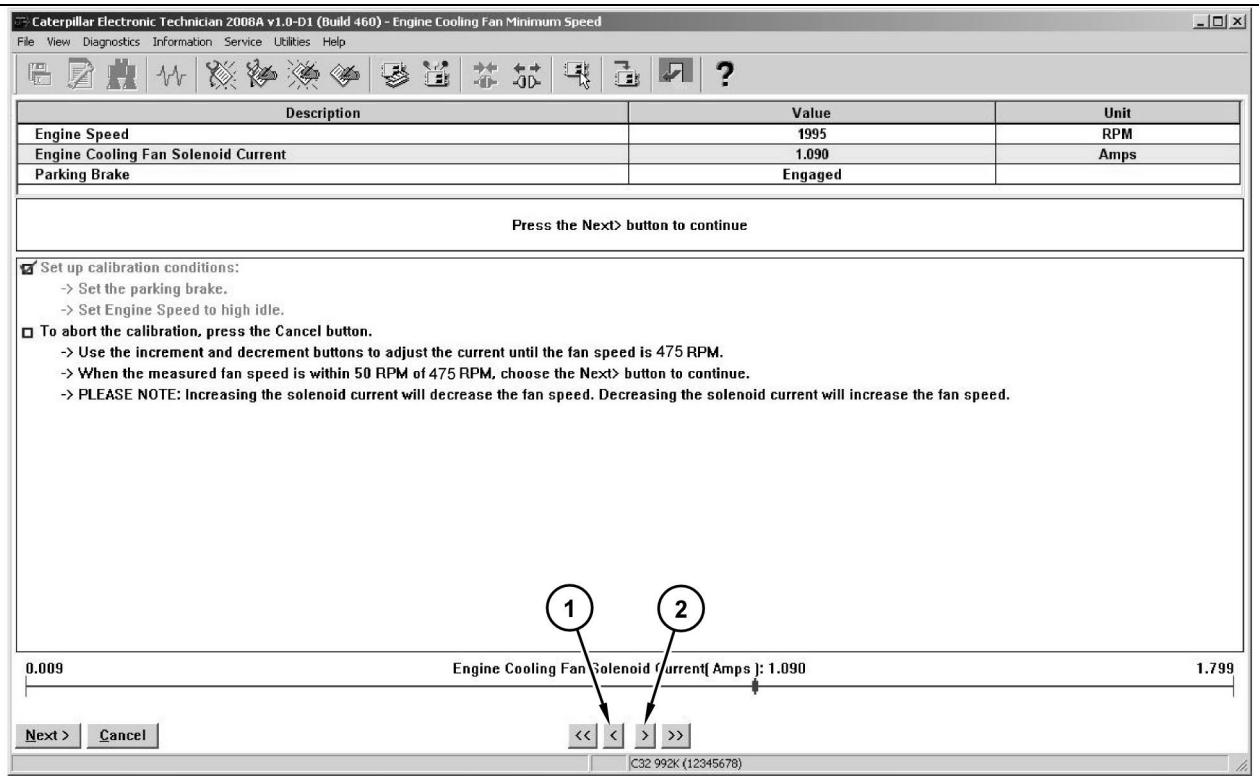


Illustration 23 g01450772

8. In order to begin the test for the minimum fan speed, select the “Next” button. Follow the directions that are on the screen. After the first box has been checked, monitor the multitach for the fan speed. Use increment button (2) in order to increase the current. An increase in current will decrease the fan speed. Use decrement button (1) in order to decrease the current. A decrease in current will increase the fan speed. When the fan speed is within 50 rpm of the desired minimum fan speed, click on the “Next” button.

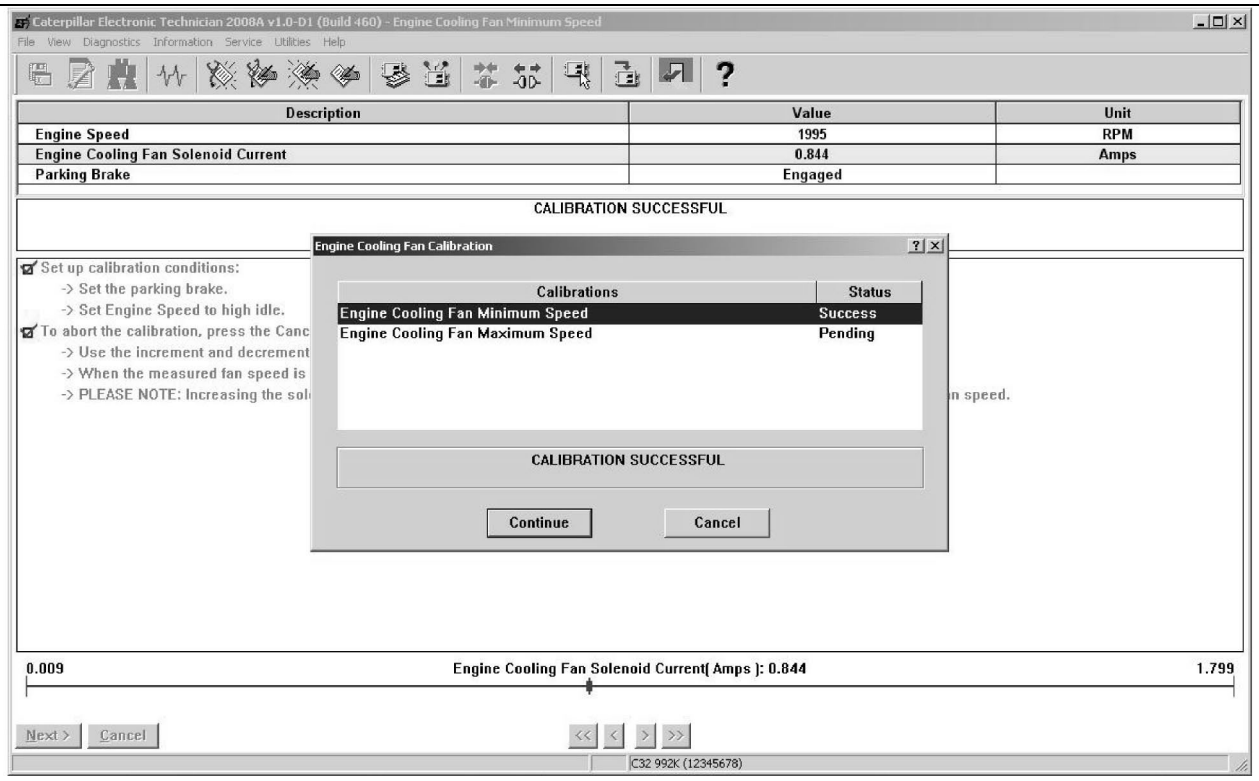


Illustration 24 g01450766

9. When the procedure for adjusting the minimum fan speed is complete, the “Calibration Successful” message will appear on the screen. In order to begin the calibration for the maximum fan speed, select the “Continue” button.

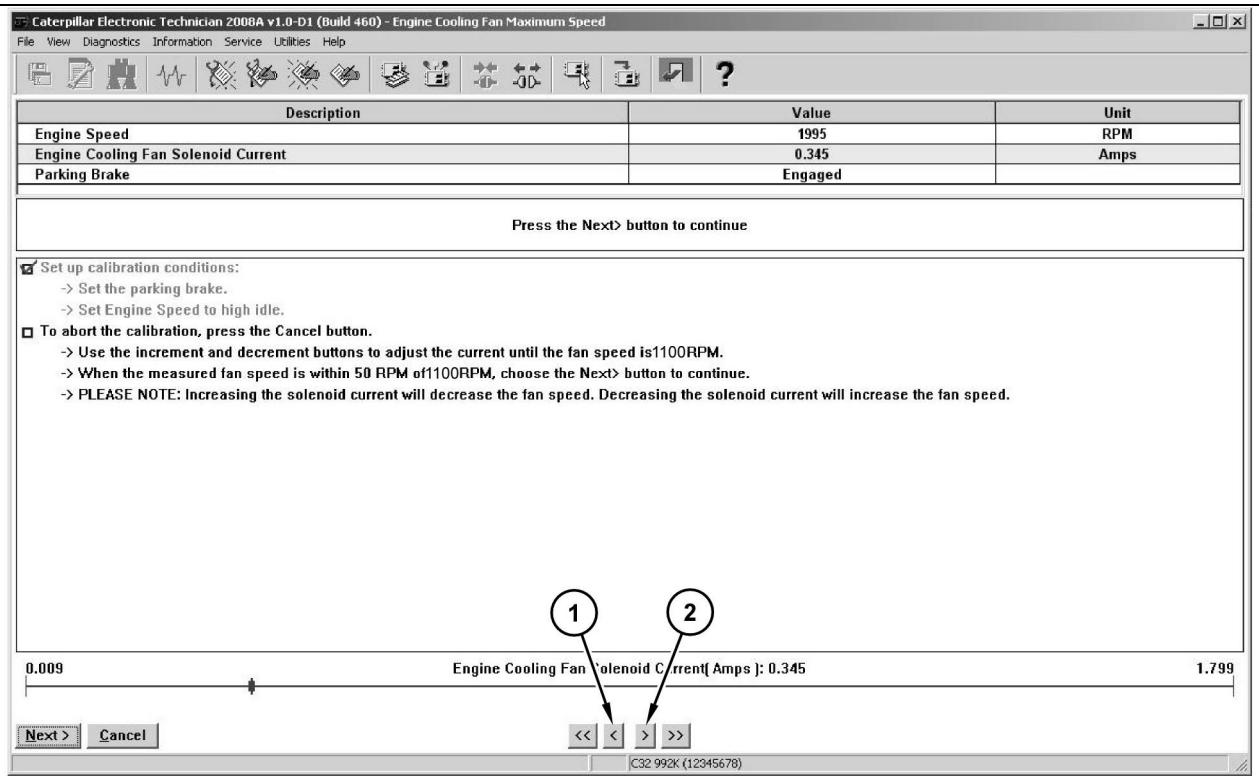


Illustration 25 g01450767

10. In order to begin the test for the maximum fan speed, select the “Next” button. Follow the directions that are on the screen. After the first box has been checked, monitor the multitach for the fan speed. Use increment button (2) in order to increase the current. An increase in current will decrease the fan speed. Use decrement button (1) in order to decrease the current. A decrease in current will increase the fan speed. When the fan speed is within 50 rpm of the desired maximum fan speed, click on the “Next” button.

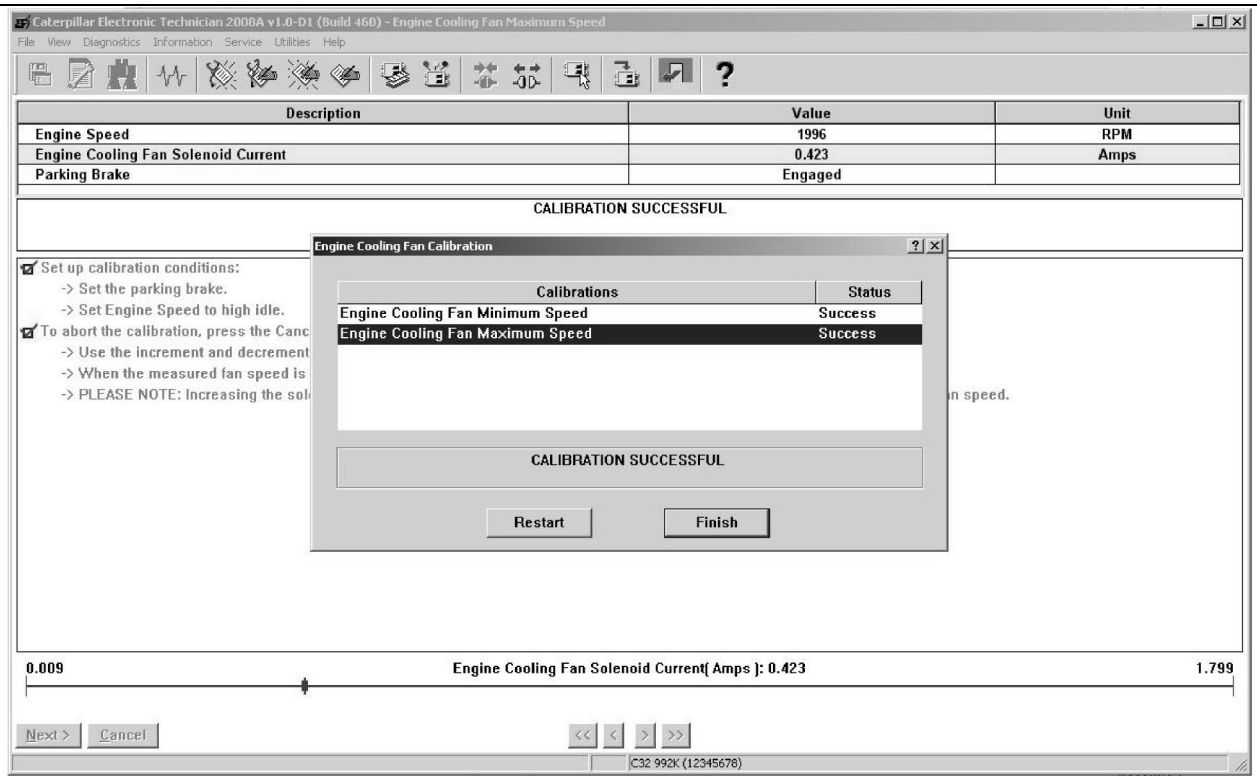


Illustration 26 g01450769

11. When the procedure for adjusting the maximum fan speed is complete, the “Calibration Successful” message will appear on the screen. In order to exit the program, select the “Finish” button. Select the “Restart” button in order to run the test again.

12. Turn the engine start switch to the OFF position. Remove the test equipment from the machine.

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CATERPILLAR®

RENR8825
October 2005



Specifications

990H Wheel Loader and 844H Wheel Dozer Machine Systems

BTW1-Up (Machine)
BWX1-Up (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Specifications Section

i01625941

Platform Mounting

SMCS Code: 7253-MT

Part No.: 8R-5531

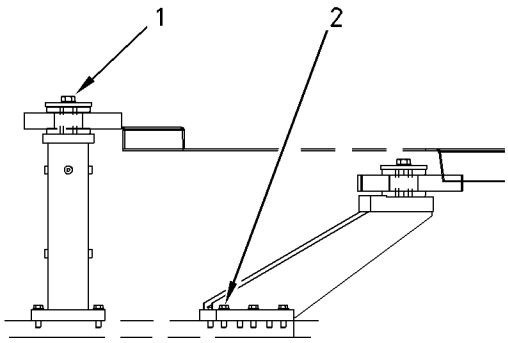


Illustration 1 g00841834

(1) Torque for the four platform bolts .. 800 ± 100 N·m (600 ± 75 lb ft)

(2) Torque for the 20 support bolts ..... 240 ± 40 N·m (180 ± 30 lb ft)

i02363129

Rollover Protective Structure (ROPS)

SMCS Code: 7266; 7323

Part No.: 8R-5537

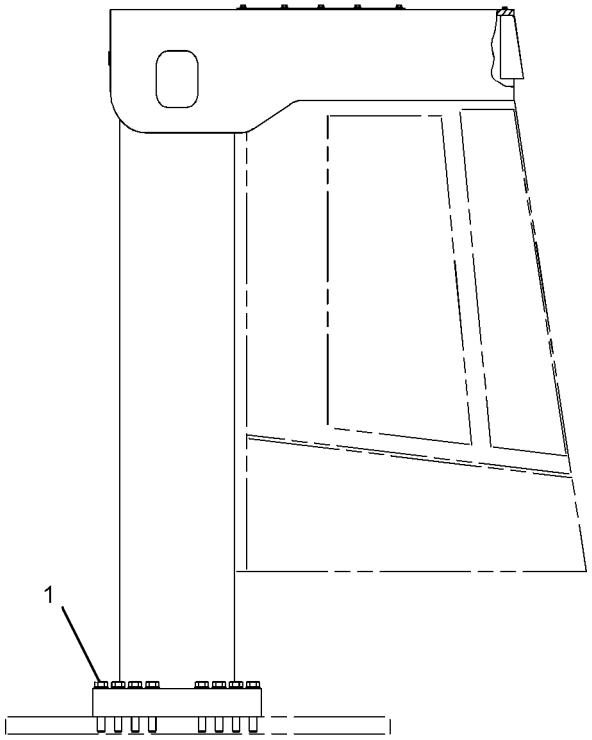


Illustration 2 g01180268

Note: At assembly, the surfaces of the Rollover Protective Structure (ROPS) must be clean and dry. Also, the surfaces must be free of paint.

(1) Torque for the 36 bolts ..... 1600 ± 200 N·m (1200 ± 150 lb ft)

i02363257

Window Wiper and Wiper Motor (Front, Rear)

SMCS Code: 7305-MQ; 7305

Part No.: 155-5784, 185-2154, 8R-5535

Note: 185-2154 Window wiper motor is installed on the front of the cab. 155-5784 Window wiper motor is installed on the back of the cab.

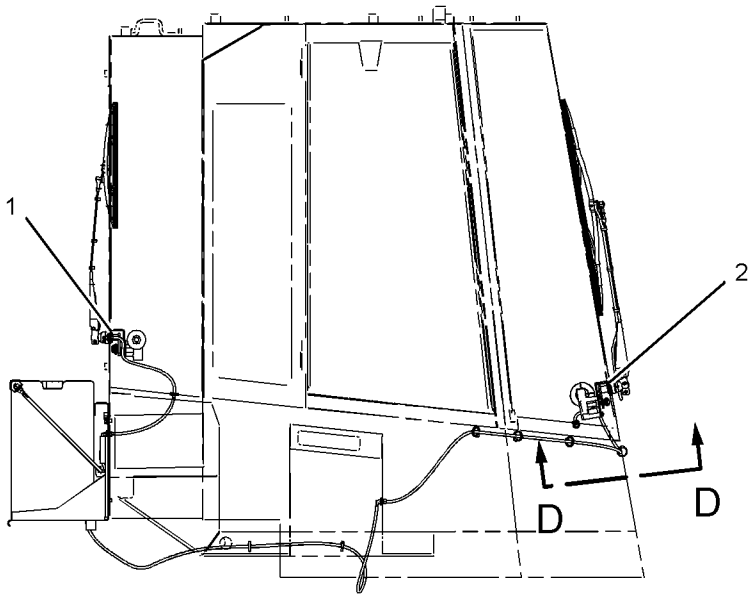


Illustration 3 g01144876

Side view of the 8R-5535 Window Wiper and Washer

(1) Rear window wiper motor (2) Front window wiper motor

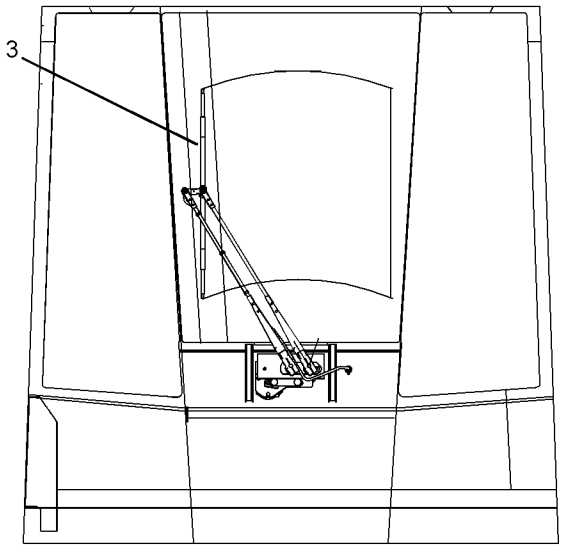


Illustration 4 g01144882

(3) Front wiper blade in the parked position

The tension of the wiper arm in the loaded position ..... 7.5 ± .5 N (1.7 ± 0.1 lb)

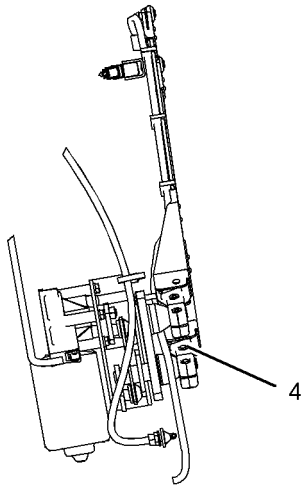


Illustration 5 g01144894

View D-D

Front wiper motor

(4) Torque for the four bolts at the base of the wiper arms ..... 14 ± 2 N·m (125 ± 18 lb in)

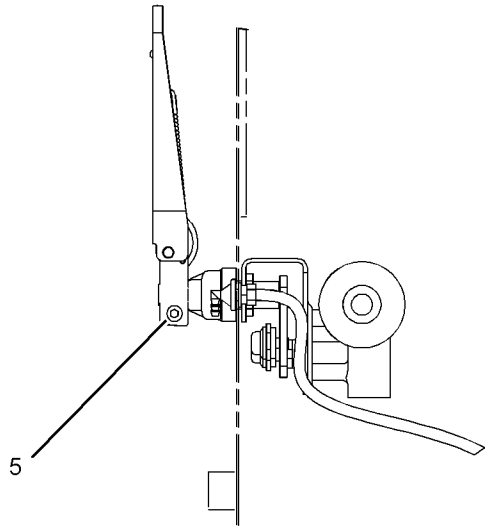


Illustration 6 g01144895

155-5784 Window Wiper Motor Gp

Rear wiper motor

(5) Torque for the two bolts at the base of the wiper arms ..... 20 ± 3 N·m (177 ± 26 lb in)

Note: By using a wire with the diameter of 0.5 mm, adjust the jets of the nozzle assembly to direct spray onto the glass directly in front of the wiper blade.

185-2154 Window Wiper Motor

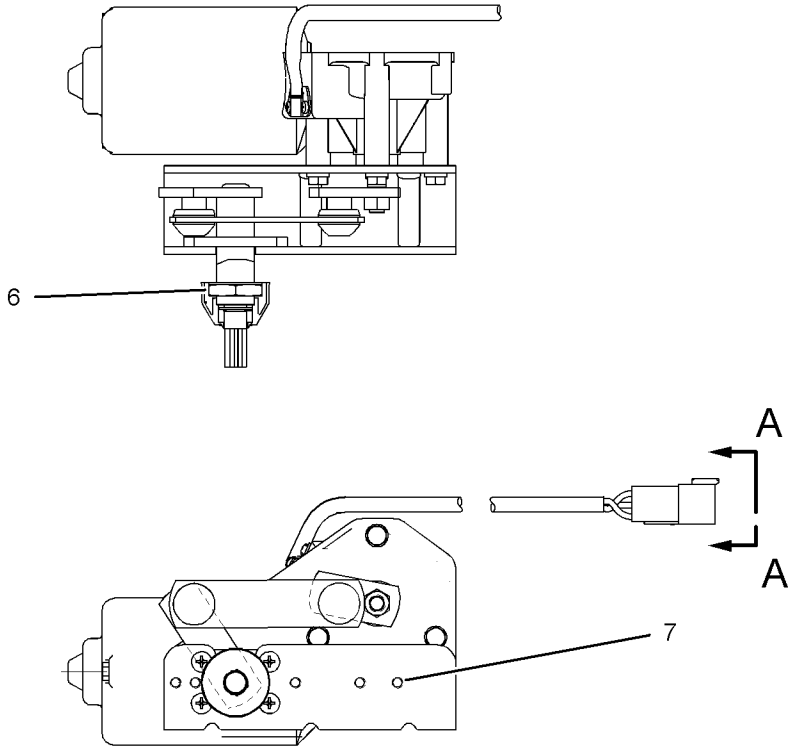


Illustration 7 g01144943

185-2154 Window wiper motor

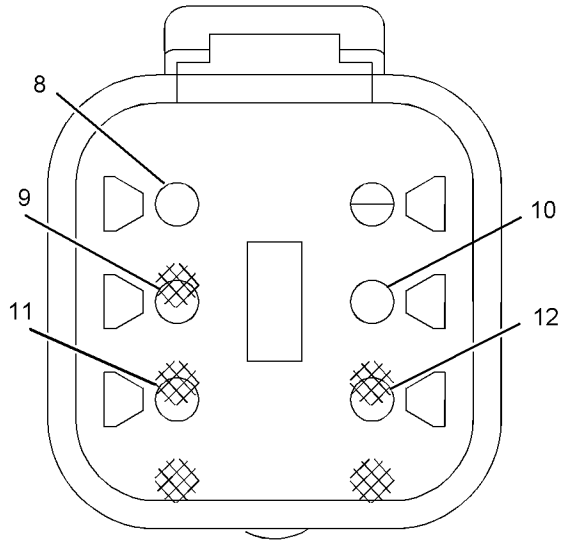


Illustration 8 g01145190

(6) Tighten the nut to the following torque. ..... 19 ± 3 N·m (168 ± 27 lb in)

(7) Tighten the 5 mounting screws to the following torque. ..... 6 ± 1 N·m (54 ± 9 lb in)

(8) Gray wire B+

(9) Orange wire High

(10) Black wire Ground

(11) Green wire Low

(12) Brown wire Park

The tension of the wiper arm in the loaded position ..... 7.5 ± .5 N (1.7 ± 0.1 lb)

Note: By using a wire with the diameter of 0.5 mm, adjust the jets of the nozzle assembly to direct spray onto the glass directly in front of the wiper blade.

155-5784 Window Wiper Motor

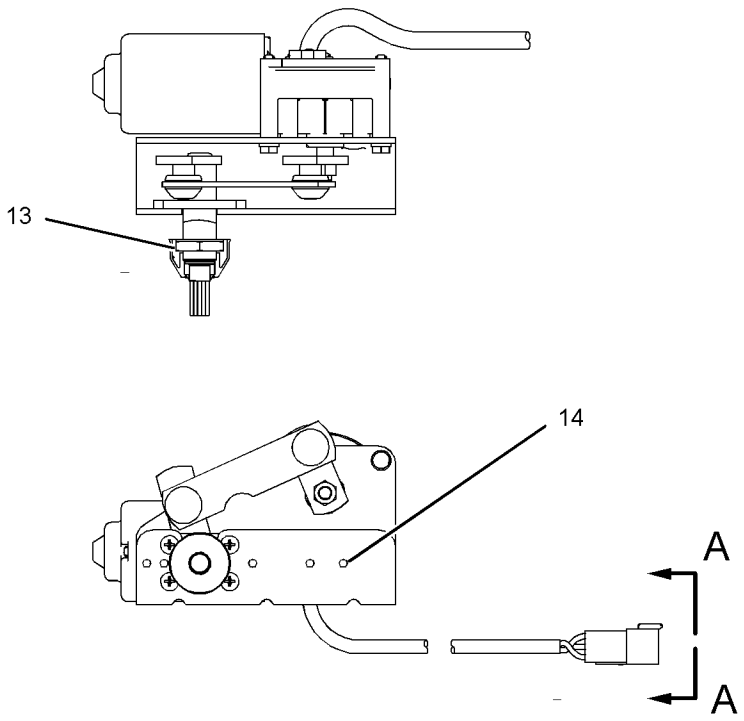


Illustration 9 g01144944

155-5784 Window wiper motor

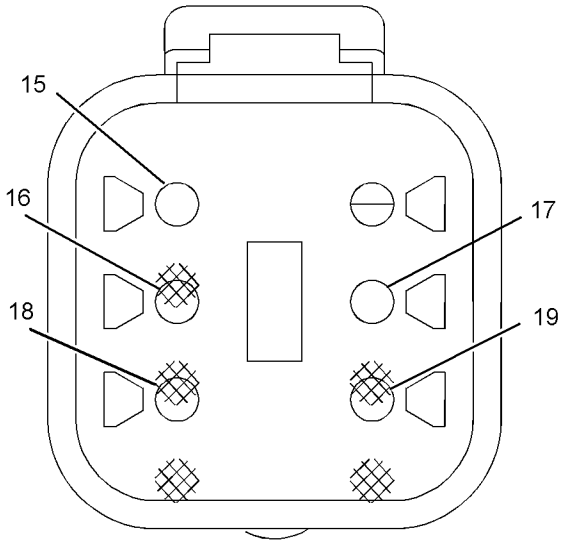


Illustration 10 g01145255

(15) Gray wire B+
(16) Orange wire High
(17) Black wire Ground
(18) Green wire Low
(19) Brown wire Park

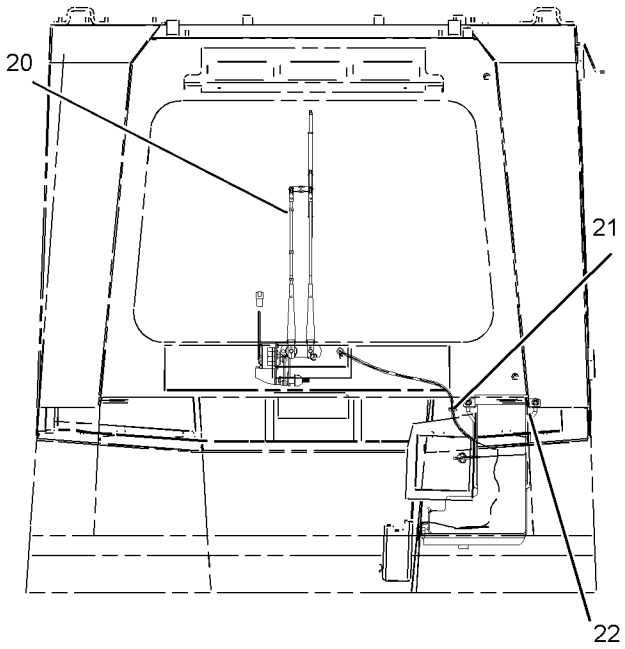


Illustration 11 g01144910

(13) Tighten the nut to the following torque. ..... 19 ± 3 N·m (168 ± 27 lb in)

(14) Tighten the 5 mounting screws to the following torque. ..... 6 ± 1 N·m (54 ± 9 lb in)

(20) Wiper blade should be positioned vertical in the park position. ..... 90 ± 5°

(21) Installation torque for the nuts on the 5 hose connectors ..... 5 N·m (45 lb in)

(22) Torque for the 2 nuts that secure the windshield washing fluid container in place ..... 30 ± 7 N·m (22 ± 5 lb ft)

The tension of the wiper arm in the loaded position ..... 7.5 ± .5 N (1.7 ± 0.1 lb)

Note: By using a wire with the diameter of 0.5 mm, adjust the jets of the nozzle assembly to direct spray onto the glass directly in front of the wiper blade.

i02363502

Window Wiper and Wiper Motor (Front Quarter)

SMCS Code: 7305; 7305-MQ

Part No.: 190-3445, 190-3446, 236-5417

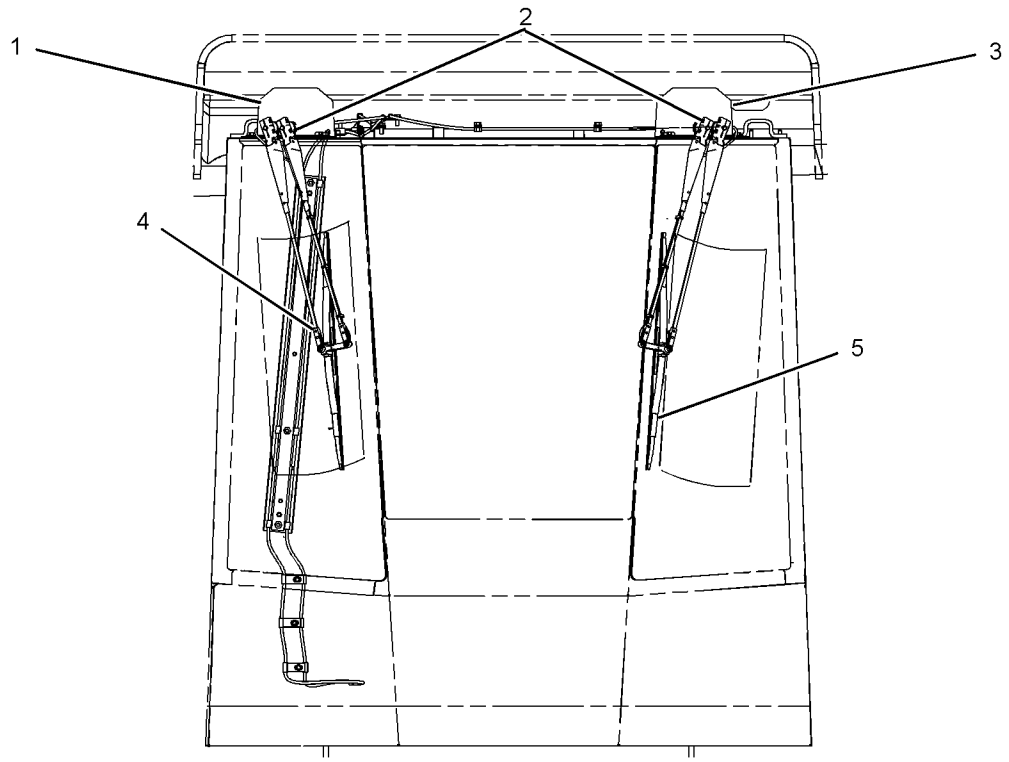


Illustration 12 g01144993

Front view of both right and left hand wiper motors

(1) Right hand wiper motor

(2) Torque for the setscrews ..... 14 ± 2 N·m (124 ± 18 lb in)

(3) Left hand wiper motor

(4) Torque for the setscrews ..... 14 ± 2 N·m (124 ± 18 lb in)

(5) The tension of the wiper arm in the loaded position ..... 7.5 ± .5 N (1.7 ± 0.1 lb)

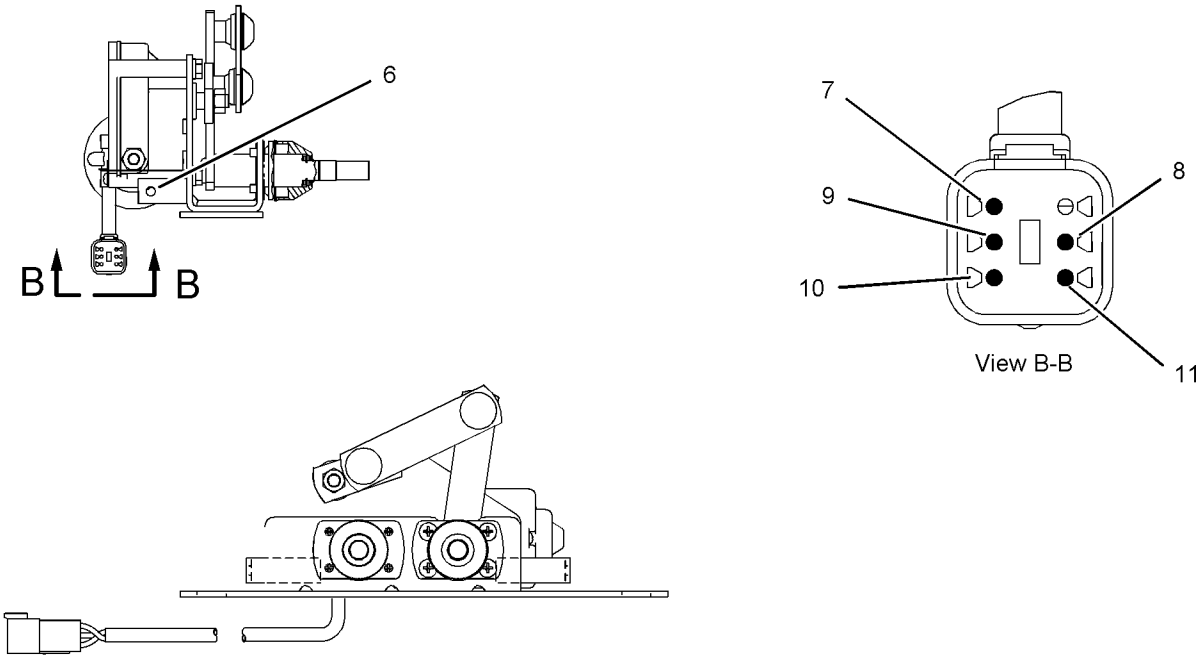


Illustration 13 g01144995

Left hand wiper motor

(6) Torque for the mounting screws ..... 6 ± 1 N·m
(53 ± 9 lb in)

(7) Gray wire B+

(8) Orange wire High

(9) Black wire Ground

(10) Green wire Low

(11) Brown wire Park

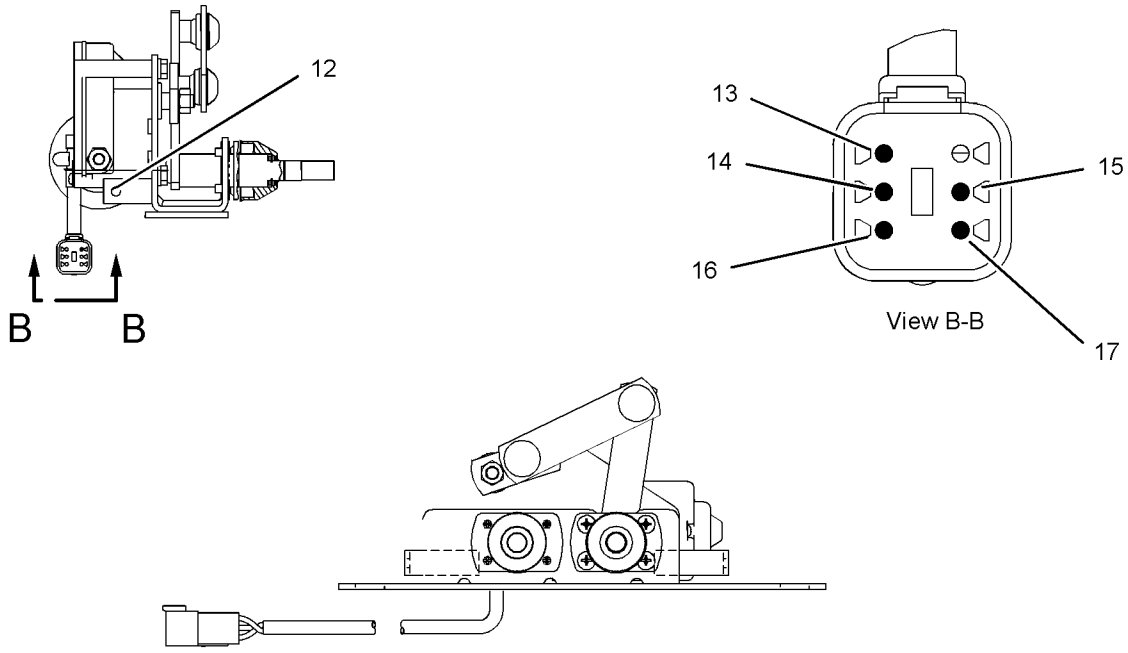


Illustration 14 g01144997

Right hand wiper motor

(12) Torque for the setscrews ..... 6 ± 1 N·m
(53 ± 9 lb in)

(13) Gray wire B+

(14) Orange wire High

(15) Black wire Ground

(16) Green wire Low

(17) Brown wire Park

i02080669

Governor Pedal

SMCS Code: 1276

Part No.: 113-4799
S/N: BTW1-Up

Part No.: 112-5763
S/N: BWX1-Up

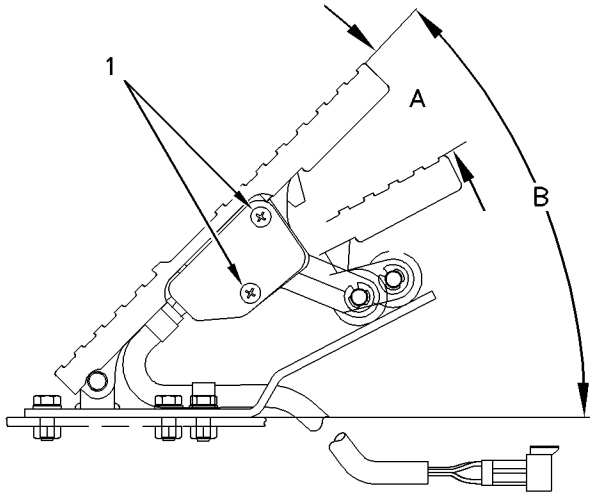


Illustration 15 g00843357

(A) Maximum travel of the governor pedal ..... 17°

(B) Reference angle from the floor ..... 45°

(1) Apply 9S-3263 Thread Lock Compound to the threads of the screws. Torque for the two screws ..... 2.25 ± 0.25 N·m (20 ± 2 lb in)

i02158419

Position Sensor (Throttle)

SMCS Code: 1913

Part No.: 204-7949

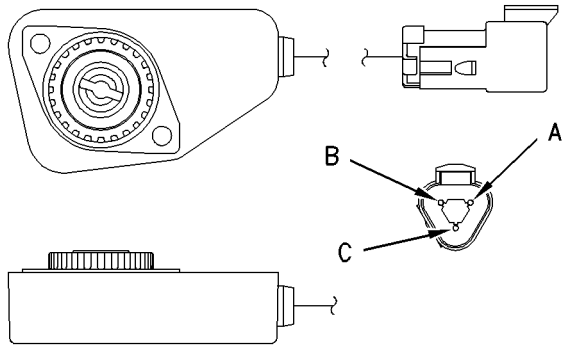


Illustration 16 g00658574

Table 1

Pin	Circuit	Color
A	+BAT	RD
B	GND	BK
C	SIG	WH

Note: The position sensor is a pulse width modulated sensor (PWM). A pulse width modulated sensor output is proportional to the rotational input.

Required torque for turning the rotor ..... 0.25 N·m (2.21 lb in)

Battery voltage ..... 9 VDC to 32 VDC

Maximum current ..... 30 mA

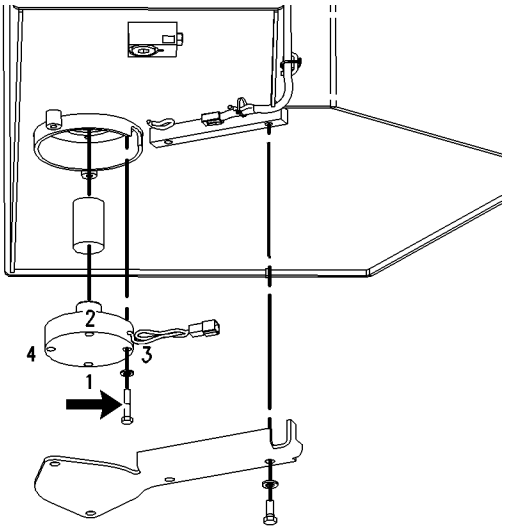
Temperature range ..... −40 to 85 °C (−40 to 185 °F)

i02363798

Fuel Level Sensor

SMCS Code: 1273-NS

Part No.: 124-9325



g00844412

Illustration 17

Fuel Level Sender assembly

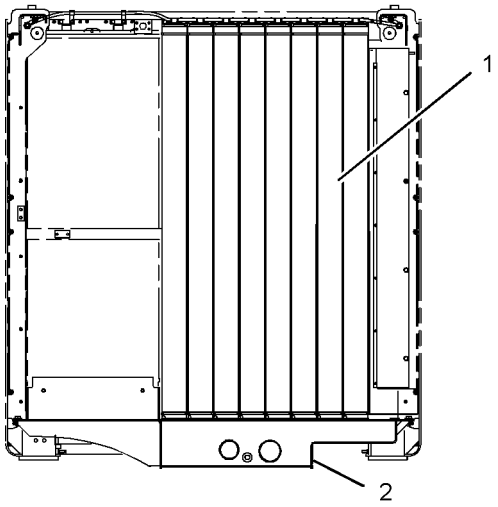
- Torque the four bolts in the numerical sequence that is shown above.
- Finger tighten the four bolts.
- Torque for the four bolts 30 ± 7 N·m (265 ± 62 lb in)
- Torque the four bolts for a second time.

i02363899

Radiator

SMCS Code: 1353

Part No.: 234-4995, 238-1339



g01180736

Illustration 18

Standard Radiator

(1) The 234-4995 Radiator Gp uses eight radiator cores. The 238-1339 Radiator Gp (HIGH AMBIENT TEMPERATURE) uses nine radiator cores.

(2) Radiator tank assembly (2) must be able to withstand 240 kPa (35 psi) of water pressure.

Internal volume of each core ..... 2.1 L (2.2 qt)

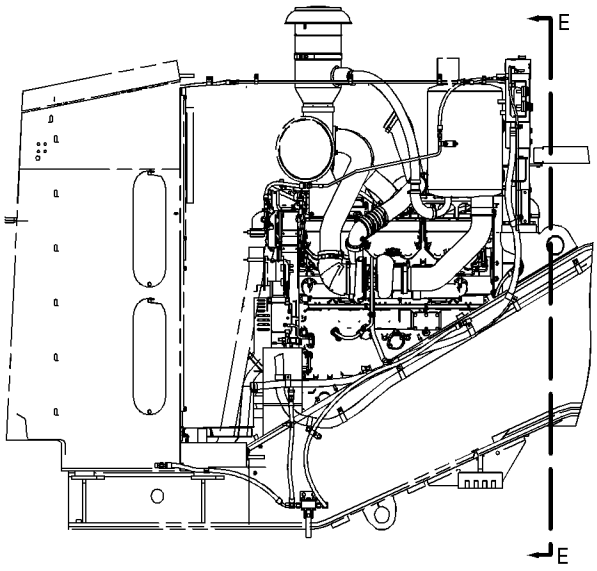
The radiator cores have a fin density of 3.7 fins per 1 cm (9.4 fins per 1 inch).

i02364016

Radiator Top Tank

SMCS Code: 1377; 1382

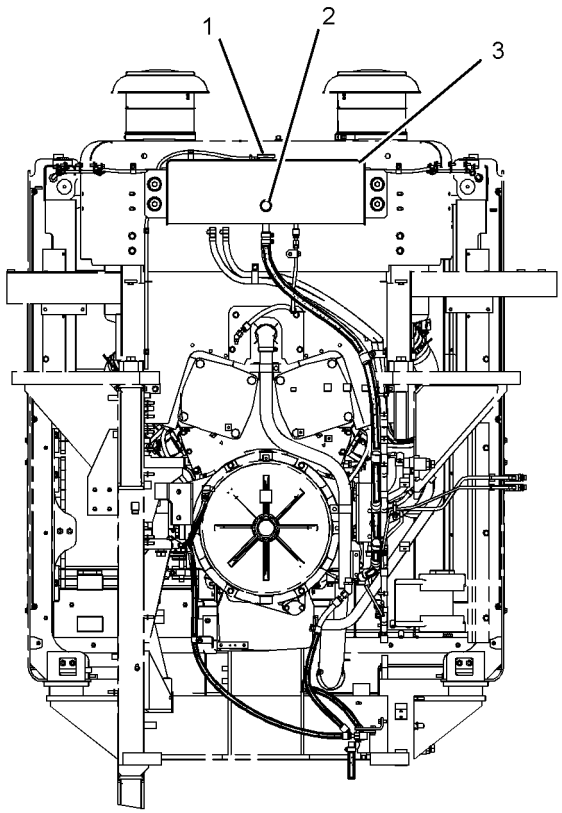
Part No.: 234-4989



g01180794

Illustration 19

Right Side View Of The Machine



g01180795

Illustration 20

View E-E

(1) Radiator Cap
(2) Gauge Body Assembly
(3) Radiator Top Tank

(1) Pressure that is required to open the valve ..... 41 to 55 kPa (6 to 8 psi)

Vacuum that is required to open the valve .. 0 to 4 kPa (0 to .6 psi)

(2) Maximum pressure for the 9Y-9236 Gauge Body Assembly ..... 282.5 kPa (41 psi)

Maximum temperature ..... 121 °C (250 °F)

Installation torque ..... 40 ± 5 N·m (354 ± 44 lb in)

(3) The radiator top tank must be able to withstand 200 kPa (29 psi) of air pressure.

i02364666

Ether Starting Aid

SMCS Code: 1456

Part No.: 236-1401

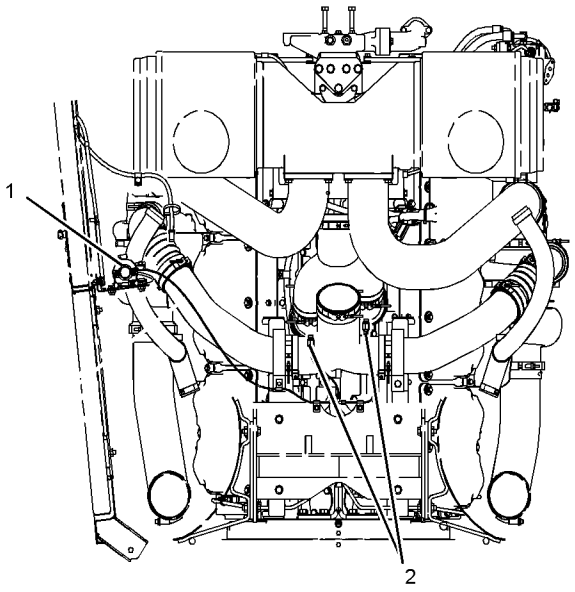


Illustration 21 g01180930

(1) Nominal voltage for the valve ..... 24 VDC

(2) Install the atomizer so that the orifice is aligned with the indicator.

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SENR6615-13 (en-us)
July 2018

Systems Operation
Testing and Adjusting
Disassembly and Assembly

Contour Series Seat

5KZ 1-UP (Machine)
CBZ 1-UP (Machine)
JJB 1-UP (Machine)
M92 1-UP (Machine)
7MN 1-UP (Machine)
85X 1-UP (Machine)
86X 1-UP (Machine)
01X 1-UP (Machine)
02X 1-UP (Machine)
63W 1-UP (Machine)
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FDC 1-UP (Machine)
FDH 1-UP (Machine)
FDW 1-UP (Machine)
ANT 1-UP (Machine)
AWY 1-UP (Machine)
ANY 1-UP (Machine)
AXC 1-UP (Machine)
ANZ 1-UP (Machine)
AXJ 1-UP (Machine)
AWP 1-UP (Machine)
AXN 1-UP (Machine)
AXR 1-UP (Machine)
AYB 1-UP (Machine)
AXS 1-UP (Machine)
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DMP 1-UP (Machine)
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K6K 1-UP (Machine)
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A7D 1-UP (Machine)
GTA 1-UP (Machine)
A7G 1-UP (Machine)
A7J 1-UP (Machine)
M5G 1-UP (Machine)
MJC 1-UP (Machine)
JKM 1-UP (Machine)
LKM 1-UP (Machine)
MCC 1-UP (Machine)
JNJ 1-UP (Machine)
Z9K 1-UP (Machine)
H4C 1-UP (Machine)
SC6 1-UP (Machine)
7GN 1-UP (Machine)
8HN 1-UP (Machine)
4CS 1-UP (Machine)

i06558969

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

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Mechanical Suspension

SMCS Code: 7324-ME

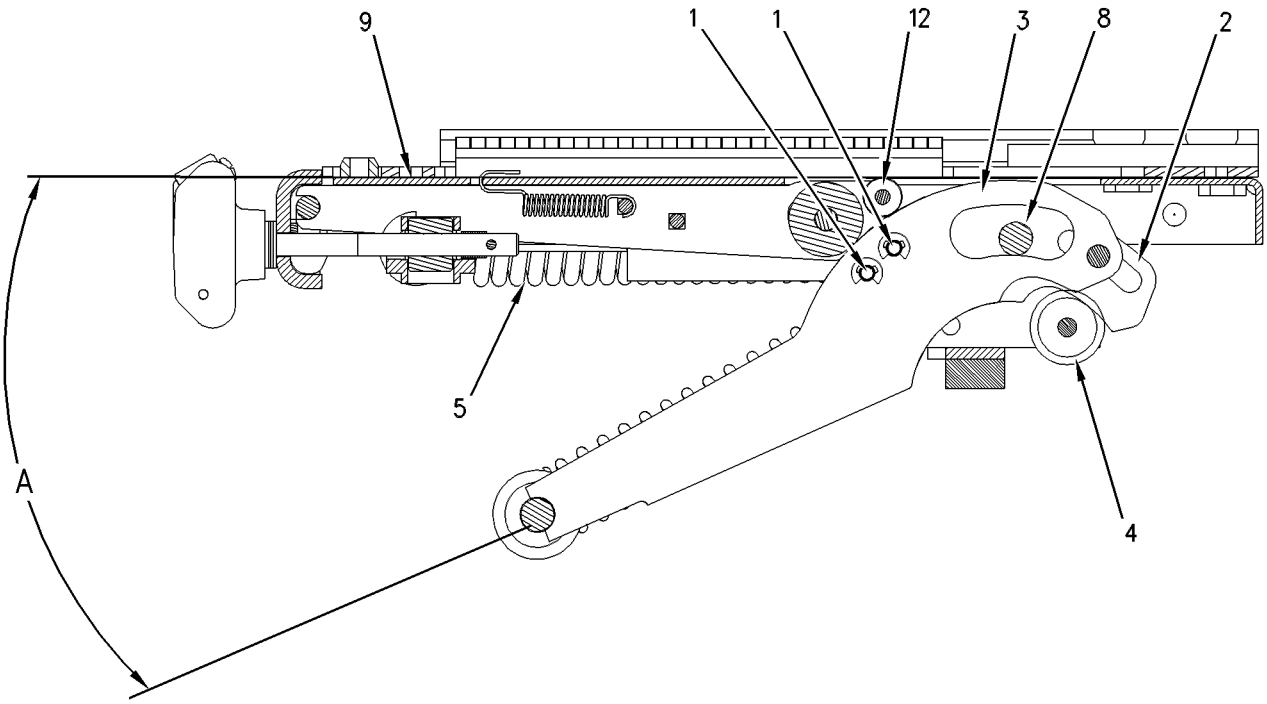


Illustration 1 g00609018

(1) Pins. (2) Cam. (3) Arm. (4) Follower. (5) Suspension springs. (8) Shaft. (9) Housing assembly. Slots. (12) Rollers. (A) Angle of housing assembly.

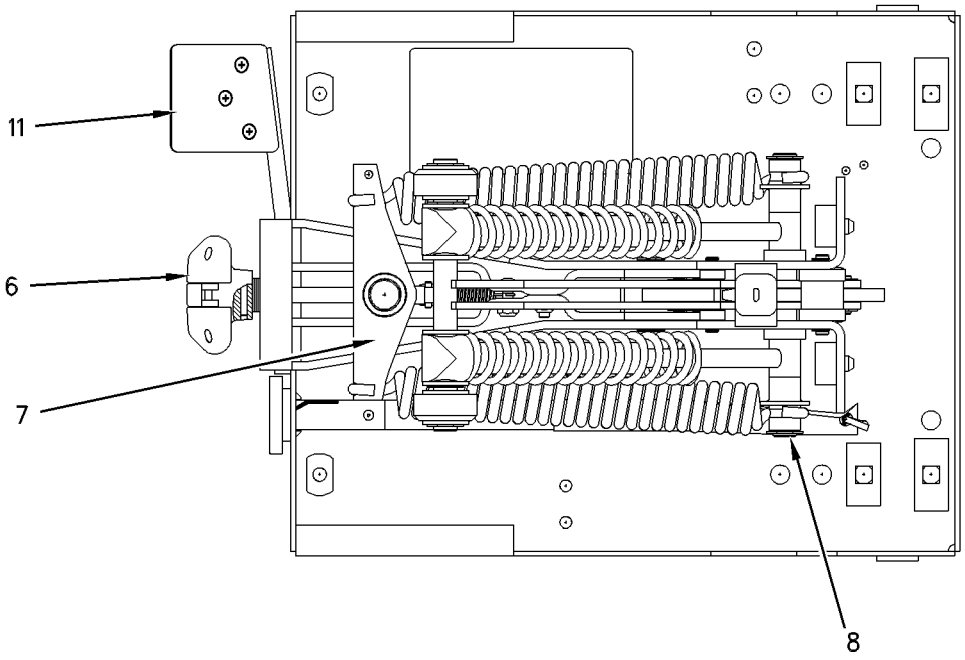


Illustration 2 g00609053

(6) Weight adjustment knob. (7) Adjuster assembly. (8) Shaft. (11) Height adjustment lever.

The suspension of the seat performs three functions:

- Isolation
- Weight adjustment
- Height adjustment

Isolation

When the seat mechanism is operated, pins (1) lock cam (2) to arm assembly (3). Cam (2) moves on follower (4), which forces motion of shaft (8) relative to adjuster assembly (7). This will extend suspension springs (5) or this will retract suspension springs (5).

Weight Adjustment

Rotating weight adjustment knob (6) will pull adjuster assembly (7) away from shaft (8) or toward shaft (8). This will extend suspension springs (5) or this will retract suspension springs (5). This adjustment sets the preload on the suspension springs. Heavier operators will need more preload than lighter operators.

Height Adjustment

The height is determined by angle (A) of housing assembly (9) relative to arm assembly (3). The relative angle is determined by the position of pins (1) in slots (10). When height adjustment lever (11) is raised, rollers (12) force cam (2) to move relative to arm assembly (3). This will disengage pins (1) from slots (10) in arm assembly (3). Pushing down on the suspension or pulling up on the suspension will move pins (1) over a set of slots. The top two slots correspond to the highest height. The middle two slots correspond to the middle height. The bottom two slots correspond to the lowest height. Release height adjustment lever (11) in order to snap the pins into the slots.

i01171391

Contour Seat Air Suspension with Air Compressor

SMCS Code: 7318; 7324-AJ

S/N: M921–Up

S/N: SC61–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: 1DD1–Up

S/N: 1JD1–Up

S/N: 1KD1–Up

S/N: 1YD1–Up

S/N: 2KD1–Up

S/N: 2SD1–Up

S/N: 2YD1–Up

S/N: 3ED1–Up

S/N: 3MD1–Up

S/N: 4KD1–Up

S/N: BXD1–99999

S/N: B9E1–Up

S/N: 2XF1–Up

S/N: 3ZF1–Up

S/N: 4YF1–Up

S/N: 5HF1–Up

S/N: 6CF1–Up

S/N: 6ZF1–Up

S/N: 7ZF1–Up

S/N: 8TF1–Up

S/N: 8ZF1–Up

S/N: 9RF1–Up

S/N: 9YF1–Up

S/N: AWF1–99999

S/N: 1SG1–Up

S/N: 2TG1–Up

S/N: 3YG1–Up

S/N: 4GG1–Up

S/N: 4LG1–Up

S/N: 4YG1–Up

S/N: 5MG1–Up

S/N: 66G1–Up

S/N: 6NG1–Up

S/N: 6YG1–Up

S/N: 7EG1–Up

S/N: 7KG1–Up

S/N: 86G1–Up

S/N: 8BG1–Up

S/N: 8YG1–Up

S/N: 9BG1–Up

S/N: 9MG1–Up

S/N: BXG1–Up

S/N: KEG1–Up

S/N: MHG1–Up

S/N: 1FJ1–Up

S/N: 1RJ1–Up

S/N: 1XJ1–Up

S/N: 2CJ1–Up

S/N: 2JJ1–Up

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S/N: 5YW1–Up

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S/N: 01X1–Up

S/N: 85X1–Up

S/N: 86X1–Up

S/N: 87X1–Up

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S/N: AZX1–99999

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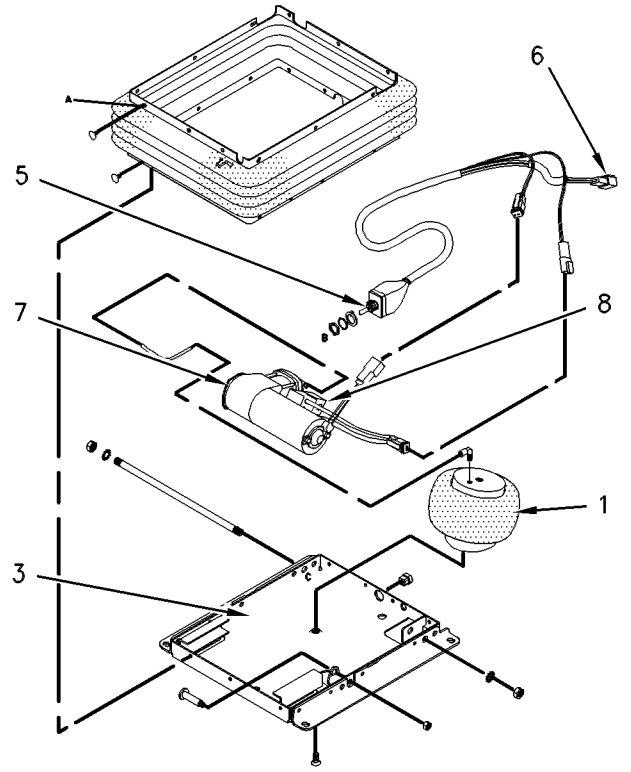


Illustration 3 g00288818

(1) Air bag. (3) Lower housing. (5) Toggle Switch. (6) Harness terminal. (7) Compressor. (8) Solenoid.

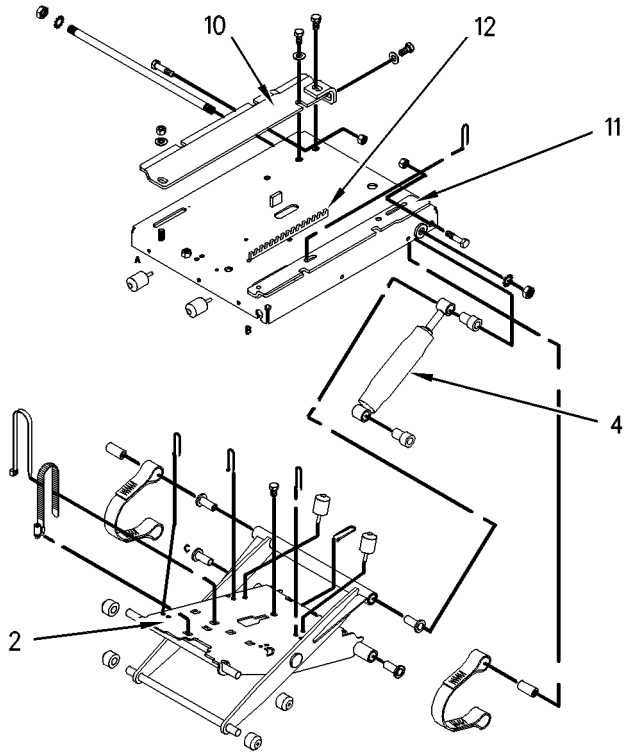


Illustration 4 g00288819

(2) Scissor arm. (4) Shock absorber. (10) Right slider track. (11) Left slider track. (12) Rack.

The suspension of the seat performs several functions:

- Isolation
- Automatic Weight Adjustment
- Height Adjustment
- Connection to the Seat

Isolation and Weight Adjustment

Air bag (1) acts as a spring as the air is compressed due to the motion of inner scissor arm (2) relative to lower housing (3). The amount of air that is in the air bag is determined by the operator. (Refer to “Isolation and Weight Adjustment”.) The pressure in the air bag is determined by the weight of the operator. This provides automatic weight adjustment. Damping is provided by shock absorber (4).

Height Adjustment

Using the Toggle Switch

The height of the seat is determined by the volume of air in the air bag (1). To raise the suspension, the operator holds toggle switch (5) upward and air enters the air bag (1). To lower the suspension, the operator pushes down on toggle switch (5) and the air in the air bag (1) is released.

Note: The operator must not change the height of the suspension so that the stroke is inadequate for the particular application. The suspension height must be changed if the seat bottoms out excessively or if the seat bounces to the maximum height too much.

The UP position of toggle switch (5) completes a 24 volt circuit from harness terminal (6) to compressor (7). Compressor (7) provides pressurized air to the air bag (1).

The DOWN position of toggle switch (5) completes a 24 volt circuit from harness terminal (6) to solenoid (8). The solenoid opens an exhaust port for the air bag (1).

Using the Air Valve Knob

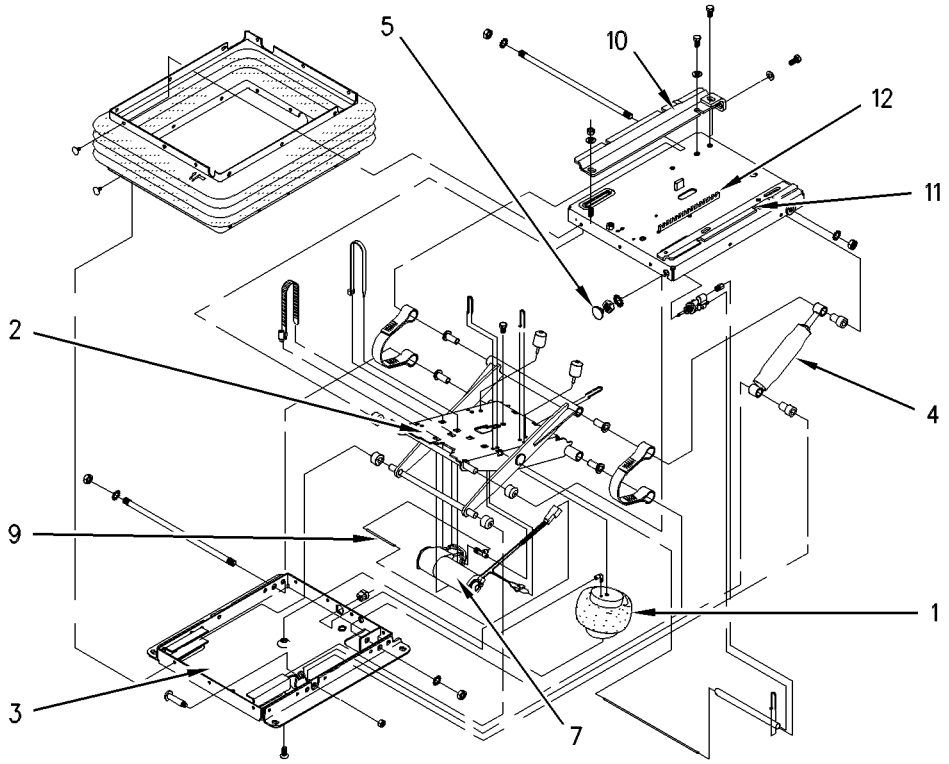


Illustration 5 g00275623

(1) Air bag. (2) Scissor arm. (3) Lower housing. (4) Shock absorber. (5) Air valve knob. (7) Compressor. (9) Solenoid. (10) Right slider track. (11) Left slider track. (12) Rack.

The height of the seat is determined by the volume of air in the air bag (1). To raise the suspension, the operator pushes in air valve knob (5) and air enters the air bag (1). To lower the suspension, the operator pulls out air valve knob (5) and the air in the air bag (1) is released.

Note: The operator must not change the height of the suspension so that the stroke is inadequate for the particular application. The suspension height must be changed if the seat bottoms out excessively or if the seat bounces to the maximum height too much.

When air valve knob (5) is pushed in, a 24 volt circuit to compressor (7) is completed. Compressor (7) provides pressurized air to the air bag (1).

When air valve knob (5) is pulled out, line (9) from the air bag (1) to the exhaust port is opened.

Connection to the Seat

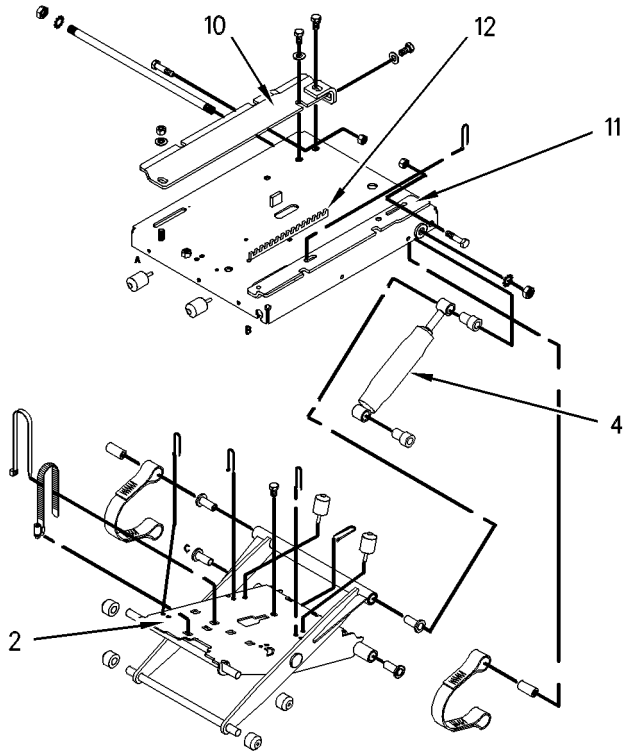


Illustration 6 g00288819

(2) Scissor arm. (4) Shock absorber. (10) Right slider track. (11) Left slider track. (12) Rack.

Right slider track (10) and left slider track (11) connect the seat assembly to the suspension. Right slider track (10) can be adjusted laterally for a snug fit. Rack (12) provides the connection to the fore and aft adjuster on the seat.

Use the following procedure to adjust the slider tracks.

1. Loosen the two fasteners on right slider track (10).

2. If additional space is needed for sliding the seat, remove the stop bolt on the front of the housing.

3. Slide the seat backward. Remove the front slider blocks if the slider blocks are worn. Clip one new slider block onto the front of each slider track if the worn slider blocks are removed. Lubricate the slider blocks with petroleum jelly or with any other approved lubricant.

4. Slide the seat forward. Remove the rear slider blocks if the slider blocks are worn. Clip one slider block onto the rear of each slider track if the worn slider blocks are removed. Lubricate the slider blocks with petroleum jelly or with any other approved lubricant.

5. Slide the seat on the slider tracks in order to make sure that the slider blocks slide within the curved ends of the frame.

6. With the seat in the back position, move the right slider track outward so that the front right slider block is flush with the inside of the curved end of the frame. Tighten the front fastener finger tight so that the slider track will not move.

7. Slide the seat forward so that the back halves of the slider tracks are exposed. Move the back of the right slider track until the slider track is flush with the inside of the curved end of the frame. Tighten the rear fastener finger tight so that the slider track will not move.

8. Slide the seat backward and recheck the positioning of the slider track at the front.

9. Move the seat back and forth in order to check for the proper sliding force of 30 ± 5 N (7 ± 1 lb). Additional adjusting of the slider track may be necessary.

Note: For uniform sliding with minimal space between the slider blocks and the curved ends of the frame, the left slider track and the right slider track must be parallel.

When the proper sliding force has been achieved and there is minimal play between the slider blocks and the curved ends of the frame, tighten the fasteners on the slider track to a torque of 47.6 N·m (35 lb ft).

10. If the stop bolt was removed, place the stop bolt in the weld nut on the front of the housing. Tighten the stop bolt.

i01171440

Contour Seat Air Suspension with Air System

SMCS Code: 7324-AJ

S/N: M921–Up

S/N: SC61–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: 1DD1–Up

S/N: 1JD1–Up

S/N: 1KD1–Up

S/N: 1YD1–Up

S/N: 2KD1–Up

S/N: 2SD1–Up

S/N: 2YD1–Up

S/N: 3ED1–Up

S/N: 3MD1–Up

S/N: 4KD1–Up

S/N: BXD1–99999

S/N: B9E1–Up

S/N: 2XF1–Up

S/N: 3ZF1–Up

S/N: 4YF1–Up

S/N: 5HF1–Up

S/N: 6CF1–Up

S/N: 6ZF1–Up

S/N: 7ZF1–Up

S/N: 8TF1–Up

S/N: 8ZF1–Up

S/N: 9RF1–Up

S/N: 9YF1–Up

S/N: AWF1–99999

S/N: 1SG1–Up

S/N: 2TG1–Up

S/N: 3YG1–Up

S/N: 4GG1–Up

S/N: 4LG1–Up

S/N: 4YG1–Up

S/N: 5MG1–Up

S/N: 66G1–Up

S/N: 6NG1–Up

S/N: 6YG1–Up

S/N: 7EG1–Up

S/N: 7KG1–Up

S/N: 86G1–Up

S/N: 8BG1–Up

S/N: 8YG1–Up

S/N: 9BG1–Up

S/N: 9MG1–Up

S/N: BXG1–Up

S/N: KEG1–Up

S/N: MHG1–Up

S/N: 1FJ1–Up

S/N: 1RJ1–Up

S/N: 1XJ1–Up

S/N: 2CJ1–Up

S/N: 2JJ1–Up

S/N: 3AJ1–Up
S/N: 3BJ1–Up
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S/N: 4DJ1–Up
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S/N: 21Z1–Up
S/N: 26Z1–Up
S/N: 2KZ1–Up
S/N: 32Z1–Up
S/N: 3TZ1–Up
S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 74Z1–Up
S/N: 92Z1–Up

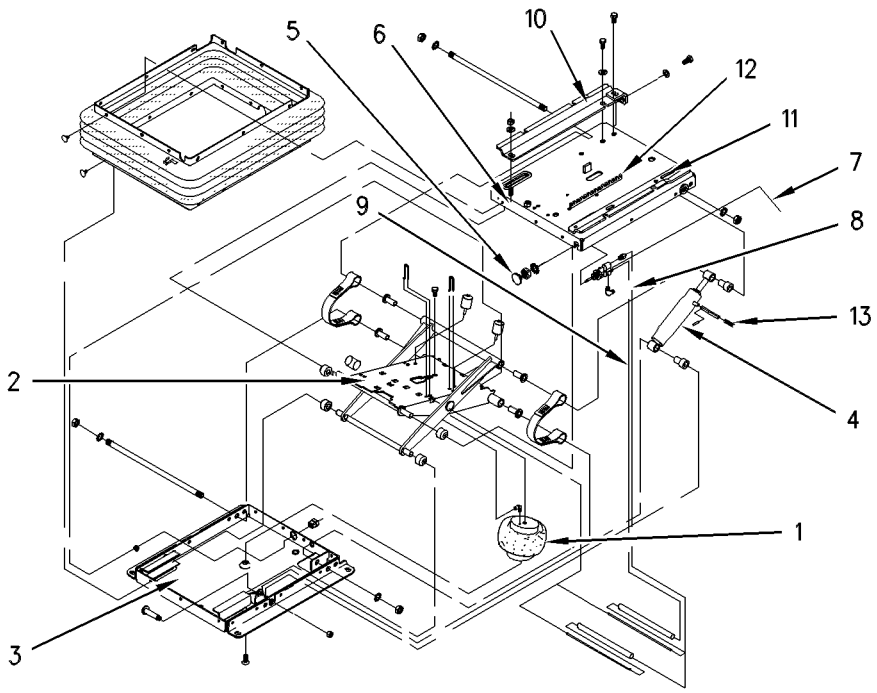


Illustration 7 g00288821

(1) Air bag. (2) Scissor arm. (3) Lower housing. (4) Shock absorber. (5) Air valve knob. (6) Indicator. (7) Exhaust line. (8) Intake hose. (9) Inlet line for the air bag. (10) Right slider track. (11) Left slider track. (12) Rack. (13) Adjustment knob.

The suspension of the seat performs several functions:

- Isolation
- Automatic Weight Adjustment
- Height Adjustment
- Connection to the Seat

Isolation and Weight Adjustment

Air bag (1) acts as a spring as the air is compressed due to the motion of inner scissor arm (2) relative to lower housing (3). The amount of air that is in the air bag is determined by the operator. (Refer to “Height Adjustment”.) The pressure in the air bag is determined by the weight of the operator. This provides automatic weight adjustment.

Damping is provided by shock absorber (4). The stiffness of the shock absorber may be adjusted by rotating knob (13). Turn the knob counterclockwise for more stiffness. Turn the knob clockwise for less stiffness. The knob does not have much range of movement.

Height Adjustment

The height of the seat is determined by the volume of air in the air bag (1). To raise the suspension, the operator pushes in air valve knob (5) and air enters the air bag (1). To lower the suspension, the operator pulls out air valve knob (5) and the air in the air bag (1) is released.

Note: The operator must not change the height of the suspension so that the stroke is inadequate for the particular application. The suspension height must be changed if the seat bottoms out excessively or if the seat bounces to the maximum height too much.

Indicator (6) must be aligned in the green zone when the machine is not running.

When air valve knob (5) is pushed in, a port opens for incoming pressurized air through air intake hose (8) and through air inlet line (9).

When air valve knob (5) is pulled out, a port from inlet line (9) to exhaust line (7) is opened.

Connection to the Seat

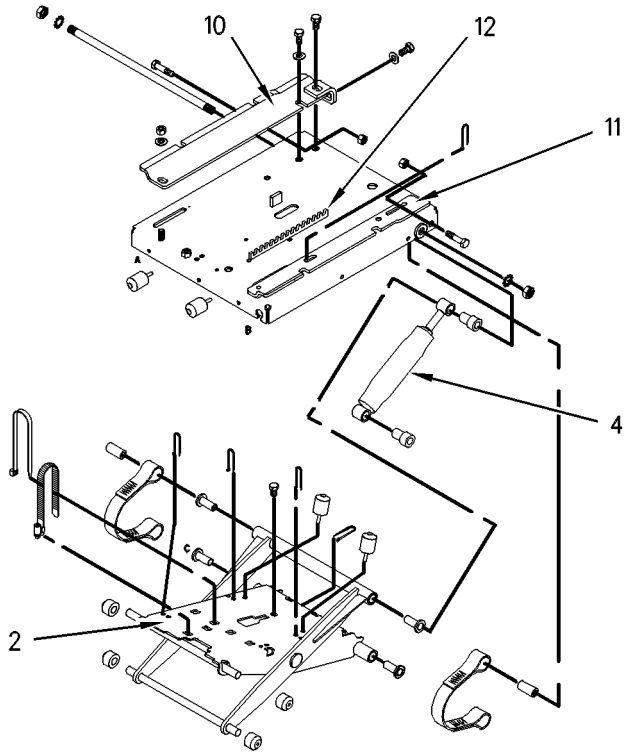


Illustration 8 g00288819

(2) Scissor arm. (4) Shock absorber. (10) Right slider track. (11) Left slider track. (12) Rack.

Right slider track (10) and left slider track (11) connect the seat assembly to the suspension. Right slider track (10) can be adjusted laterally for a snug fit. Rack (12) provides the connection to the fore and aft adjuster on the seat.

Use the following procedure to adjust the slider tracks.

1. Loosen the two fasteners on right slider track (10).

2. If additional space is needed for sliding the seat, remove the stop bolt on the front of the housing.

3. Slide the seat backward. Remove the front slider blocks if the slider blocks are worn. Clip one new slider block onto the front of each slider track if the worn slider blocks are removed. Lubricate the slider blocks with petroleum jelly or with any other approved lubricant.

4. Slide the seat forward. Remove the rear slider blocks if the slider blocks are worn. Clip one slider block onto the rear of each slider track if the worn slider blocks are removed. Lubricate the slider blocks with petroleum jelly or with any other approved lubricant.

5. Slide the seat on the slider tracks in order to make sure that the slider blocks slide within the curved ends of the frame.

6. With the seat in the back position, move the right slider track outward so that the front right slider block is flush with the inside of the curved end of the frame. Tighten the front fastener finger tight so that the slider track will not move.

7. Slide the seat forward so that the back halves of the slider tracks are exposed. Move the back of the right slider track until the slider track is flush with the inside of the curved end of the frame. Tighten the rear fastener finger tight so that the slider track will not move.

8. Slide the seat backward and recheck the positioning of the slider track at the front.

9. Move the seat back and forth in order to check for the proper sliding force of 30 ± 5 N (7 ± 1 lb). Additional adjusting of the slider track may be necessary.

Note: For uniform sliding with minimal space between the slider blocks and the curved ends of the frame, the left slider track and the right slider track must be parallel.

When the proper sliding force has been achieved and there is minimal play between the slider blocks and the curved ends of the frame, tighten the fasteners on the slider track to a torque of 47.6 N·m (35 lb ft).

10. If the stop bolt was removed, place the stop bolt in the weld nut on the front of the housing. Tighten the stop bolt.

i00643646

Contour Seat Controls

SMCS Code: 7324

S/N: M921–Up

S/N: SC61–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: 1DD1–Up

S/N: 1JD1–Up

S/N: 1KD1–Up

S/N: 1YD1–Up

S/N: 2KD1–Up

S/N: 2SD1–Up

S/N: 2YD1–Up

S/N: 3ED1–Up

S/N: 3MD1–Up

S/N: 4KD1–Up

S/N: BXD1–99999

S/N: B9E1–Up

S/N: 2XF1–Up

S/N: 3ZF1–Up

S/N: 4YF1–Up

S/N: 5HF1–Up

S/N: 6CF1–Up

S/N: 6ZF1–Up

S/N: 7ZF1–Up

S/N: 8TF1–Up

S/N: 8ZF1–Up

S/N: 9RF1–Up

S/N: 9YF1–Up

S/N: AWF1–99999

S/N: 1SG1–Up

S/N: 2TG1–Up

S/N: 3YG1–Up

S/N: 4GG1–Up

S/N: 4LG1–Up

S/N: 4YG1–Up

S/N: 5MG1–Up

S/N: 66G1–Up

S/N: 6NG1–Up

S/N: 6YG1–Up

S/N: 7EG1–Up

S/N: 7KG1–Up

S/N: 86G1–Up

S/N: 8BG1–Up

S/N: 8YG1–Up

S/N: 9BG1–Up

S/N: 9MG1–Up

S/N: BXG1–Up

S/N: KEG1–Up

S/N: MHG1–Up

S/N: 1FJ1–Up

S/N: 1RJ1–Up

S/N: 1XJ1–Up

S/N: 2CJ1–Up

S/N: 2JJ1–Up

S/N: 3AJ1–Up

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S/N: 92Z1–Up

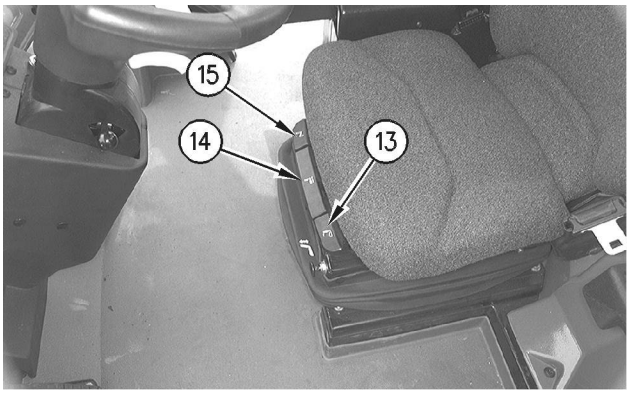


Illustration 9 g00275626

The operator pulls up on back cushion angle lever (13) in order to adjust the back cushion to the desired angle. Release the lever in order to lock the back cushion into position.

The operator pulls up on fore/aft lever (14) in order to slide the seat forward or backward to the desired position. Release the lever in order to lock the seat into position.

The operator pulls up on seat cushion tilt lever (15) in order to move the seat cushion up and down to the desired position. Release the lever in order to lock the seat cushion into position.

Contour Seat With Lumbar Option

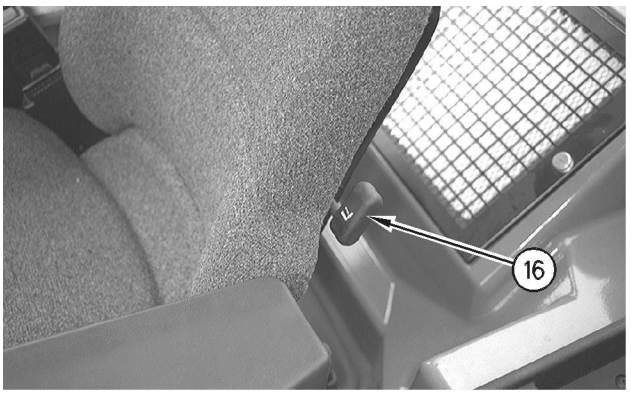


Illustration 10 g00275627

The operator pushes back lever (16) for lumbar support in order to increase support for the lower back. The operator pulls lever (16) for lumbar support forward in order to decrease support for the lower back.

Armrest Adjustment

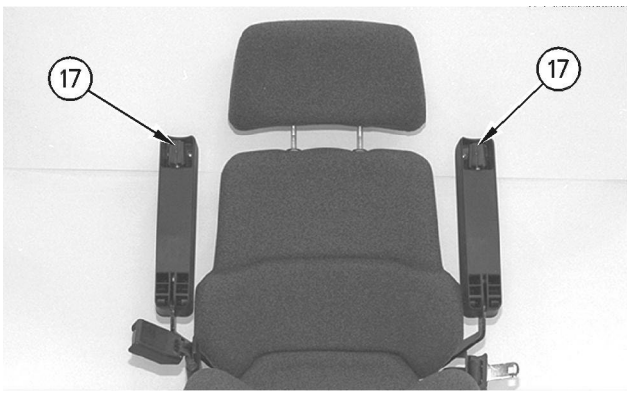


Illustration 11 g00275629

Adjustment knobs (17) for the armrests are used to adjust the angle of the armrests when the armrests are in the operating position. Rotate the knob clockwise in order to raise the angle of the armrest. Rotate the knob counterclockwise in order to lower the angle of the armrest.

Upper Back Support

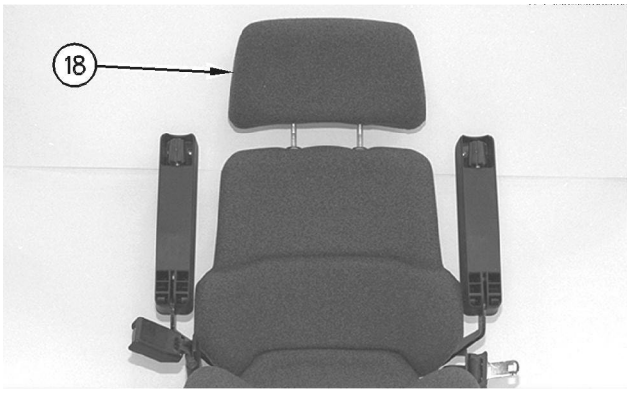


Illustration 12 g00275630

Pull up on upper back support (18) in order to remove the upper back support.

Testing And Adjusting Section

Troubleshooting

i04324431

Troubleshooting Chart

SMCS Code: 7324-035-AJ; 7324-035-ME

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S/N: M921–Up
S/N: SC61–Up
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S/N: BAA1–Up
S/N: BCA1–Up
S/N: BDA1–Up
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S/N: N1A1–Up
S/N: N4A1–Up
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S/N: 8HB1–Up
S/N: 8KB1–Up
S/N: 8PB1–Up
S/N: 9DB1–Up
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S/N: BBB1–Up
S/N: FDB1–Up
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S/N: 92Z1–Up
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S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Note: The seat belt has a maximum life of 5 years. This date starts on the day of manufacture. See the attached label that is on the seat belt for the correct manufactured date. The seat belt has an installed life of 3 years. See the installation sticker or the stamped foil tag that is on the seat belt.

Note: Check the seat and the seat suspension for looseness when the machine is serviced. Inspect the seat at every 1,000 hours of service. Adjust the seat, as needed.

Note: Use a dry lubricant to reduce wear and provide smooth operation of seat suspensions. Use 1U-8268 Dry Film Lubricant or use 9U-6331 Dry Film Lubricant in order to maintain ease of operation, especially in colder temperatures. An alternative lubricant is a locally obtained clear silicone aerosol spray.

Table 1

Troubleshooting	
Symptom	**Correction**
Upper Seat	
Lateral looseness	See Systems Operation, “Comfort Air Suspension With System Air”.
The angle of the seat cushion cannot be adjusted. The seat does not stay in position.	Inspect the seat and replace the parts, as needed. See the appropriate topic in the Disassembly and Assembly section of this manual.
Lumbar support cannot be adjusted. Lumbar support does not stay in position.	Inspect the seat and replace the parts, as needed. See the appropriate topic in the Disassembly and Assembly section of this manual.
Air Suspension	
Looseness in the suspension	Replace the rollers (if equipped). See the appropriate topic in the Disassembly and Assembly section of this manual.
Seat height cannot be adjusted.	Check the connections to the solenoid and/or to the air lines. See the appropriate topic in the Disassembly and Assembly section .
Insufficient damping	Inspect the shock absorber and the cable. Replace the shock absorber or the cable, if necessary. See the appropriate topic in the Disassembly and Assembly section of this manual for the proper procedure.
Seat height cannot be maintained.	Check the air bag and the related components for leaks. (1)

(1) Check for leaks if the air bag deflates during one shift. The air bag is designed to keep air filled for at least one shift.

Note: The 192-7848 Shock Absorber Kit is available for operators over 136 kg (300 lb) or for use in extreme operating environments. The 192-7848 Shock Absorber Kit is a dual shock absorber kit that adds additional dampening.

Disassembly and Assembly Section

i00643745

Contour Seat With Front Controls - Disassemble

SMCS Code: 7324-015

S/N: M921–Up
S/N: SC61–Up
S/N: 8GB1–Up
S/N: 8HB1–Up
S/N: 8KB1–Up
S/N: 8PB1–Up
S/N: 9DB1–Up
S/N: 2AC1–Up
S/N: 3AC1–Up
S/N: 4RC1–Up
S/N: 6FC1–Up
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S/N: 4GZ1–Up
S/N: 74Z1–Up
S/N: 92Z1–Up

Disassembly Procedure

1. Remove the contour series seat from the machine.

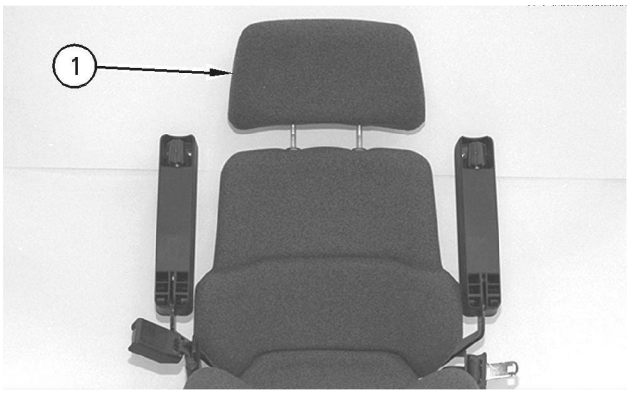


Illustration 13 g00275631

2. Remove back extension (1) from the seat assembly. The back extension is a slip fit.

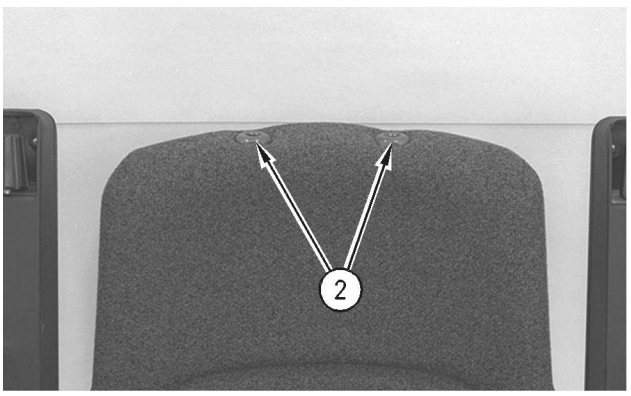


Illustration 14 g00275632

3. Remove two bushings (2) from the seat assembly. Turn each bushing counterclockwise by 1/4 of a turn in order to remove the bushings.

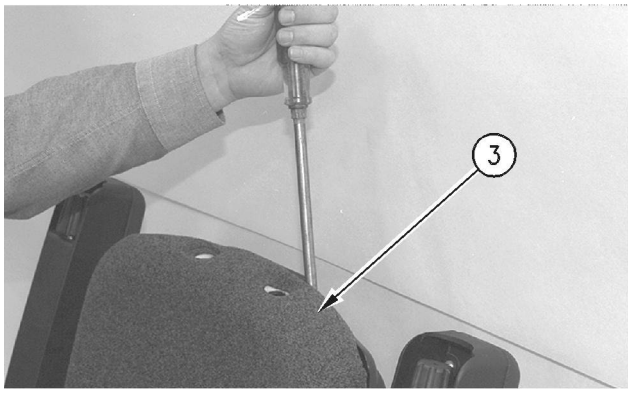


Illustration 15 g00275633

4. Use a screwdriver to carefully pry seat cushion (3) from the seat backrest.



Illustration 16 g00275634

5. Use a screwdriver to carefully pry bottom seat cushion (4) from the seat tilt pan.

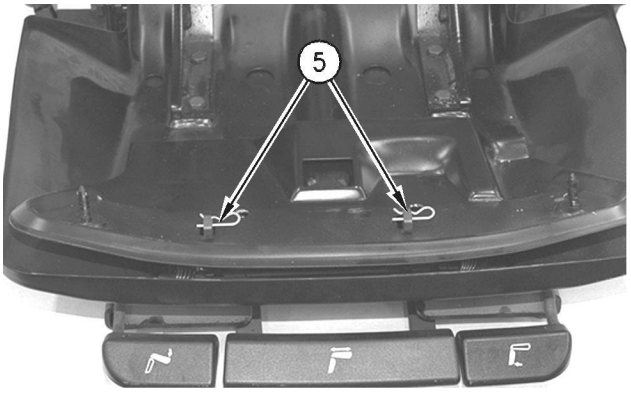


Illustration 17 g00275635

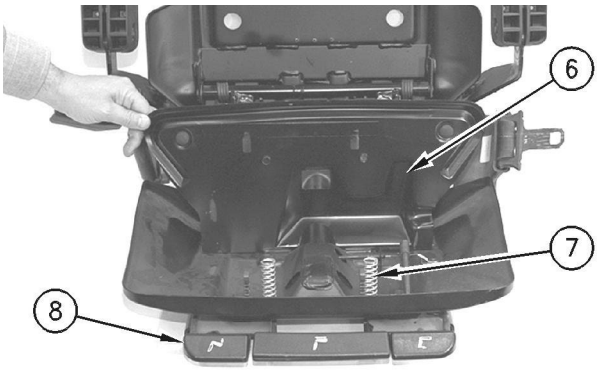


Illustration 18 g00275676

⚠ WARNING

There is spring force against the seat tilt plate. When the cotter pins are removed and the lever is raised, the spring force will be released.

To prevent personal injury, retain the seat tilt plate by hand when the cotter pins are being removed. Remove the two cotter pins and slowly release the spring force with your hand against the seat tilt plate.

6. While you hold down seat tilt plate (6), remove two cotter pins (5). Slowly release the spring force against seat tilt plate (6). Pull up on seat cushion tilt lever (8) and remove seat tilt plate (6). Remove two springs (7) from the seat tilt pan.

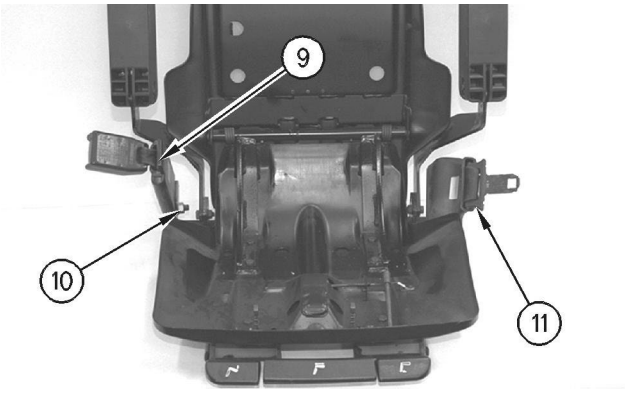


Illustration 19 g00275677

7. Remove the nut and bolt (10) that holds comfort ride sleeve (9) to the seat. Remove comfort ride sleeve (9). Remove the bolt that holds seat belt retractor (11) to the seat. Remove seat belt retractor (11).

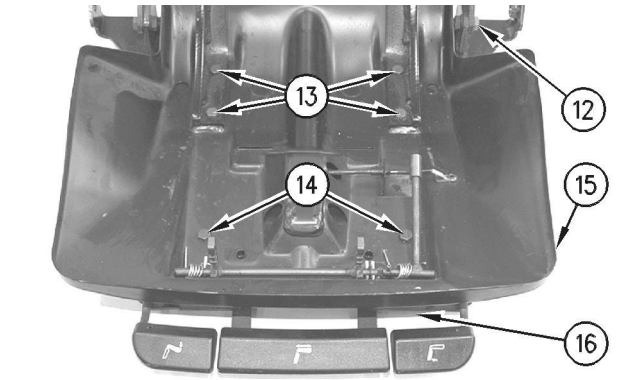


Illustration 20 g00275678

8. Remove two bolts (12) and the locknuts. Remove six bolts (13) and (14), and separate seat pan assembly (15) and the seat backrest from upper slide plate (16).

9. Lift lever (A) in order to allow the seat backrest to pivot forward.

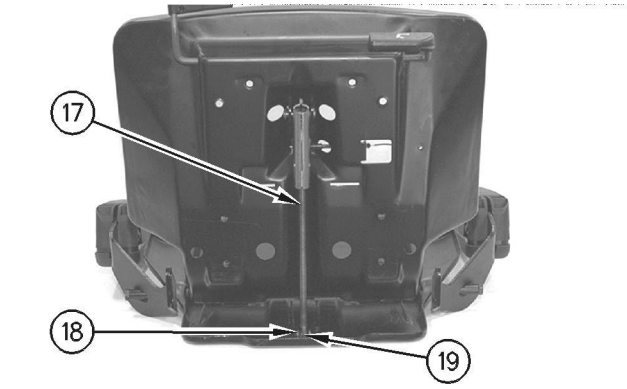


Illustration 21 g00275679

10. Remove retainer clip (18) and pin (19) from each end of seat back angling adjuster (17).

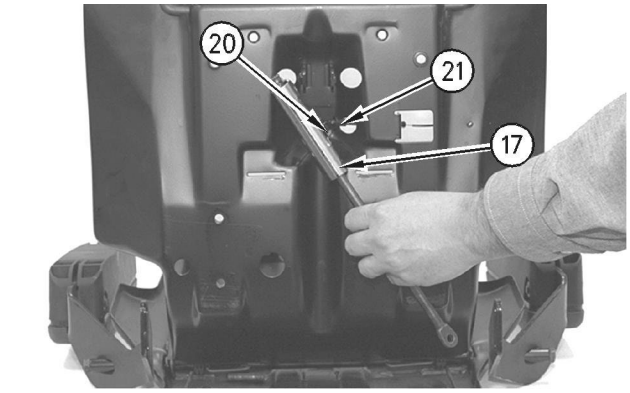


Illustration 22 g00275680

11. Remove retainer clip (20) and cable (21) as a unit from the spring lever. Remove retainer clip (20) and separate seat back angling adjuster (17) from cable (21).

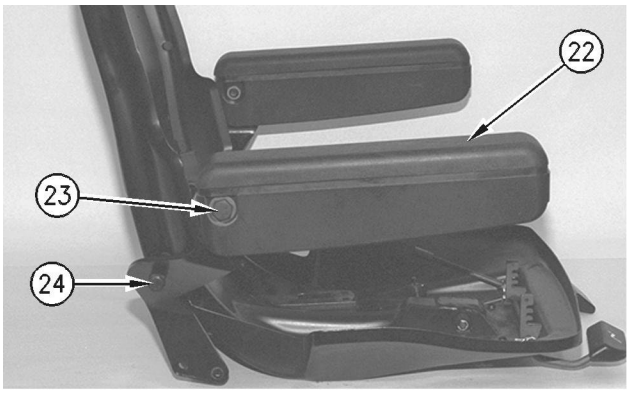


Illustration 23 g00275681

Note: When the armrests are removed, the back panel and springs will be removed at the same time.

12. Remove bolt (24). Remove bolt (23) and the lock washer. Remove right armrest (22), the spacer and the bushing.

13. Use the procedure in Step 12 to remove the left armrest.

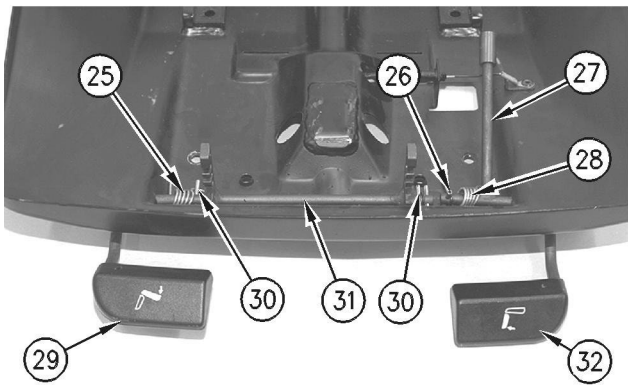


Illustration 24 g00275682

14. Remove handle (32) from lever assembly (27). Remove roll pin (26) from lever assembly (27). Slide the lever to the outboard side of the seat in order to disengage the lever from inside pivot tab (B). Slide spring (28) from the lever. Remove lever assembly (27) from the seat pan assembly.

15. Remove handle (29) from seat cushion tilt lever assembly (31). Disengage spring (25) from the roll pin in order to relieve spring pressure. Remove three roll pins (30) from seat cushion tilt lever assembly (31). Slide spring (25) from the lever. Remove seat cushion tilt lever assembly (31) from the seat pan assembly.

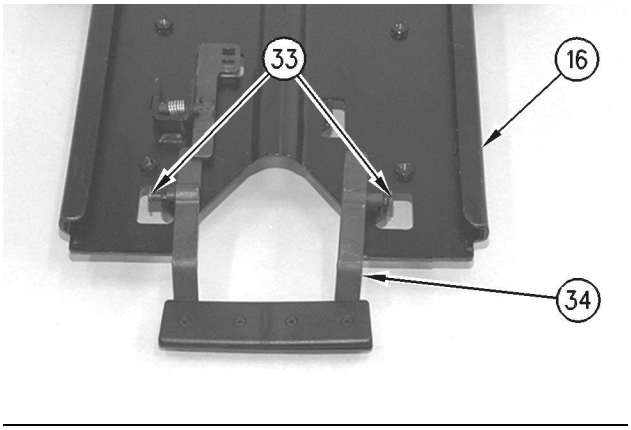


Illustration 25 g00275683

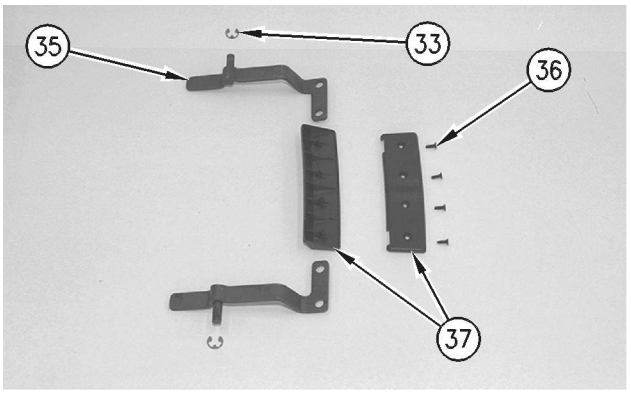


Illustration 26 g00275684

16. Remove two retainer clips (33). Remove handle assembly (34) from upper slide plate (16).

17. Disassemble handle assembly (34) for fore and aft positioning by removing four screws (36). Then, separate handle (37) from lever assemblies (35).

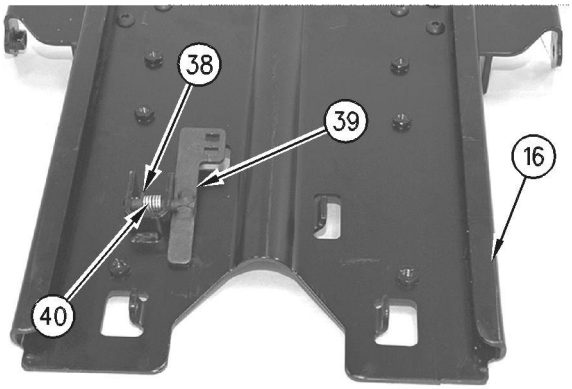


Illustration 27 g00275685

18. Unhook spring (40) in order to relieve spring force. Remove pin (38). Remove slide lever/lock shaft (39) and spring (40) from upper slide plate (16).

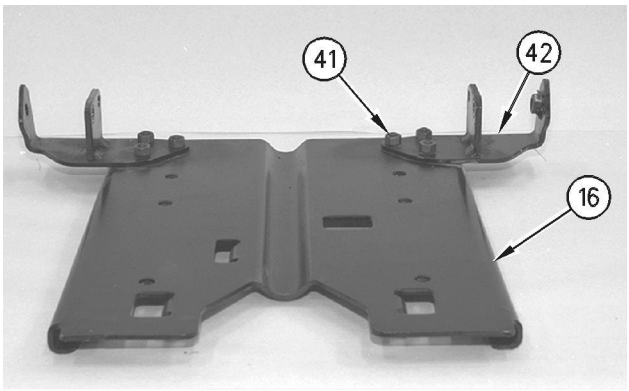


Illustration 28 g00275686

19. Turn upper slide plate (16) onto the opposite side. Remove six bolts (41), the locknuts and two brackets (42).

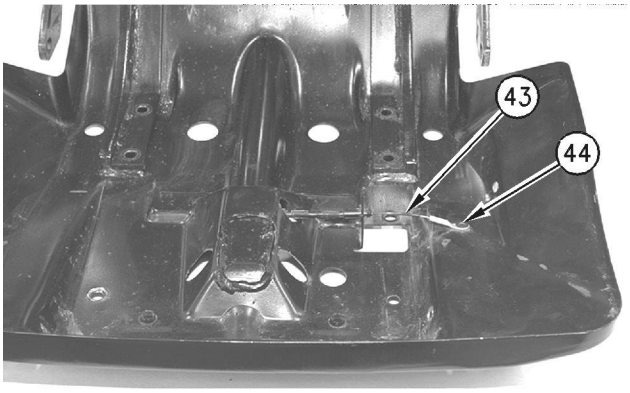


Illustration 29 g00275687

20. Drill out rivet (44). Remove cable assembly (43) from the seat pan assembly.

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Contour Seat With Front Controls - Assemble

SMCS Code: 7324-016

S/N: M921–Up

S/N: SC61–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

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S/N: 9TC1–Up

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S/N: 4GZ1–Up

S/N: 74Z1–Up

S/N: 92Z1–Up

Assembly Procedure

1. Check the condition of all parts of the contour series seat. If any of the parts are worn or damaged, install new parts.

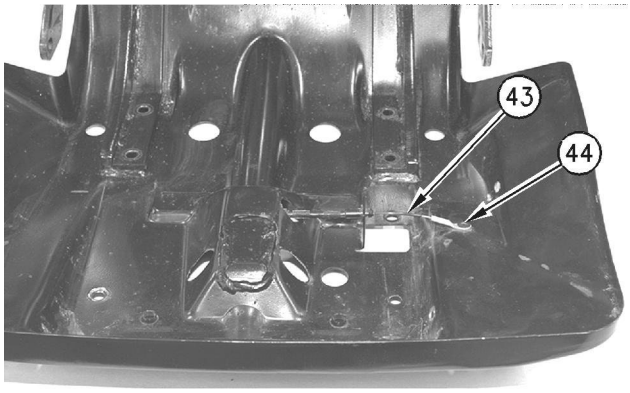


Illustration 30 g00275687

2. Install cable assembly (43) in the seat pan assembly. Install rivet (44).

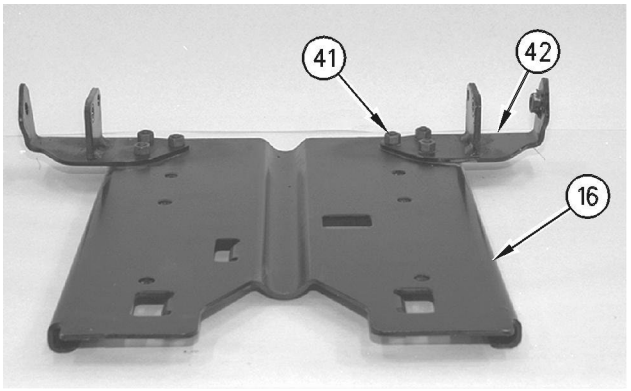


Illustration 31 g00275686

3. Install two brackets (42), the locknuts and six bolts (41) on the bottom of upper slide plate (16).

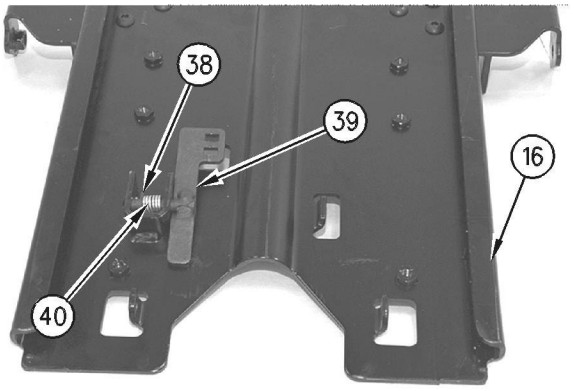


Illustration 32 g00275685

4. Install slide lever/lock shaft (39) and spring (40) on upper slide plate (16). Install pin (38). Hook up spring (40).

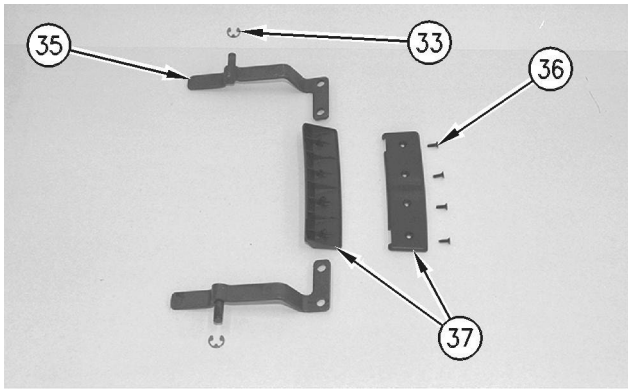


Illustration 33 g00275684

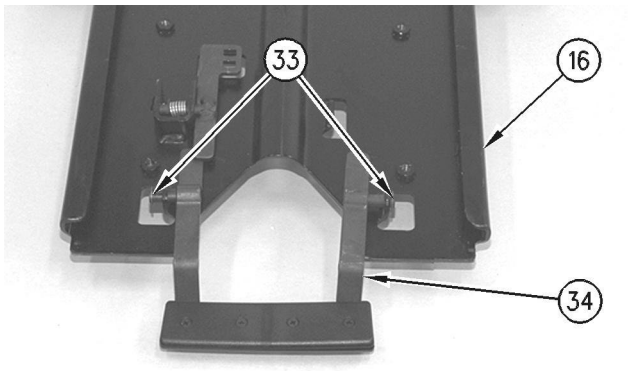


Illustration 34 g00275683

5. Install handle assembly (34) on upper slide plate (16). Install two retainer clips (33).

6. Install handle (37) on lever assemblies (35). Assemble handle assembly (34) for fore and aft positioning by installing four screws (36).

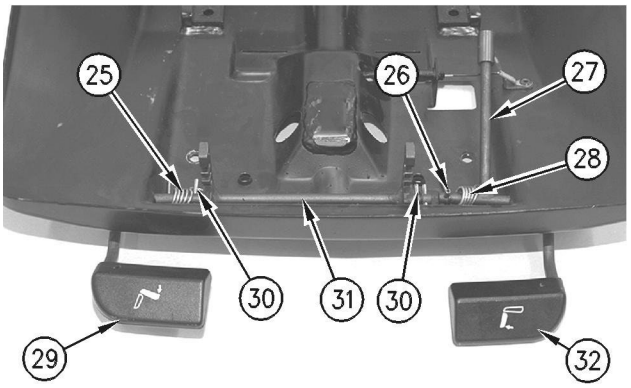


Illustration 35 g00275682

7. Install seat cushion tilt lever assembly (31) on the seat pan assembly. Slide spring (25) into the lever. Install three roll pins (30) in seat cushion tilt lever assembly (31). Hook up spring (25) to the roll pin. Install handle (29) on seat cushion tilt lever assembly (31).

8. Install lever assembly (27) for seat cushion adjustment on the seat pan assembly. Slide spring (28) into the lever. Slide the lever to the inboard side of the seat in order to engage the lever with inside tab (B). Install roll pin (26) in lever assembly (27). Install handle (32) in lever assembly (27).

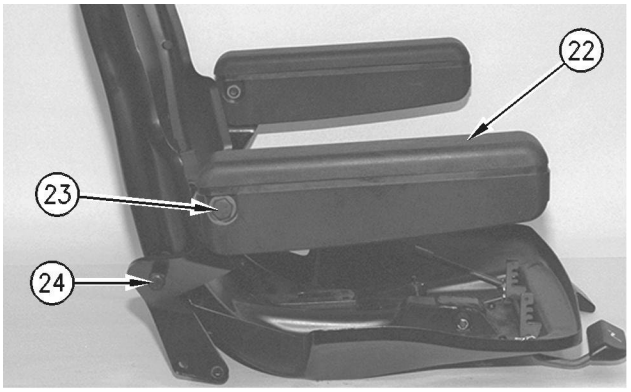


Illustration 36 g00275681

Note: When the armrests are removed, the back panel and springs will be removed at the same time.

9. Install the bushing, the spacer and left armrest (22). Install bolt (23) and the lock washer. Install bolt (24).

10. Use the procedure in Step 9 to install the right armrest.

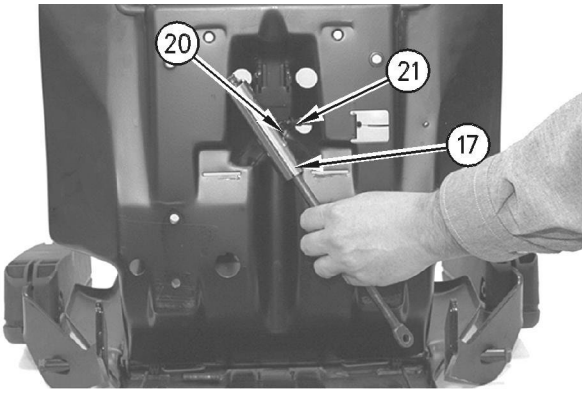


Illustration 37 g00275680

11. Hook up adjuster (17) for the seat back to cable (21) and install retainer clip (20). Install retainer clip (20) and cable (21) as a unit in the spring lever.

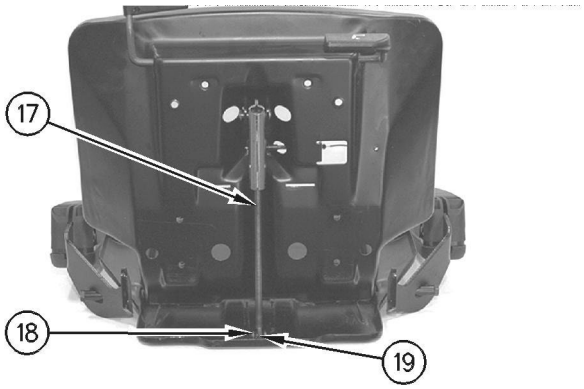


Illustration 38 g00275679

12. Install pin (19) and retainer clip (18) on each end of adjuster (17).

13. Lift lever (A) in order to allow the seat backrest to pivot backward.

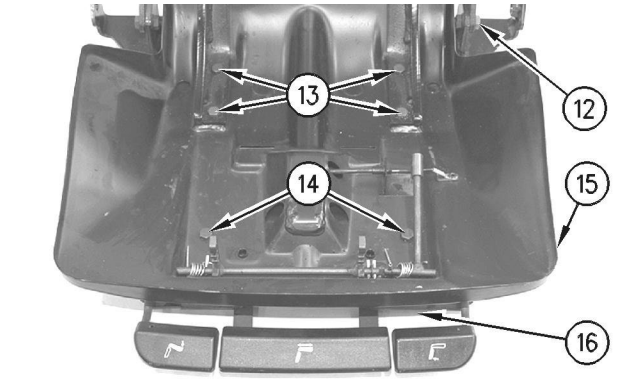


Illustration 39 g00275678

14. Install the seat backrest and seat pan assembly (15) on upper slide plate (16). Install six bolts (13) and (14). Install two bolts (12) and the locknuts.

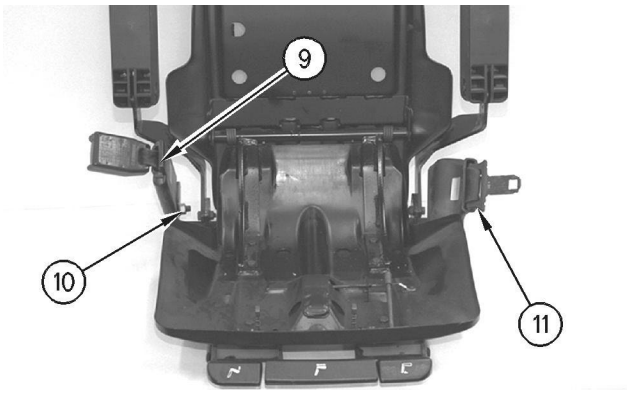


Illustration 40 g00275677

15. Install seat belt retractor (11). Install the bolt that holds seat belt retractor (11) to the seat. Install comfort ride sleeve (9). Install the nut and bolt (10) that holds comfort ride sleeve (9) to the seat.

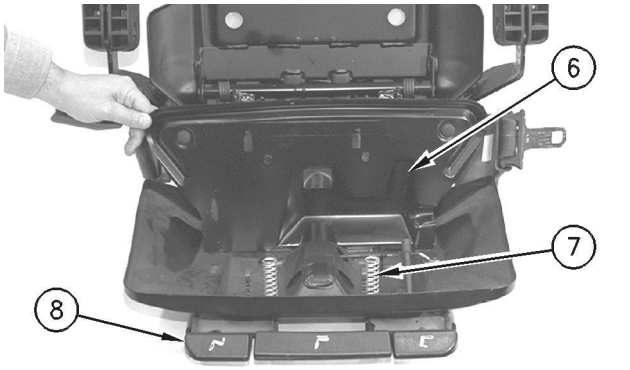


Illustration 41 g00275676

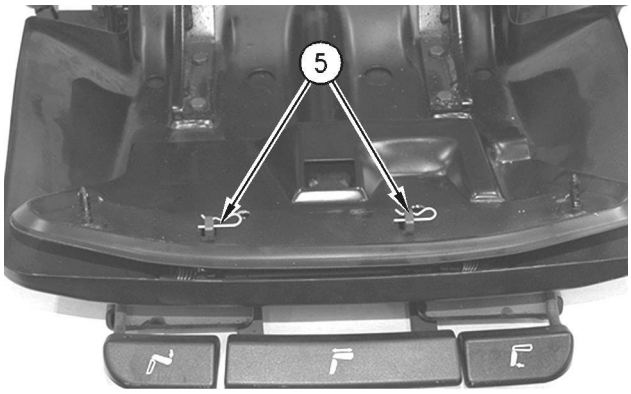


Illustration 42 g00275635

⚠ WARNING

There is spring force against the seat tilt plate when the seat tilt plate is being installed.

To prevent personal injury, retain the seat tilt plate by hand during installation.

16. Install two springs (7) in the plate. Pull up on seat cushion tilt lever (8) and install plate (6). Hold down plate (6) and install two cotter pins (5).



Illustration 43 g00275634

17. Install bottom seat cushion (4) on the seat tilt pan.

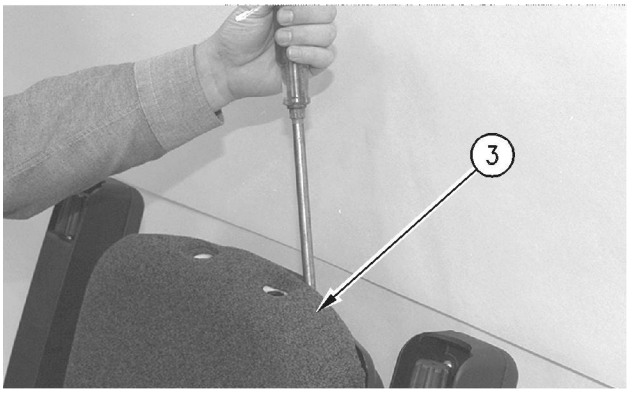


Illustration 44 g00275633

18. Install seat cushion (3) on the seat backrest.

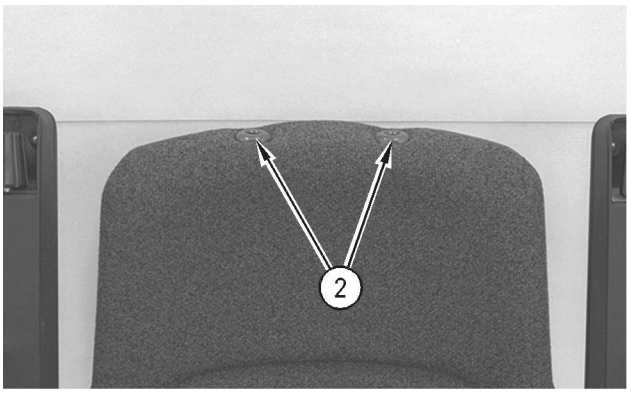


Illustration 45 g00275632

19. Install two bushings (2) on the seat assembly. Turn each bushing clockwise by 1/4 of a turn in order to install the bushings.

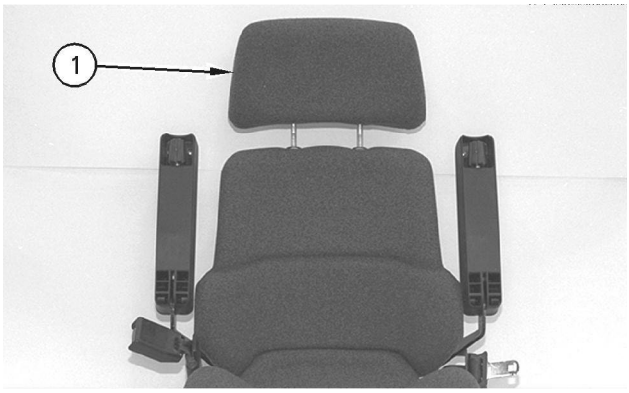


Illustration 46 g00275631

20. Install back extension (1) on the seat assembly. The back extension is a slip fit.

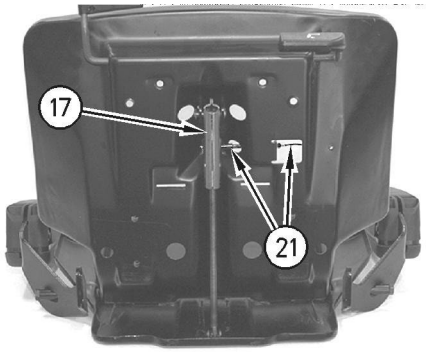


Illustration 47 g00713003

21. Adjust the cable to the proper position after the seat has been assembled. Use the adjuster (17) in order to adjust the cable. The cable should not be tight. A small amount of slack should be present in the cable. The cable should move slightly before the seat will recline.

22. Install the contour series seat in the machine.

i00643854

Contour Seat With Lumbar Option and Side Controls - Disassemble

SMCS Code: 7324-015

S/N: M921–Up

S/N: SC61–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: 1DD1–Up

S/N: 1JD1–Up

S/N: 1KD1–Up

S/N: 1YD1–Up

S/N: 2KD1–Up

S/N: 2SD1–Up

S/N: 2YD1–Up

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Disassembly Procedure

1. Remove the contour series seat from the machine.

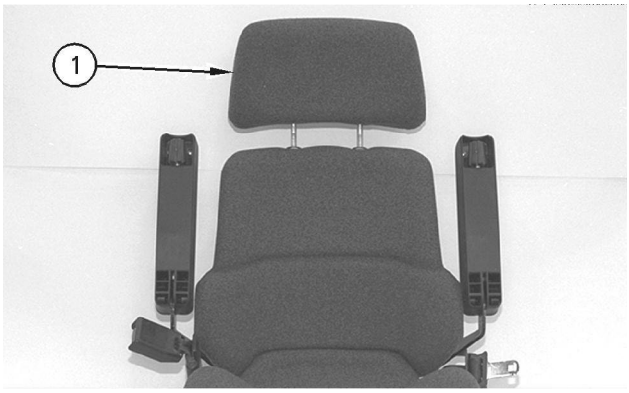


Illustration 48 g00275631

2. Remove back extension (1) from the seat assembly. The back extension is a slip fit.

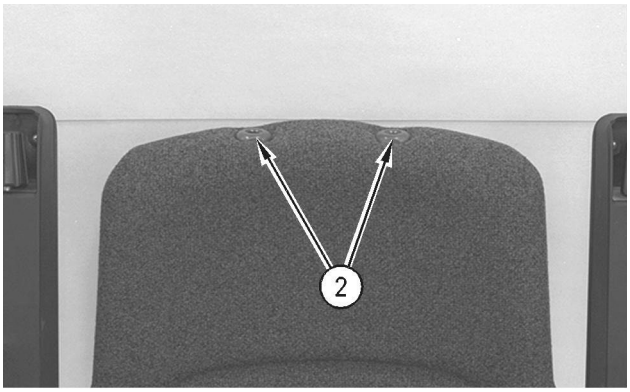


Illustration 49 g00275632

3. Remove two bushings (2) from the seat assembly. Turn each bushing counterclockwise by 1/4 of a turn in order to remove the bushings.

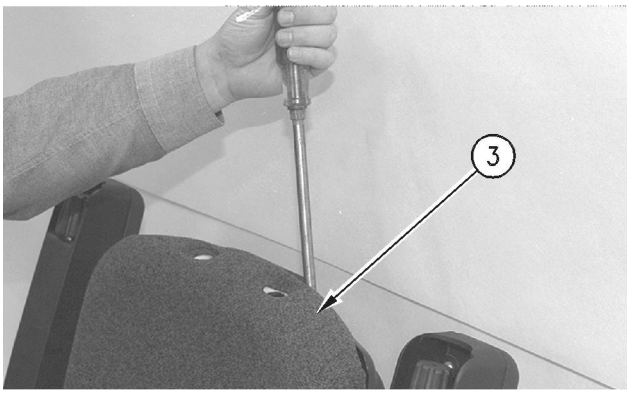


Illustration 50 g00275633

4. Use a screwdriver to carefully pry seat cushion (3) from the seat backrest.

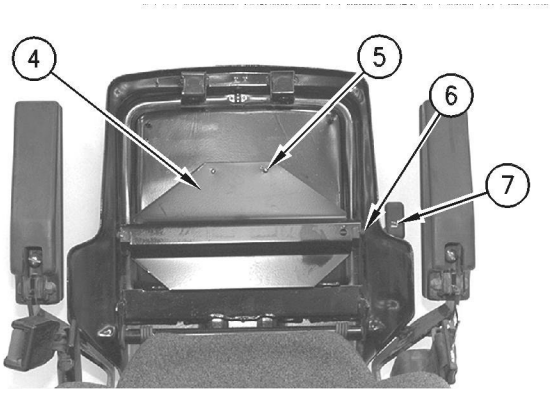


Illustration 51 g00275688

5. Remove rivets (5) in order to remove lumbar plate (4) from the seat backrest. Remove two pins (6), two spacer blocks (7), the adjustment rod and two cams from the seat backrest.

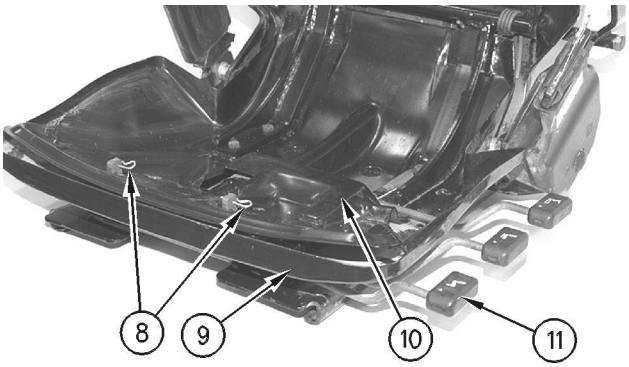


Illustration 52 g00275689

⚠ WARNING

There is spring force against the seat lift plate. When the cotter pins are removed and the lever is raised, the spring force will be released.

To prevent personal injury, retain the seat lift plate by hand when the cotter pins are being removed. Remove the two cotter pins and slowly release the spring force with your hand against the seat lift plate.

6. Use a screwdriver to carefully pry the bottom seat cushion from seat pan assembly (9). While you hold down seat lift plate (10), remove two cotter pins (8). Slowly release the spring force against seat lift plate (10). Pull up on seat cushion tilt lever (11) and remove seat lift plate (10).

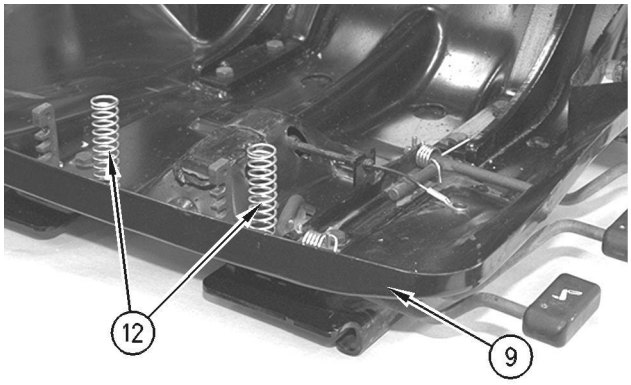


Illustration 53 g00275690

7. Remove two springs (12) from seat pan assembly (9).

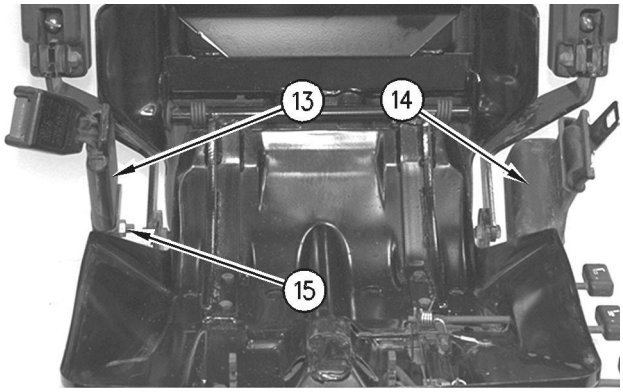


Illustration 54 g00275691

8. Remove the nut and bolt (15) that holds comfort ride sleeve (13) to the seat. Remove comfort ride sleeve (13). Remove the bolt that holds seat belt retractor (14) to the seat. Remove seat belt retractor (14).

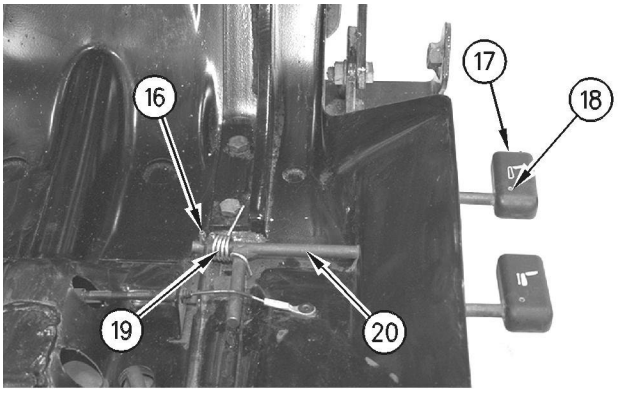


Illustration 55 g00275692

9. Remove pin (18) from seat back adjustment knob (17). Remove seat back adjustment knob (17). Remove two pins (16) from seat back adjustment shaft (20). Slide spring (19) from seat back adjustment shaft (20). Remove seat back adjustment shaft (20).

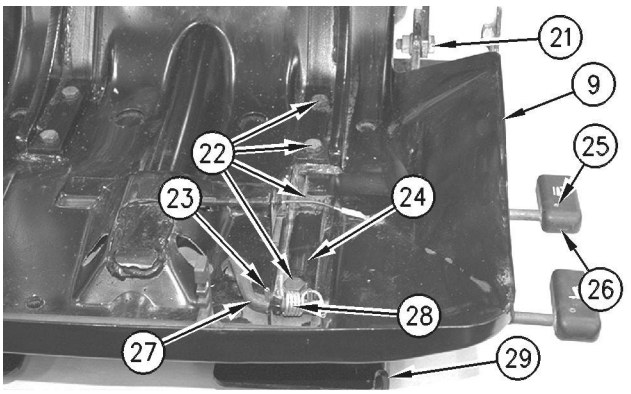


Illustration 56 g00275693

10. Remove seven bolts (22) from the seat pan assembly. Remove two bolts (21) and the locknuts from the brackets on both sides of the seat. Separate seat pan assembly (9) and the seat backrest from upper slide plate (29).

11. Remove pin (25) from fore and aft adjustment knob (26). Remove fore and aft adjustment knob (26). Remove three pins (23) from fore and aft adjustment shaft (27). Remove bracket (24), fore and aft adjustment shaft (27) and spring (28) from the seat pan assembly.

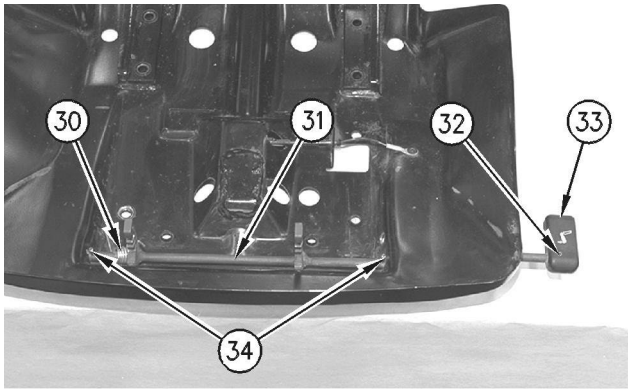


Illustration 57 g00275694

12. Remove pin (32) from seat cushion tilt knob (33). Remove two pins (34) from seat cushion tilt shaft (31). Slide spring (30) from the seat cushion tilt shaft. Remove seat cushion tilt shaft (31) from the seat pan assembly.

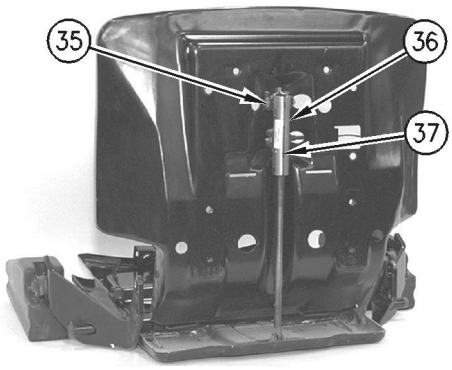


Illustration 58 g00275695

13. Relieve the spring pressure of the spring on the back pan assembly. Remove retainer clip (35) and pin (36) from each end of seat back angling adjuster (37).

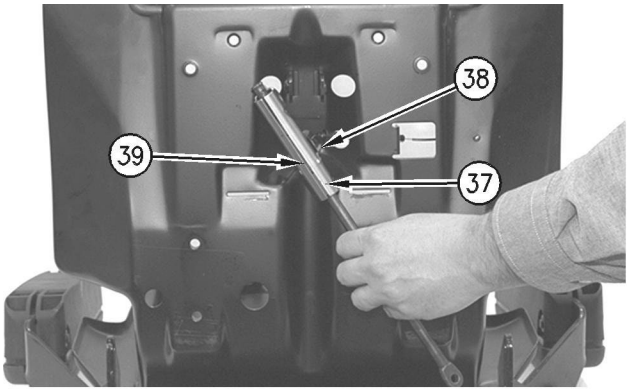


Illustration 59 g00275736

14. Remove retainer clip (39) and cable (38) as a unit from the spring lever. Remove retainer clip (39) and seat back angling adjuster (37) from cable (38).

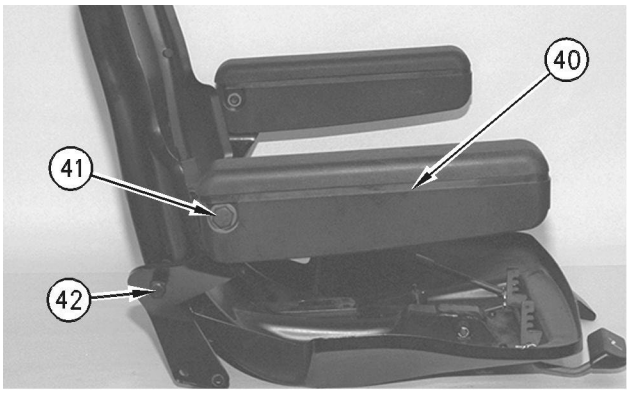


Illustration 60 g00275737

Note: When the armrests are removed, the back panel and springs will be removed at the same time.

15. Remove bolt (42). Remove bolt (41) and the lock washer. Remove right armrest (40), the spacer and the bushing.

16. Use the procedure in Step 15 to remove the left armrest.

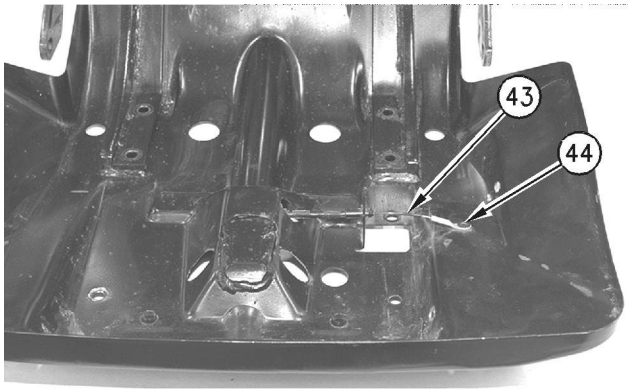


Illustration 61 g00275687

17. Remove rivet (44). Remove cable assembly (43) from the seat pan assembly.

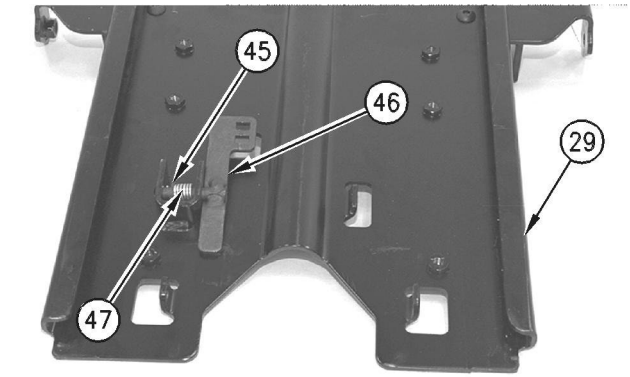


Illustration 62 g00275738

18. Remove pin (45) from slide lever/lock shaft (46). Remove slide lever/lock shaft (46) and spring (47) from upper slide plate (29).

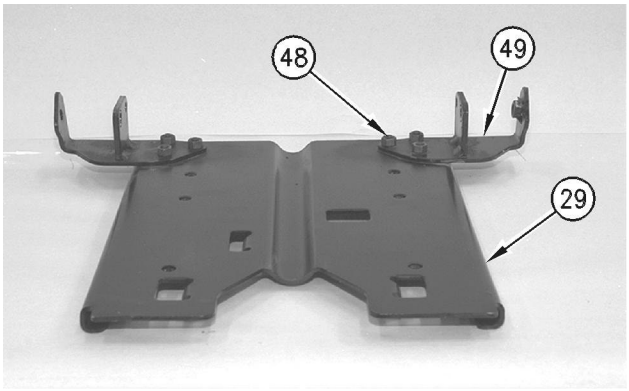


Illustration 63 g00275739

19. Turn upper slide plate (29) onto the opposite side. Remove six bolts (48), the locknuts and two brackets (49).

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Contour Seat With Lumbar Option and Side Controls - Assemble

SMCS Code: 7324-016

S/N: M921–Up

S/N: SC61–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

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S/N: 8YC1–Up

S/N: 9HC1–Up

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S/N: 17Z1–Up

S/N: 18Z1–Up

S/N: 21Z1–Up

S/N: 26Z1–Up

S/N: 2KZ1–Up

S/N: 32Z1–Up

S/N: 3TZ1–Up

S/N: 48Z1–Up

S/N: 4GZ1–Up

S/N: 74Z1–Up

S/N: 92Z1–Up

Assembly Procedure

1. Check the condition of all parts of the contour series seat. If any of the parts are worn or damaged, install new parts.

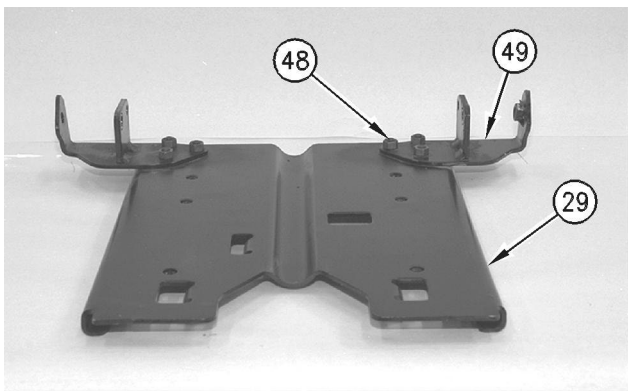


Illustration 64 g00275739

2. Install six bolts (48), the locknuts and two brackets (49) on the bottom of upper slide plate (29).

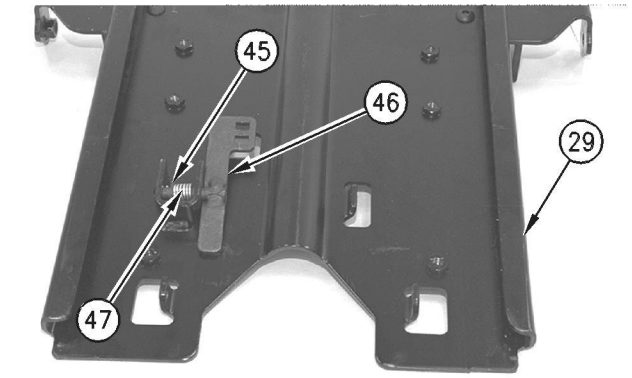


Illustration 65 g00275738

3. Install slide lever/lock shaft (46) and spring (47) on upper slide plate (29). Install pin (45) on slide lever/lock shaft (46).

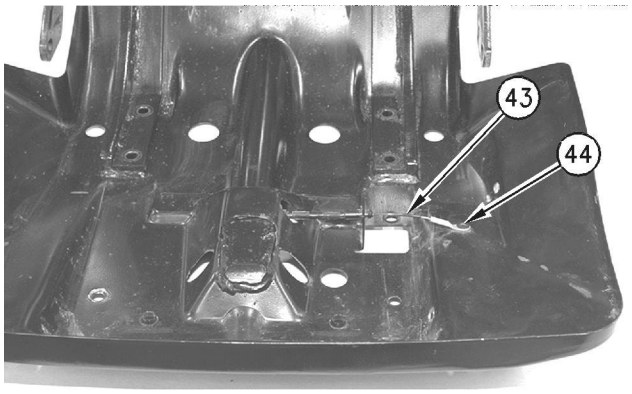


Illustration 66 g00275687

4. Install cable assembly (43) on the seat pan assembly. Install rivet (44).

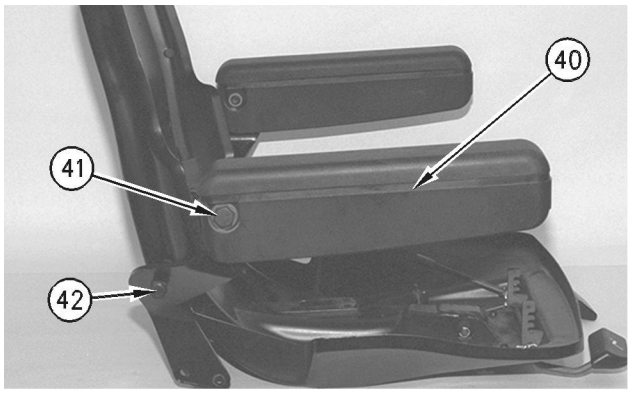


Illustration 67 g00275737

Note: When the armrests are removed, the back panel and springs will be removed at the same time.

5. Install the bushing, the spacer and left armrest (40). Install the lock washer and bolt (41). Install bolt (42).

6. Use the procedure in Step 5 to install the right armrest.

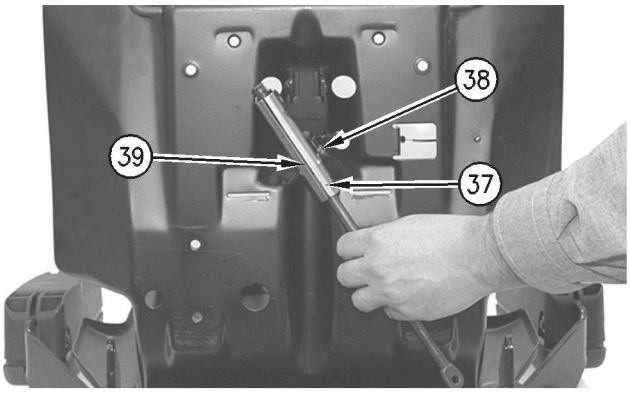


Illustration 68 g00275736

7. Install adjuster (37) and retainer clip (39) on cable (38). Install retainer clip (39) and cable (38) as a unit on the spring lever.

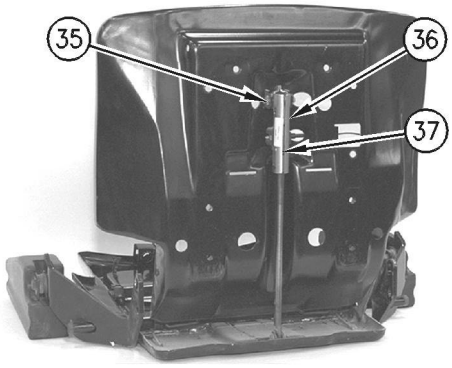


Illustration 69 g00275695

8. Install pin (36) and retainer clip (35) on each end of adjuster (37).

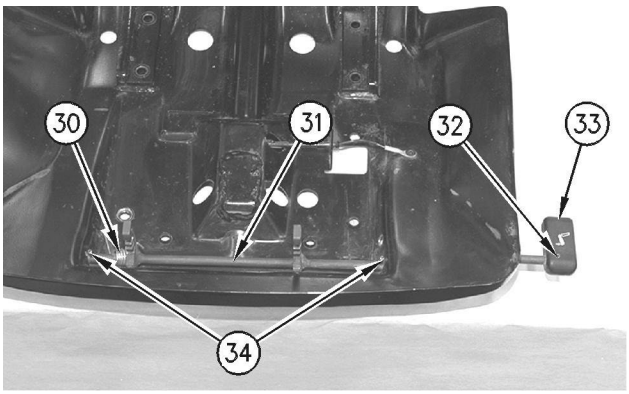


Illustration 70 g00275694

9. Install seat cushion tilt shaft (31) on the seat pan assembly. Slide spring (30) onto the seat cushion tilt shaft. Install two pins (34) in seat cushion tilt shaft (31). Install pin (32) in seat cushion tilt knob (33).

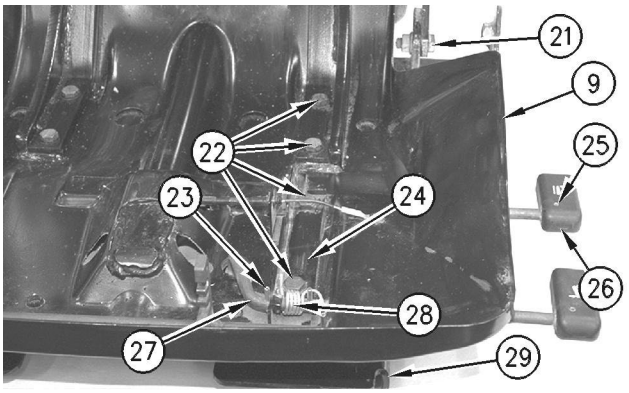


Illustration 71 g00275693

10. Install spring (28), fore and aft adjustment shaft (27), and bracket (24) on the seat pan assembly. Install three pins (23) in fore and aft adjustment shaft (27). Install fore and aft adjustment knob (26). Install pin (25) in fore and aft adjustment knob (26).

11. Install seat pan assembly (9) and the seat backrest on upper slide plate (29). Install two bolts (21) and the locknuts on the brackets on both sides of the seat. Install seven bolts (22) on the seat pan assembly.

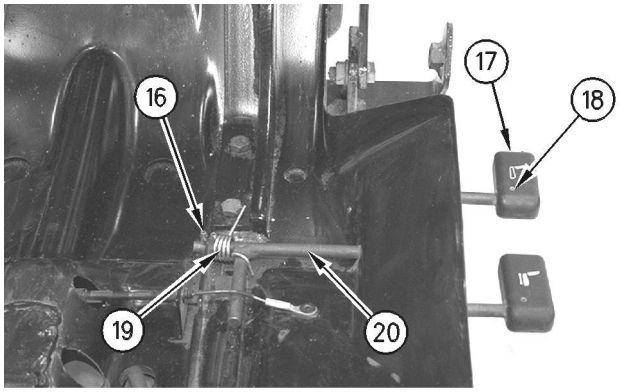


Illustration 72 g00275692

12. Install shaft (20). Slide spring (19) onto shaft (20). Install two pins (16) in shaft (20). Install seat back adjustment knob (17). Install pin (18) in seat back adjustment knob (17).

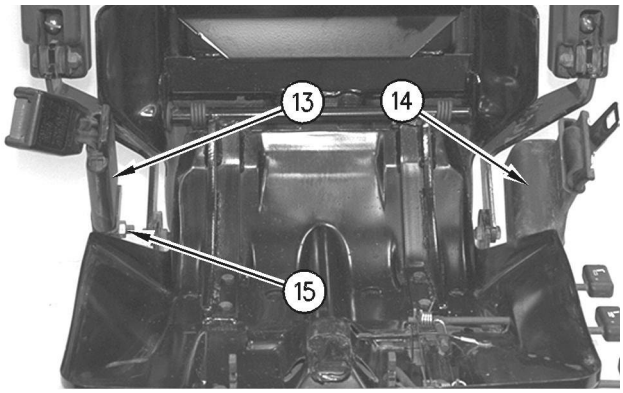


Illustration 73 g00275691

13. Install seat belt retractor (14). Install the bolt that holds seat belt retractor (14) to the seat. Install comfort ride sleeve (13). Install the nut and bolt (15) that holds comfort ride sleeve (13) to the seat.

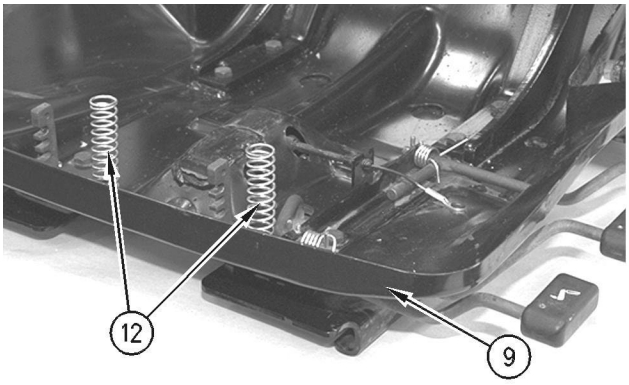


Illustration 74 g00275690

14. Install two springs (12) on seat pan assembly (9).

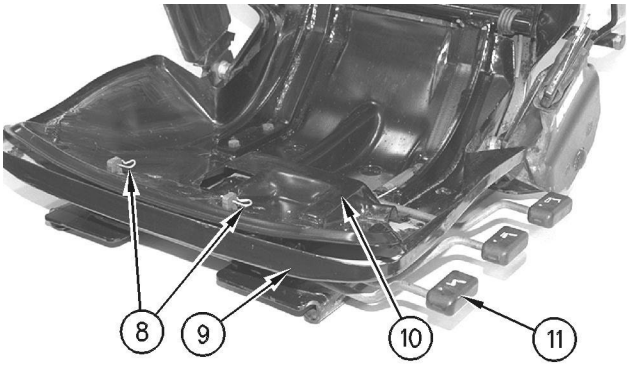


Illustration 75 g00275689

⚠ WARNING

There is spring force against the seat lift plate when the seat lift plate is being installed.

To prevent personal injury, retain the seat lift plate by hand during installation.

15. Pull up on seat cushion tilt lever (11) and install seat lift plate (10). While you hold down seat lift plate (10), install two cotter pins (8). Install the bottom seat cushion on seat pan assembly (9).

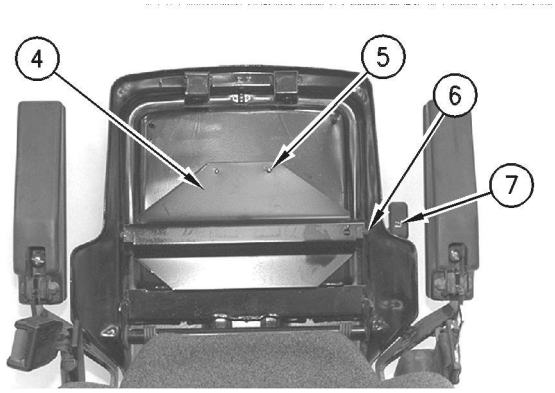


Illustration 76 g00275688

16. Install two cams, the adjustment rod, two spacer blocks (7) and two pins (6) on the seat backrest. Install lumbar plate (4) on the seat backrest and install rivets (5).

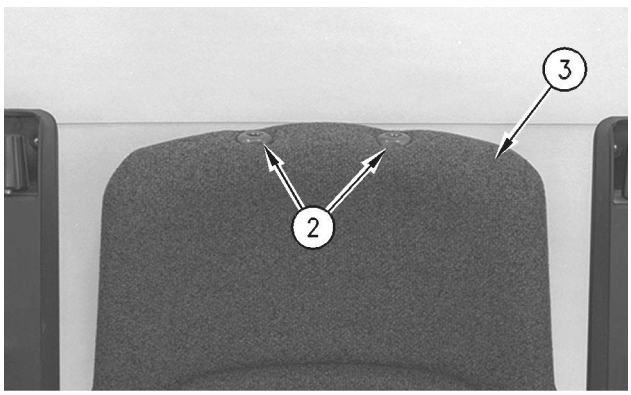


Illustration 77 g00287944

17. Install seat cushion (3) on the seat backrest.

18. Install two bushings (2) on the seat assembly. Turn each bushing clockwise by 1/4 of a turn in order to install the bushings.

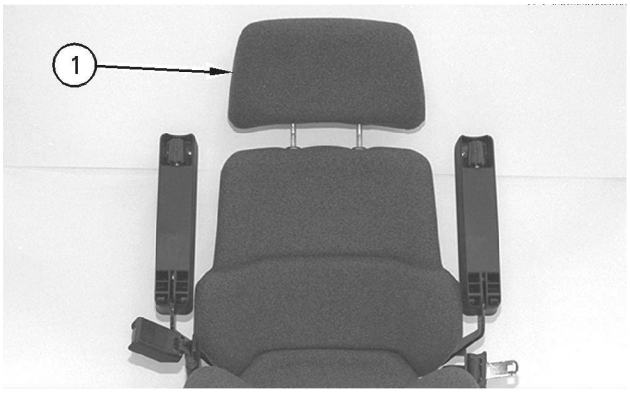


Illustration 78 g00275631

19. Install back extension (1) on the seat assembly. The back extension is a slip fit.

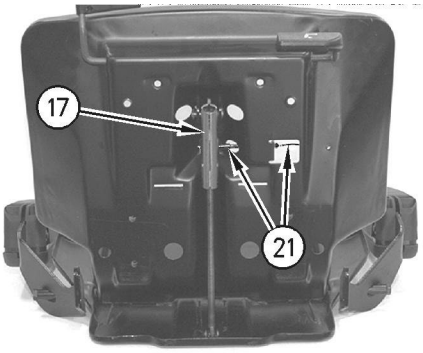


Illustration 79 g00713003

20. Adjust the cable to the proper position after the seat has been assembled. Use the adjuster (17) in order to adjust the cable. The cable should not be tight. A small amount of slack should be present in the cable. The cable should move slightly before the seat will recline.

21. Install the contour series seat in the machine.

i01510918

Swivel Seat - Disassemble

SMCS Code: 7324-015

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

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S/N: N4A1–Up
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S/N: 7PZ1–Up
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S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Disassembly Procedure

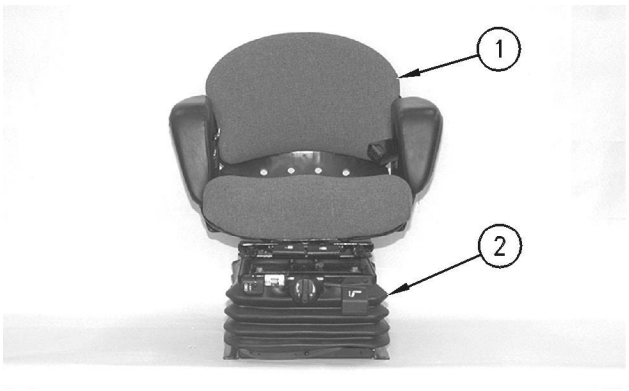


Illustration 80 g00275740

1. Remove the seat from the machine. Separate seat (1) from suspension (2).

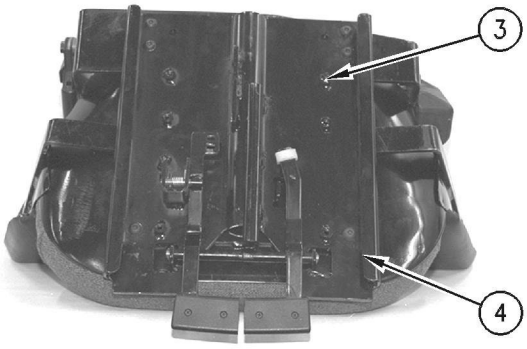


Illustration 81 g00275743

2. Remove six bolts (3). Remove plate (4).

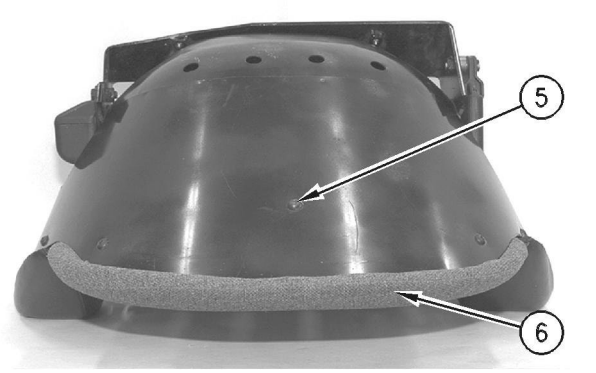


Illustration 82 g00275744

3. Remove three bolts (5). Then, remove back seat cushion (6).

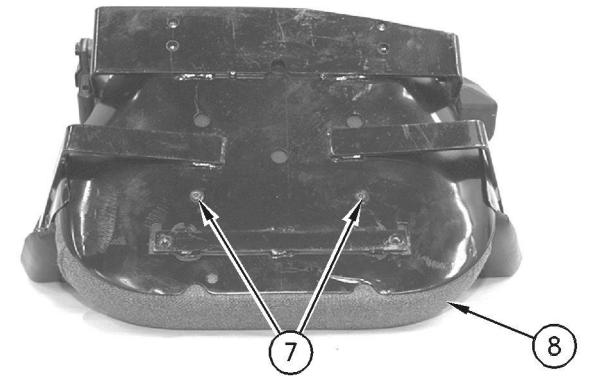


Illustration 83 g00275745

4. Remove two bolts (7). Then, remove bottom seat cushion (8).

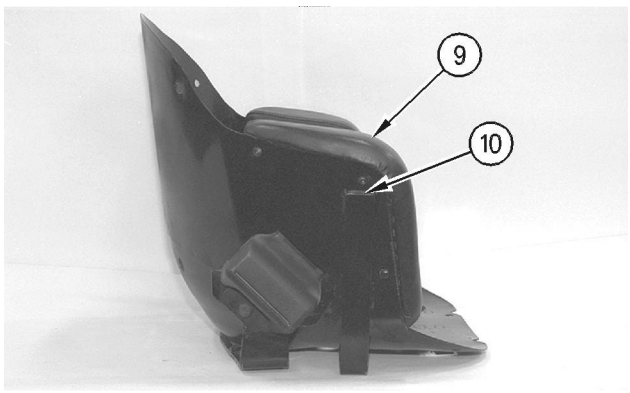


Illustration 84 g00275746

5. Remove three bolts (10). Then, remove side cushion (9).

6. Repeat Step 5 in order to remove the side cushion on the other side of the seat.



Illustration 85 g00275747

7. Remove the nut and bolt (12) that holds comfort ride sleeve (11) to the seat. Remove comfort ride sleeve (11) and bushing (14). Remove the nut and bolt (15) that holds seat belt retractor (13) to the seat. Remove seat belt retractor (13).



Illustration 86 g00275748

8. Remove four bolts (17) and the washers. Remove swivel assembly (16) from the suspension.

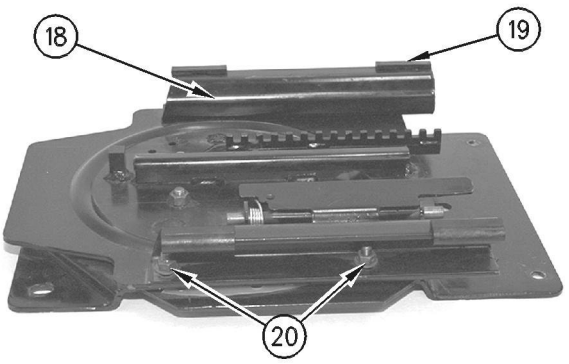


Illustration 87 g00275749

9. Remove four slides (19) from two brackets (18). Remove four nuts (20) and the washers. Remove two brackets (18).

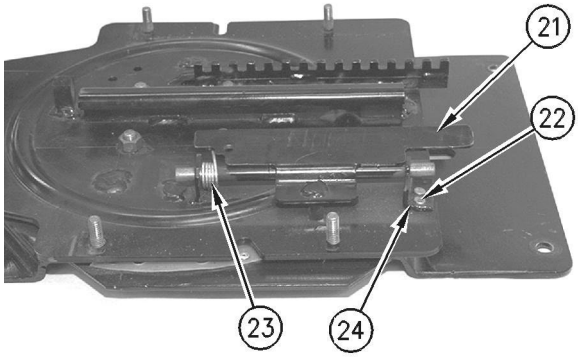


Illustration 88 g00275750

10. Remove two rivets (22). Remove angle (24), spring (23) and plate assembly (21).

i00644521

Swivel Seat - Assemble

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S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up

S/N: FDB1–Up

S/N: JJB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: AAC1–Up

S/N: AEC1–Up

S/N: AGC1–Up

S/N: AXC1–Up

S/N: BEC1–Up

S/N: BNC1–Up

S/N: BPC1–Up

S/N: CFC1–Up

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S/N: ALY1–Up
S/N: ANY1–Up
S/N: ATY1–Up
S/N: AWY1–Up
S/N: AXY1–Up
S/N: BMY1–Up
S/N: BXY1–Up
S/N: NYY1–Up
S/N: 06Z1–Up
S/N: 11Z1–Up
S/N: 15Z1–Up
S/N: 16Z1–Up
S/N: 17Z1–Up
S/N: 18Z1–Up
S/N: 21Z1–Up
S/N: 26Z1–Up
S/N: 2HZ1–Up
S/N: 2KZ1–Up
S/N: 2PZ1–Up
S/N: 32Z1–Up
S/N: 3TZ1–Up
S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 5AZ1–Up
S/N: 5KZ1–Up
S/N: 6GZ1–Up
S/N: 6YZ1–Up
S/N: 74Z1–Up
S/N: 79Z1–Up
S/N: 7MZ1–Up
S/N: 7PZ1–Up
S/N: 80Z1–Up
S/N: 92Z1–Up

S/N: ADZ1–Up

S/N: ANZ1–Up

S/N: AZZ1–Up

S/N: CBZ1–Up

Assembly Procedure

1. Check the condition of all parts of the swivel seat assembly. If any of the parts are worn or damaged, install new parts.

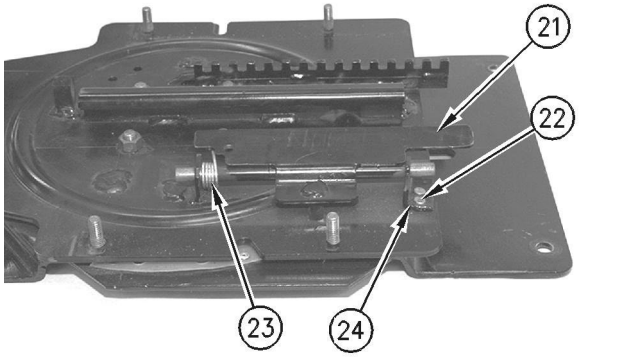


Illustration 89 g00275750

2. Install angle (24), spring (23) and plate assembly (21). Install two rivets (22).

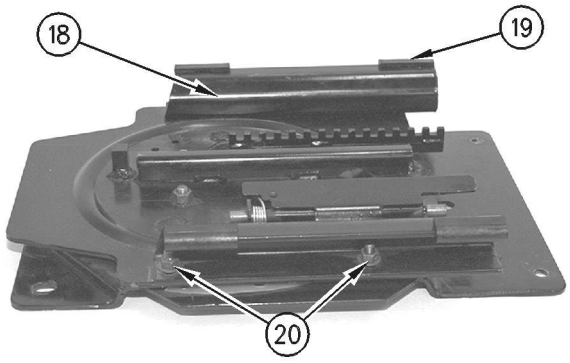


Illustration 90 g00275749

3. Install two slide brackets (18). Install four nuts (20) and the washers. Install four slides (19) on two slide brackets (18).

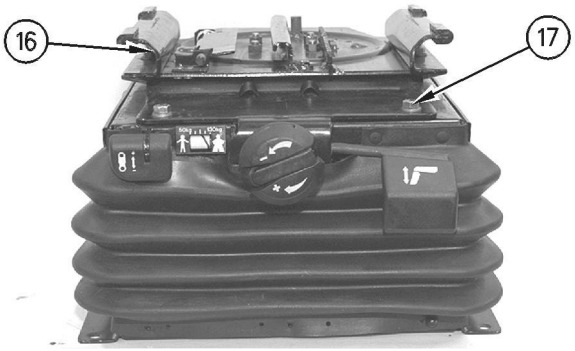


Illustration 91 g00275748

4. Install swivel assembly (16) on the suspension. Install four bolts (17) and the washers.



Illustration 92 g00275747

5. Install seat belt retractor (13). Install the nut and bolt (15) that holds seat belt retractor (13) to the seat. Install bushing (14) and comfort ride sleeve (11). Install the nut and bolt (12) that holds comfort ride sleeve (11) to the seat.

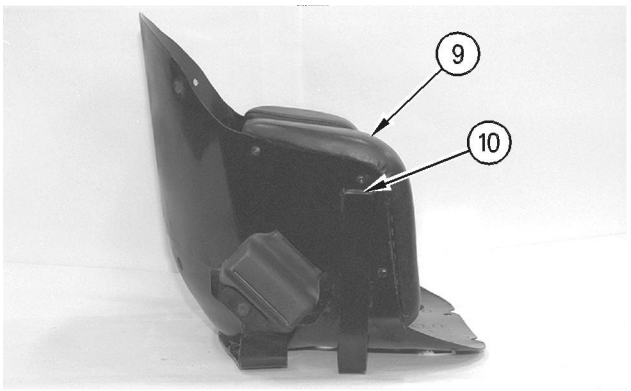


Illustration 93 g00275746

6. Install side cushion (9). Install three bolts (10).

7. Repeat Step 6 in order to install the side cushion on the other side of the seat.

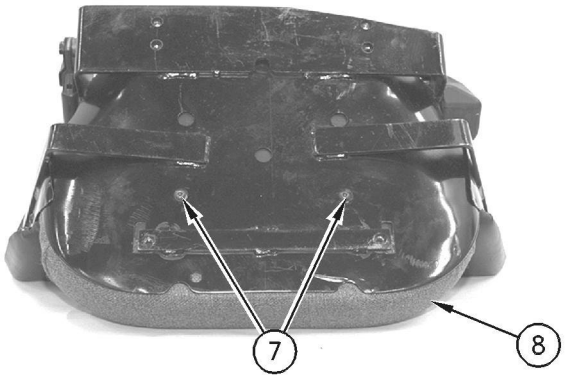


Illustration 94 g00275745

8. Install bottom seat cushion (8). Install two bolts (7).

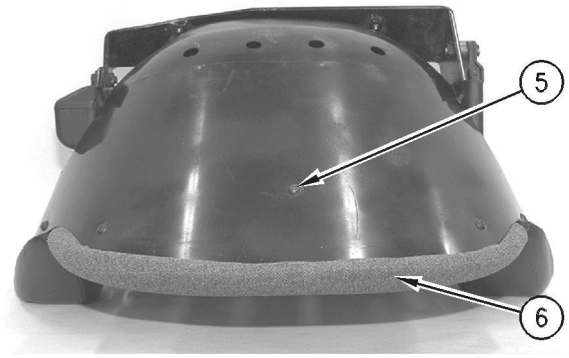


Illustration 95 g00275744

9. Install back seat cushion (6). Install three bolts (5).

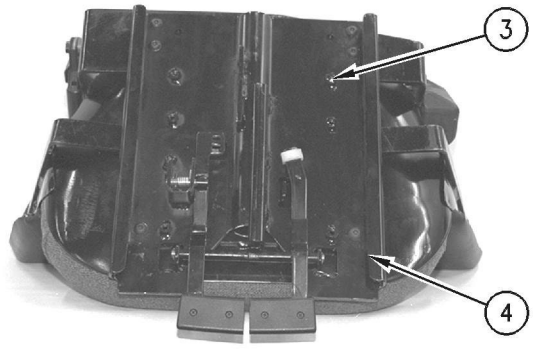


Illustration 96 g00275743

10. Install bottom seat plate (4). Install six bolts (3).

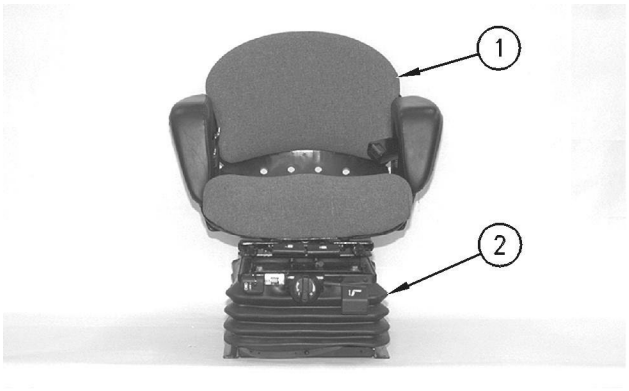


Illustration 97 g00275740

11. Install swivel seat (1) on suspension (2). Install the swivel seat assembly in the machine.

i00644554

Air Suspension With Toggle Switch Height Adjustment - Disassemble

SMCS Code: 7324-015-AJ

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up

S/N: FDB1–Up

S/N: JJB1–Up
S/N: 2AC1–Up
S/N: 3AC1–Up
S/N: 4RC1–Up
S/N: 6FC1–Up
S/N: 7NC1–Up
S/N: 7PC1–Up
S/N: 8FC1–Up
S/N: 8RC1–Up
S/N: 8YC1–Up
S/N: 9HC1–Up
S/N: 9TC1–Up
S/N: AAC1–Up
S/N: AEC1–Up
S/N: AGC1–Up
S/N: AXC1–Up
S/N: BEC1–Up
S/N: BNC1–Up
S/N: BPC1–Up
S/N: CFC1–Up
S/N: FDC1–Up
S/N: H4C1–Up
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S/N: MJC1–Up
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S/N: 1JD1–Up
S/N: 1KD1–Up
S/N: 1MD1–Up
S/N: 1YD1–Up
S/N: 2KD1–Up
S/N: 2SD1–Up
S/N: 2YD1–Up
S/N: 3ED1–Up
S/N: 3MD1–Up
S/N: 4KD1–Up
S/N: A6D1–Up
S/N: A7D1–Up
S/N: AKD1–Up
S/N: BAD1–Up
S/N: BXD1–Up
S/N: JAD1–Up
S/N: ADE1–Up
S/N: AYE1–Up
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S/N: BLE1–Up
S/N: 2XF1–Up
S/N: 3ZF1–Up
S/N: 4YF1–Up
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S/N: 9MG1–Up
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S/N: BXG1–Up
S/N: KEG1–Up
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S/N: M3G1–Up
S/N: M5G1–Up
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S/N: 2JS1–Up
S/N: 2RS1–Up
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S/N: 3AS1–Up
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S/N: 8XW1–Up
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S/N: ADW1–Up
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S/N: AZW1–Up
S/N: FDW1–Up
S/N: 01X1–Up
S/N: 02X1–Up
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S/N: BMY1–Up

S/N: BXY1–Up

S/N: NYY1–Up

S/N: 06Z1–Up

S/N: 11Z1–Up

S/N: 15Z1–Up

S/N: 16Z1–Up

S/N: 17Z1–Up

S/N: 18Z1–Up

S/N: 21Z1–Up

S/N: 26Z1–Up

S/N: 2HZ1–Up

S/N: 2KZ1–Up

S/N: 2PZ1–Up

S/N: 32Z1–Up

S/N: 3TZ1–Up

S/N: 48Z1–Up

S/N: 4GZ1–Up

S/N: 5AZ1–Up

S/N: 5KZ1–Up

S/N: 6GZ1–Up

S/N: 6YZ1–Up

S/N: 74Z1–Up

S/N: 79Z1–Up

S/N: 7MZ1–Up

S/N: 7PZ1–Up

S/N: 80Z1–Up

S/N: 92Z1–Up

S/N: ADZ1–Up

S/N: ANZ1–Up

S/N: AZZ1–Up

S/N: CBZ1–Up

Disassembly Procedure

1. Remove the seat assembly from the machine. Separate the seat from the air suspension.

⚠ WARNING

The air spring of the air suspension is filled with air pressure.

Prior to disassembly, release the air pressure in the air spring. Failure to do so could result in personal injury.

2. Use the following procedure to release the air pressure in the air spring:

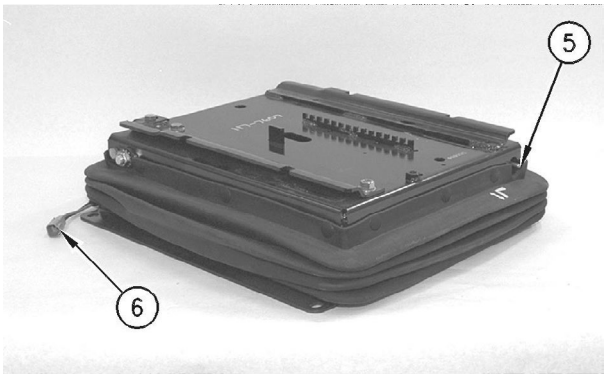


Illustration 98 g00291076

a. Connect a 24 volt power supply to two-pin connector (6). No. 1 connector pin is positive.

Note: The air spring will completely deflate in approximately 60 seconds.

b. Push down toggle (5). While you hold down the toggle, apply the 24 volt power supply for approximately 60 seconds.

c. Allow the air spring to deflate without any weight on the suspension.

d. Turn off the power supply when all the air has been released.

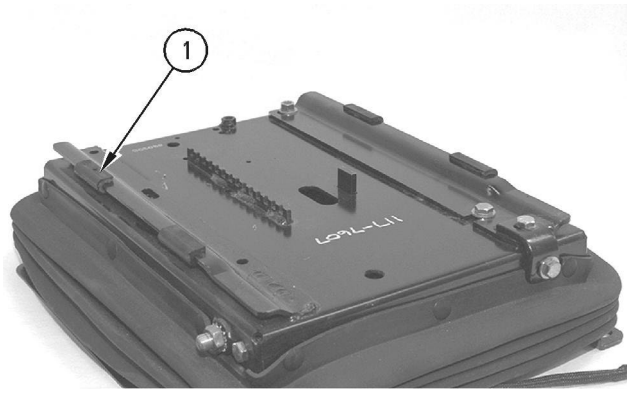


Illustration 99 g00275751

3. Remove four slides (1).

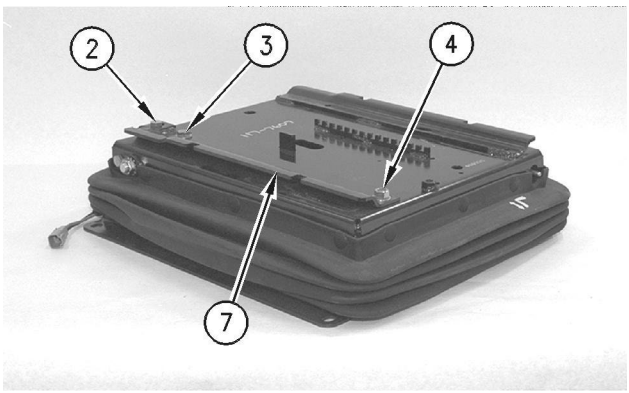


Illustration 100 g00291077

4. Remove two bolts (3), the washers, one bolt (2) and locknut (4). Remove fore and aft slider track (7).

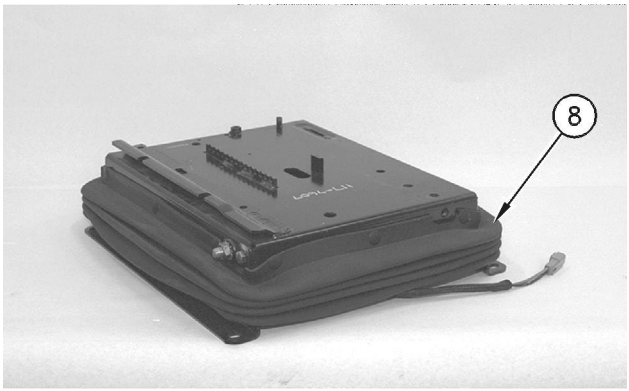


Illustration 101 g00275753

5. Remove boot (8).

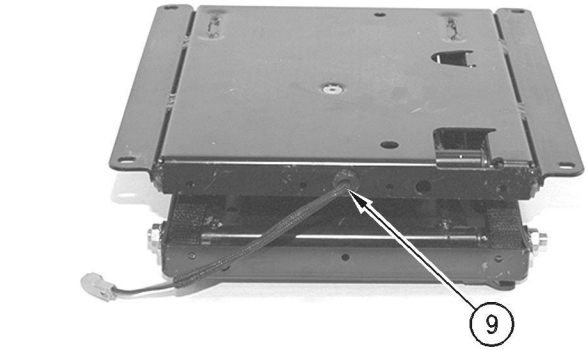


Illustration 102 g00275754

6. Remove bushing (9).

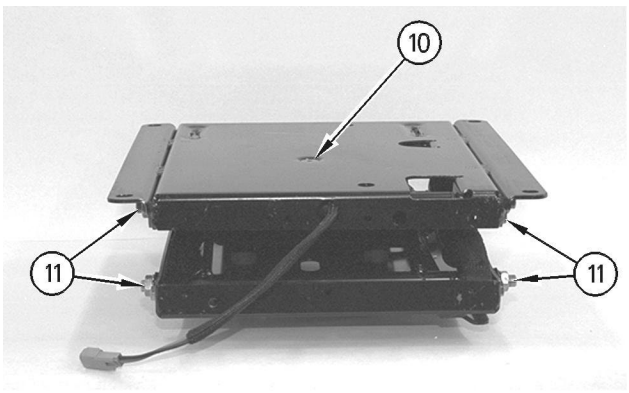


Illustration 103 g00275755

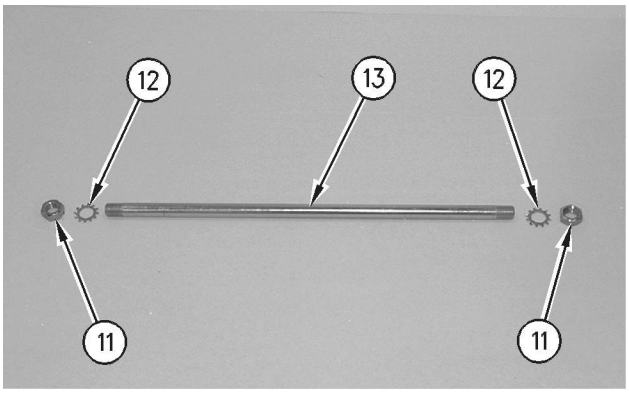


Illustration 104 g00275776

7. Remove four locknuts (11) and lock washers (12). Remove two shafts (13).

8. Remove bolt (10) from the air spring, which is not shown.

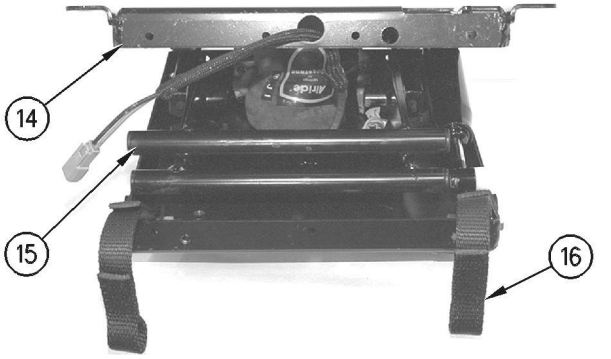


Illustration 105 g00275777

9. Disconnect two tether belts (16) and the damper from lower housing (14). Separate lower housing (14) from scissor assembly (15). Tip lower housing (14) while you slide the lower housing from scissor assembly (15).

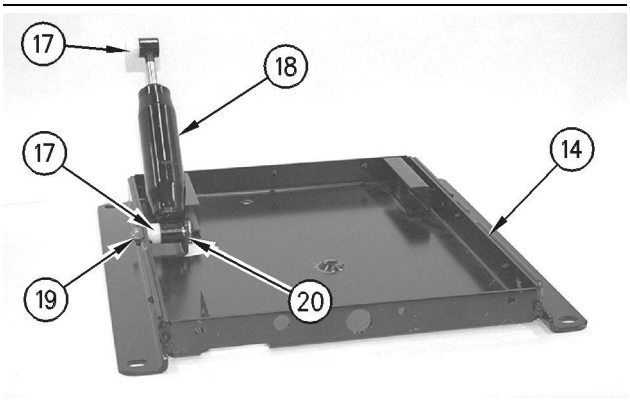


Illustration 106 g00275778

10. Remove nut (19), pin (20), two bearings (17) and damper (18) from lower housing (14).

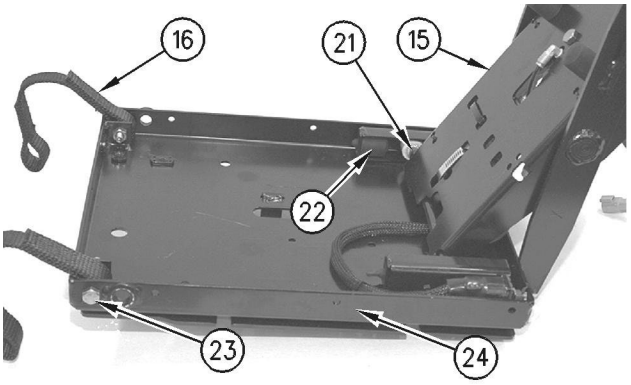


Illustration 107 g00275780

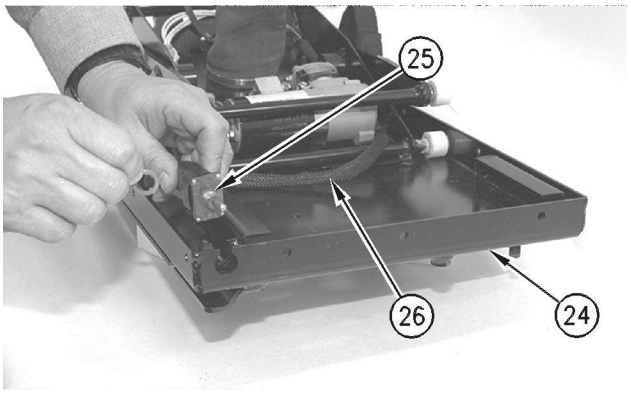


Illustration 108 g00275782

11. Remove one bumper (22). Remove scissor assembly (15) from upper housing (24) by twisting the scissor assembly off rollers (21). Remove bolt (23) and the locknut. Remove tether belts (16) from each side of upper housing (24).

12. Remove the tie-wraps from wiring harness (26). Disconnect wiring harness connection (25) and the washer from upper housing (24).

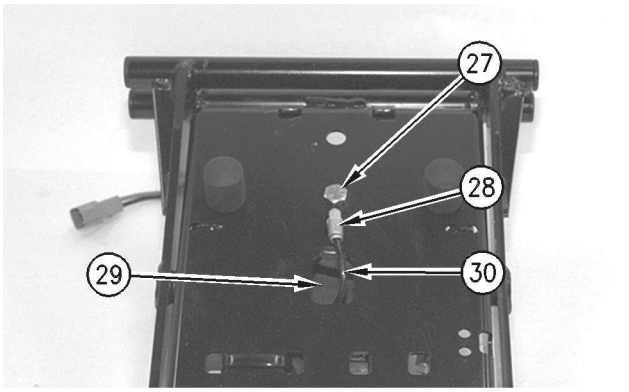


Illustration 109 g00275783

13. Remove bolt (27) and air spring (29). Use a small wrench to press fitting (28) while you pull tube (30) out of fitting (28).

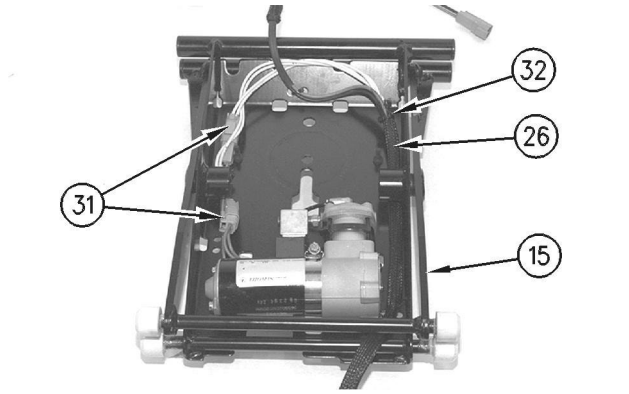


Illustration 110 g00275785

14. Put identification marks on two electrical connectors (31) for installation purposes. Disconnect two electrical connectors (31). Cut tie-wraps (32) that are holding wiring harness (26) to scissor assembly (15). Remove wiring harness (26).

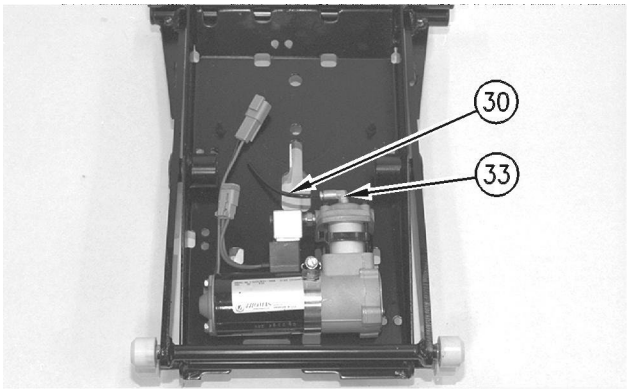


Illustration 111 g00275786

15. Remove tube (30) from fitting (33).

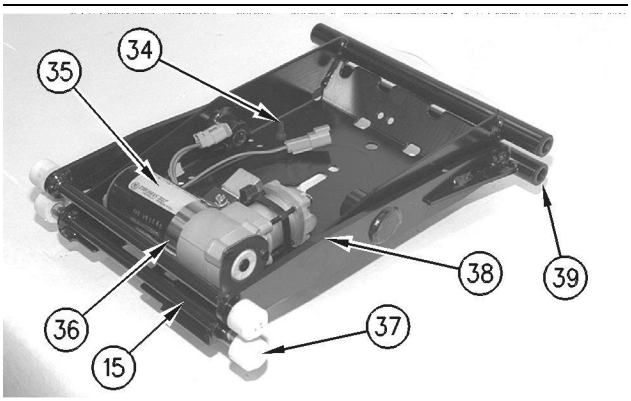


Illustration 112 g00275788

16. Remove clamp (36) and tie-wrap (38) from air compressor (35). Remove air compressor (35) from scissor assembly (15).

17. Remove four bushings (39) and four rollers (37). Remove two rubber bumpers (34).

i07432503

Air Suspension With Toggle Switch Height Adjustment - Assemble

SMCS Code: 7324-016-AJ

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up
S/N: GTA1–Up
S/N: N1A1–Up
S/N: N4A1–Up
S/N: 8GB1–Up
S/N: 8HB1–Up
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S/N: AYB1–Up
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S/N: JJB1–Up
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S/N: 3AC1–Up
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S/N: BMY1–Up

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S/N: 17Z1–Up

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S/N: 7MZ1–Up

S/N: 7PZ1–Up

S/N: 80Z1–Up

S/N: 92Z1–Up

S/N: ADZ1–Up

S/N: ANZ1–Up

S/N: AZZ1–Up

S/N: CBZ1–Up

Assembly Procedure

Table 2

Tools Needed			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 243	-
B	-	Loctite LB 8632 Silicone Lubricant (1)	-
	-	Loctite LB 8104 Silicone Lubricant (2)	-
	-	Loctite LB 8801 Silicone Lubricant (3)	-
	-	Loctite LB Superlube (4)	-

(1) North America
(2) EAME
(3) Asia Pacific Division
(4) South America

1. Check the condition of all parts of the air suspension. If any of the parts are worn or damaged, install new parts.

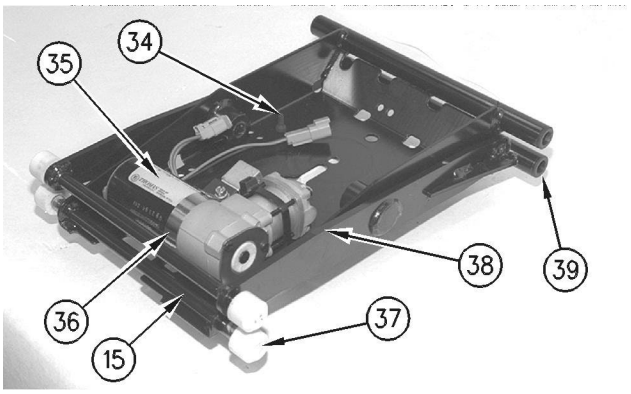


Illustration 113 g00275788

2. Install two rubber bumpers (34). Apply Tooling (B) to the scissor assembly at the point of installation for four rollers (37). Install four bushings (39) and four rollers (37).

3. Position air compressor (35) in scissor assembly (15). Install clamp (36) and tie-wrap (38) to secure air compressor (35) to the scissor assembly. Tighten clamp (36) to a torque of 3.2 ± 0.6 N·m (29 ± 5 lb in).

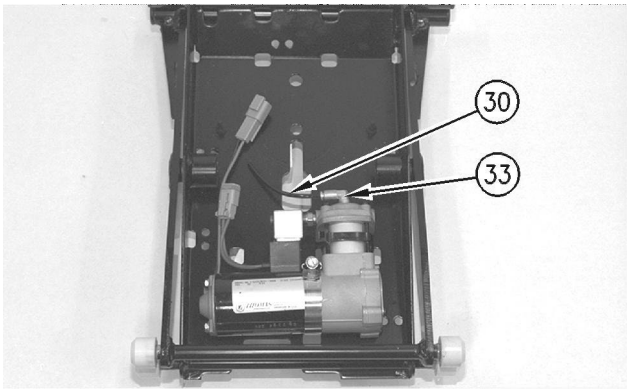


Illustration 114 g00275786

4. Connect tube (30) to fitting (33). Make sure that the tube is securely seated in the fitting.

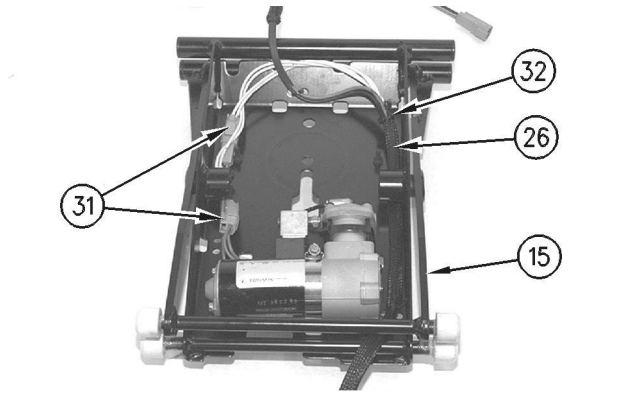


Illustration 115 g00275785

5. Position wiring harness (26). Connect two electrical connectors (31) in the original positions. Install tie-wraps (32) to secure wiring harness (26) to scissor assembly (15).

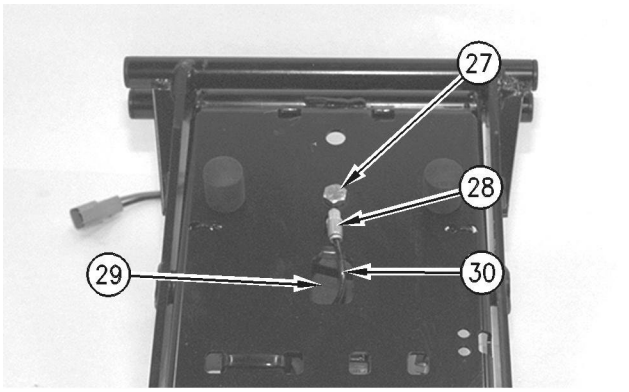


Illustration 116 g00275783

6. Connect tube (30) to fitting (28). Make sure that the tube is securely seated in the fitting. Apply Tooling (A) to the threads of bolt (27). Position air spring (29) on the scissor assembly. Install bolt (27) to secure air spring (29). Tighten bolt (27) to a torque of 4.3 ± 1 N·m (38 ± 9 lb in).

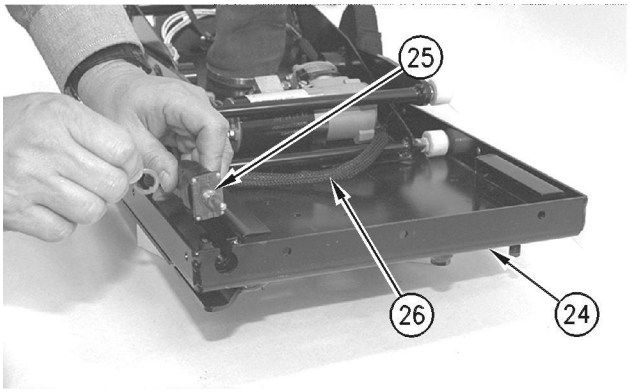


Illustration 117 g00275782

7. Install wiring harness connection (25) and the washer in upper housing (24). Install new tie-wraps on wiring harness (26) to secure the wiring harness to the upper housing.

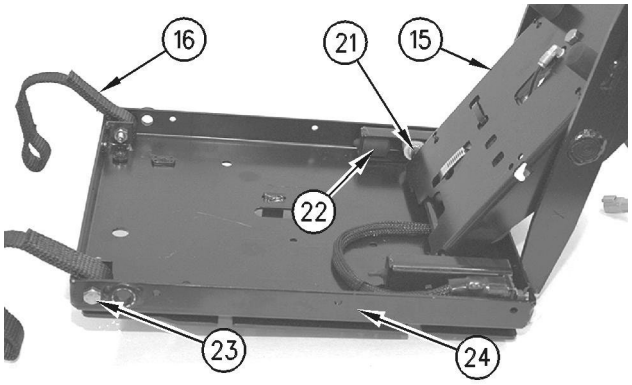


Illustration 118 g00275780

8. Install scissor assembly (15) in upper housing (24) by sliding rollers (21) into the slider track. Slide bumper (22) into the slider track to secure the scissor assembly. Install two tether belts (16), bolts (23) and the locknuts in upper housing (24). Tighten bolts (23) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

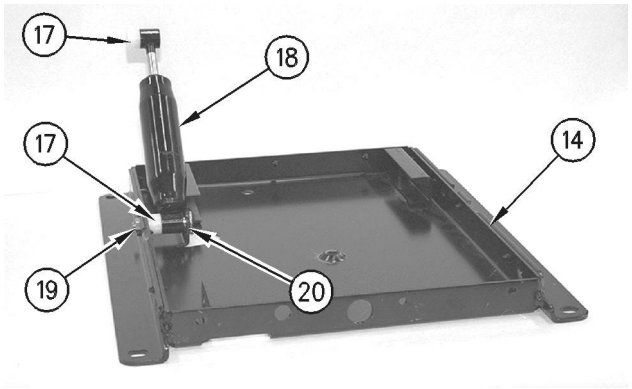


Illustration 119 g00275778

9. Install two bearings (17), damper (18), pin (20) and nut (10) into lower housing (14). Tighten nut (19) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

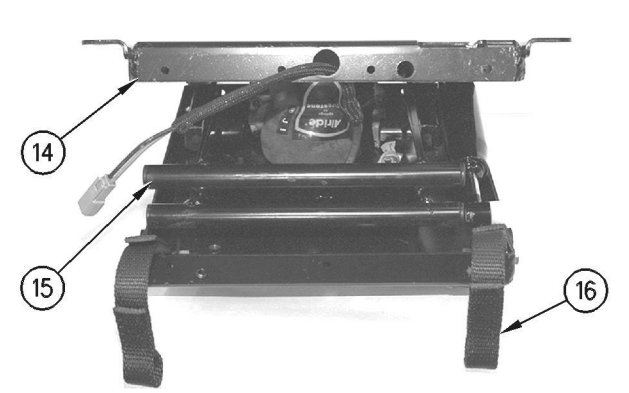


Illustration 120 g00275777

10. Install scissor assembly (15) into lower housing (14). Connect the damper and two tether belts (16) to lower housing (14).

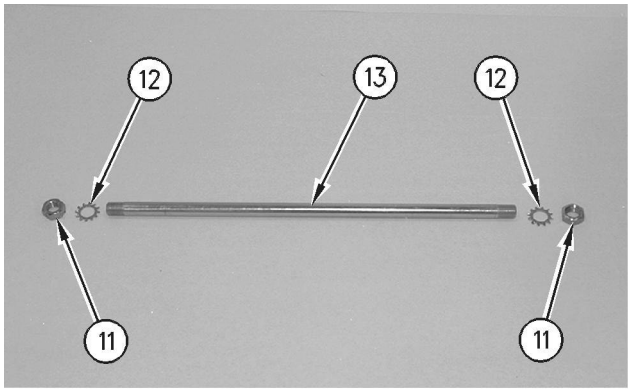


Illustration 121 g00275776

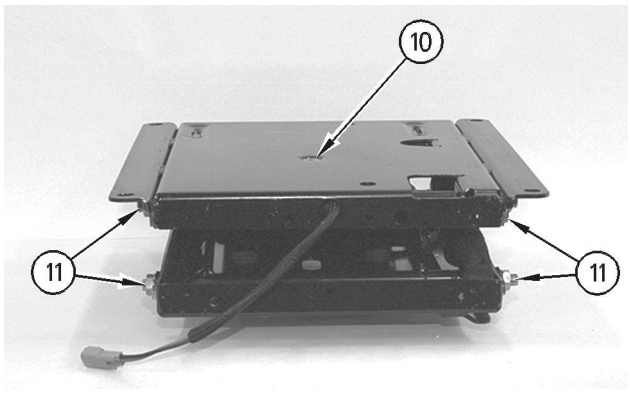


Illustration 122 g00275755

11. Apply 9S-3263 Thread Lock on bolt (10). Position the air spring on lower housing (14). Install bolt (10). Tighten bolt (10) to a torque of 4.3 ± 1 N·m (38 ± 9 lb in). Install two shafts (13). Install four locknuts (11) and lock washers (12). Tighten locknuts (11) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

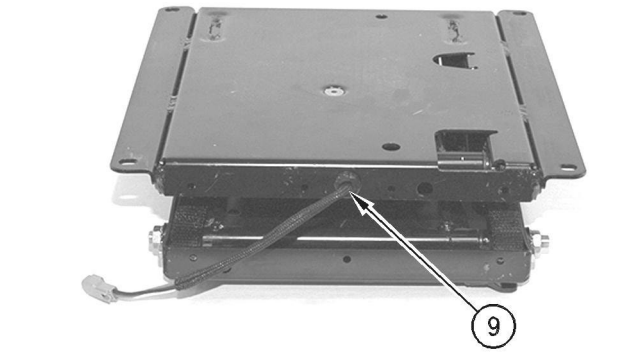


Illustration 123 g00275754

12. Install bushing (9) into the lower housing.

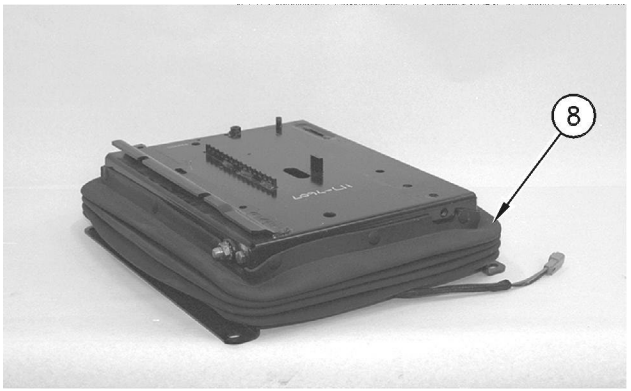


Illustration 124 g00275753

13. Install boot (8).

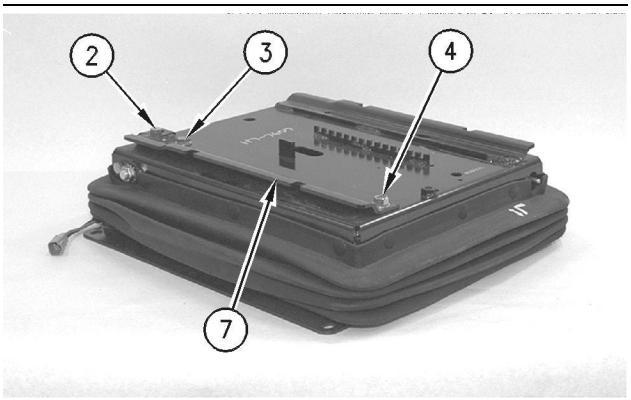


Illustration 125 g00291077

14. Position fore and aft slider track (7). Install two bolts (3), the washers, one bolt (2) and locknut (4). Tighten bolts (2) and (3) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Also, tighten locknut (4) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

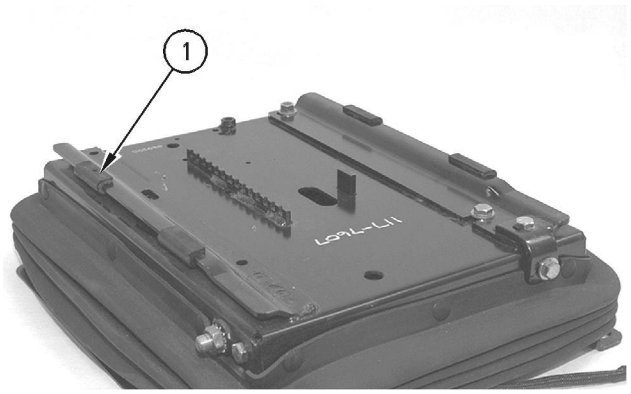


Illustration 126 g00275751

15. Install four slides (1).

16. Install the seat on the air suspension. Install the seat assembly in the machine.

i01693748

Air Suspension with Air Valve Knob Height Adjustment - Disassemble

SMCS Code: 7324-015-AJ

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up

S/N: FDB1–Up

S/N: JJB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: AAC1–Up

S/N: AEC1–Up

S/N: AGC1–Up

S/N: AXC1–Up

S/N: BEC1–Up

S/N: BNC1–Up

S/N: BPC1–Up

S/N: CFC1–Up

S/N: FDC1–Up

S/N: H4C1–Up

S/N: MCC1–Up

S/N: MJC1–Up

S/N: 1DD1–Up

S/N: 1JD1–Up

S/N: 1KD1–Up

S/N: 1MD1–Up

S/N: 1YD1–Up

S/N: 2KD1–Up

S/N: 2SD1–Up

S/N: 2YD1–Up

S/N: 3ED1–Up

S/N: 3MD1–Up

S/N: 4KD1–Up

S/N: A6D1–Up

S/N: A7D1–Up

S/N: AKD1–Up

S/N: BAD1–Up

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S/N: AWY1–Up
S/N: AXY1–Up
S/N: BMY1–Up
S/N: BXY1–Up
S/N: NYY1–Up
S/N: 06Z1–Up
S/N: 11Z1–Up
S/N: 15Z1–Up
S/N: 16Z1–Up
S/N: 17Z1–Up
S/N: 18Z1–Up
S/N: 21Z1–Up
S/N: 26Z1–Up
S/N: 2HZ1–Up
S/N: 2KZ1–Up
S/N: 2PZ1–Up
S/N: 32Z1–Up
S/N: 3TZ1–Up
S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 5AZ1–Up
S/N: 5KZ1–Up
S/N: 6GZ1–Up
S/N: 6YZ1–Up
S/N: 74Z1–Up
S/N: 79Z1–Up
S/N: 7MZ1–Up
S/N: 7PZ1–Up
S/N: 80Z1–Up
S/N: 92Z1–Up
S/N: ADZ1–Up
S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Disassembly Procedure

WARNING

The air spring of the air suspension is filled with air pressure.

Prior to disassembly, release the air pressure in the air spring. Failure to do so could result in personal injury.

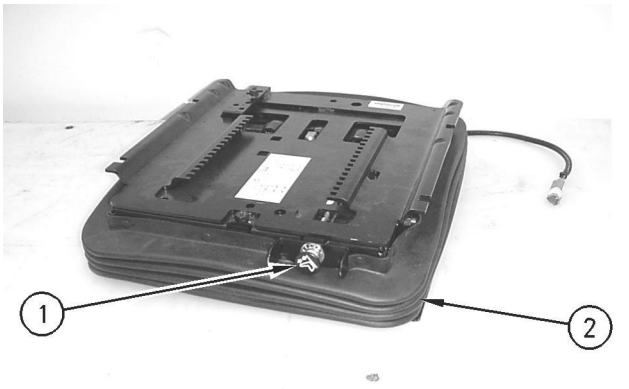


Illustration 127 g00871915

1. Pull adjustment knob (1) in order to release the air from the seat.

2. Remove boot (2).

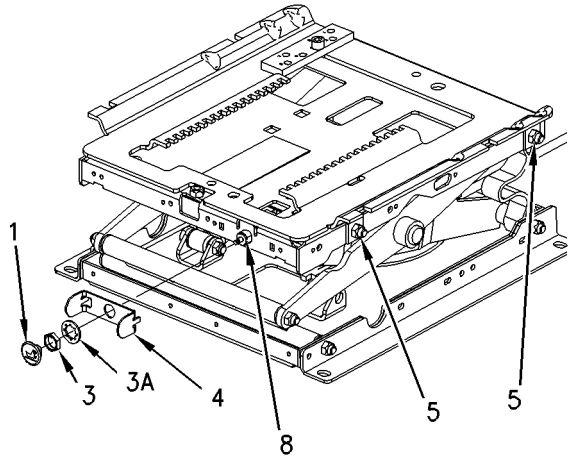


Illustration 128 g00876043

3. Loosen the setscrew in adjustment knob (1) and remove adjustment knob (1). Remove nut (3) and lockwasher (3A). Remove plate (4) from air valve (8).

4. Remove shaft assemblies (5).

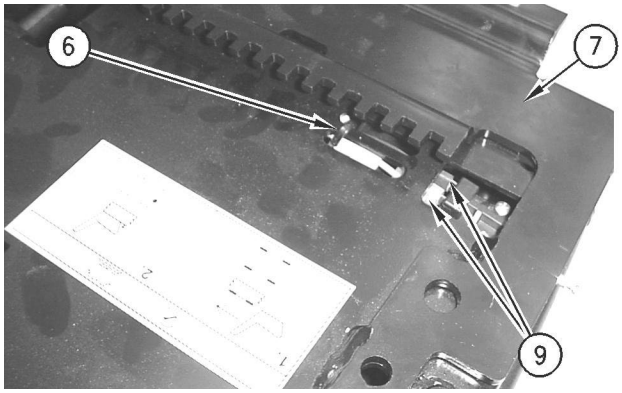


Illustration 129 g00871951

5. Remove cable strap (6) in order to disconnect harness assemblies (9) from upper housing assembly (7).

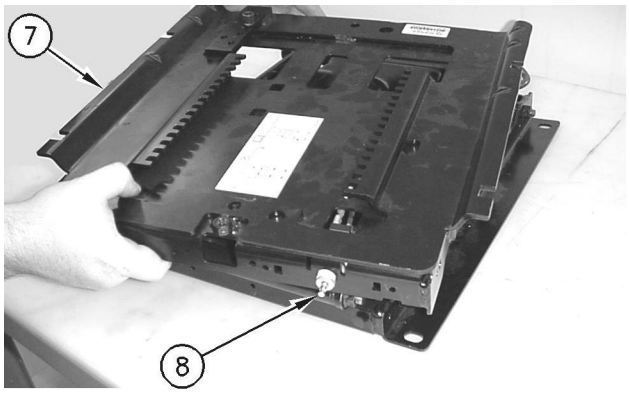


Illustration 130 g00871971

6. Lift upper housing assembly (7) and push air valve (8) away from upper housing assembly (7). Remove upper housing assembly (7).

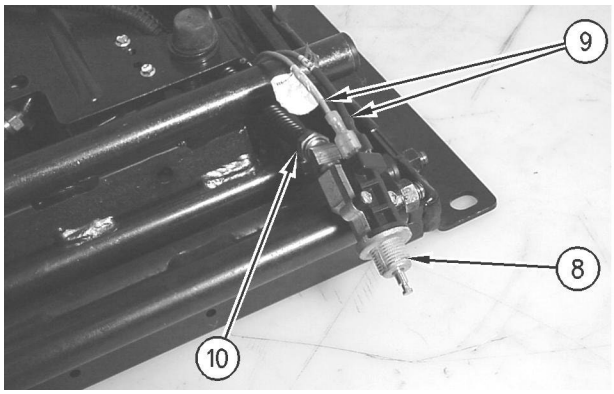


Illustration 131 g00871994

7. Disconnect harness assemblies (9) and hose assembly (10) from air valve (8).

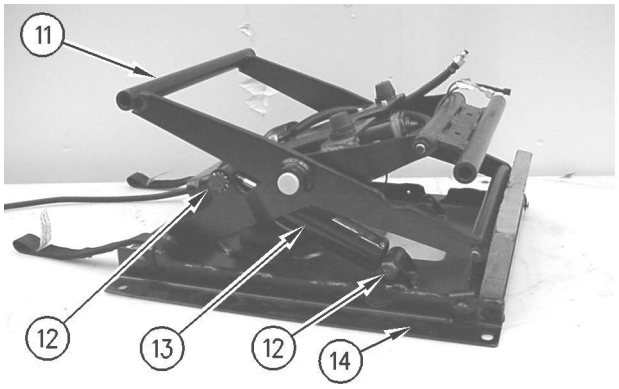


Illustration 132 g00872007

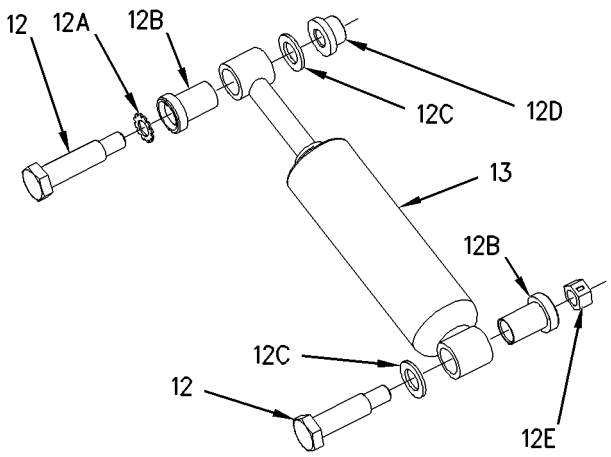


Illustration 133 g00897454

8. Raise scissor assembly (11) and install blocking in order to prevent scissor assembly (11) from falling.

9. Remove bolts (12) in order to remove shock absorber (13) from scissor assembly (11) and housing assembly (14).

10. Remove bearings (12B) from shock absorber (13).

Note: Illustration 133 shows the location of lockwasher (12A), bearings (12B), washers (12C), nut (12D), and locknut (12E).

11. Repeat Steps 9 and 10 if the seat is equipped with a shock absorber on the opposite side.

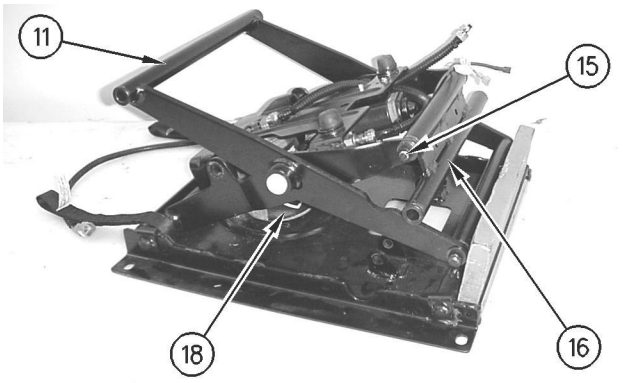


Illustration 134 g00872020

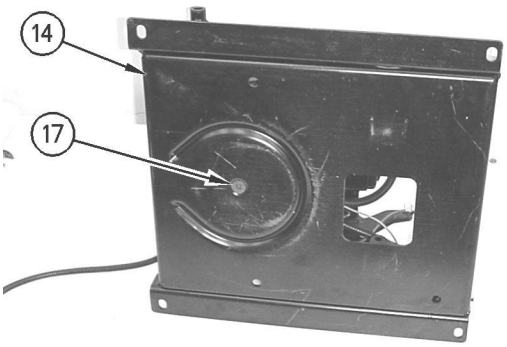


Illustration 135 g00872029

12. Remove shaft (15) in order to remove toggle assembly (16) from scissor assembly (11).

13. Remove screw (17) in order to disconnect spring assembly (18) from housing assembly (14).

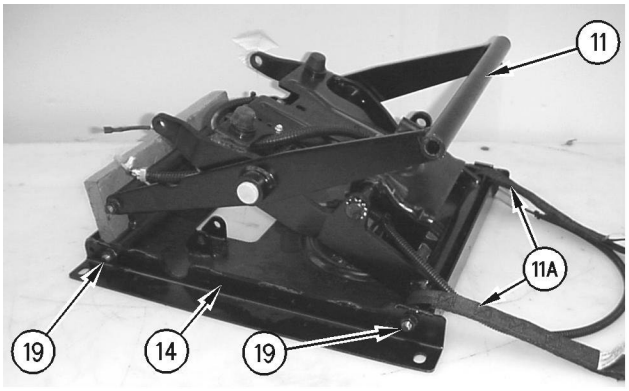


Illustration 136 g00872031

14. Remove shaft assemblies (19) in order to remove scissor assembly (11) from housing assembly (14) and tether straps (11A).

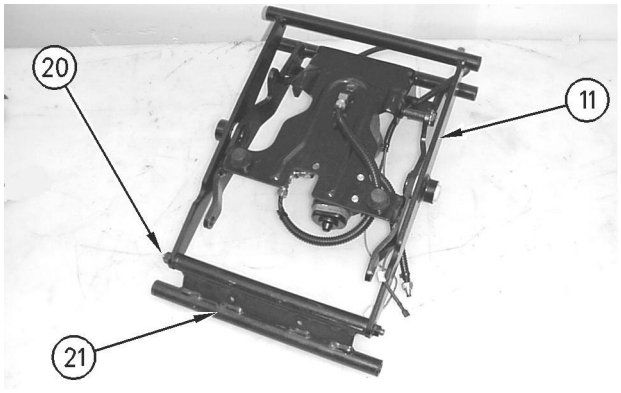


Illustration 137 g00872037

15. Remove shaft (20) in order to remove toggle assembly (21) from scissor assembly (11).

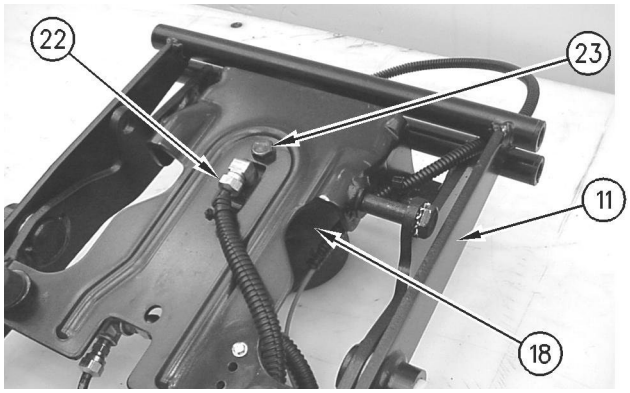


Illustration 138 g00872043

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

16. Remove hose assembly (22) and bolt (23) in order to remove spring assembly (18) from scissor assembly (11).

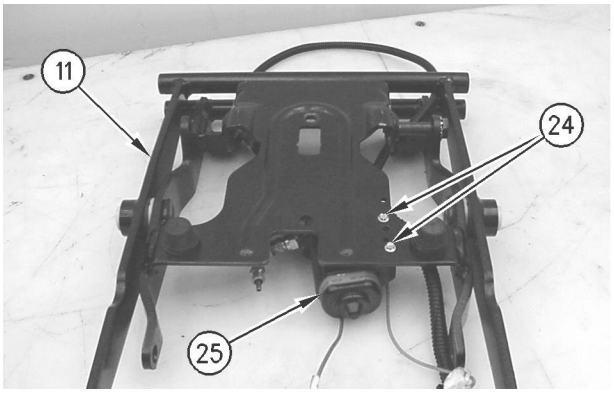


Illustration 139 g00872046

17. Remove bolts (24) in order to remove compressor assembly (25) from scissor assembly (11).

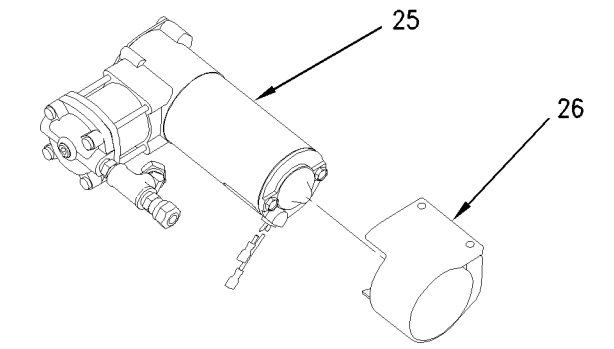


Illustration 140 g00891451

18. Remove compressor assembly (25) from mount (26).

i01723170

Air Suspension With Air Valve Knob Height Adjustment - Assemble

SMCS Code: 7324-016-AJ

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up
S/N: N1A1–Up
S/N: N4A1–Up
S/N: 8GB1–Up
S/N: 8HB1–Up
S/N: 8KB1–Up
S/N: 8PB1–Up
S/N: 9DB1–Up
S/N: AXB1–Up
S/N: AYB1–Up
S/N: BAB1–Up
S/N: BBB1–Up
S/N: FDB1–Up
S/N: JJB1–Up
S/N: 2AC1–Up
S/N: 3AC1–Up
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S/N: 9TC1–Up
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S/N: 1KD1–Up
S/N: 1MD1–Up
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S/N: BZR1–Up
S/N: CBR1–Up
S/N: 29S1–Up
S/N: 2GS1–Up
S/N: 2HS1–Up
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S/N: 3BS1–Up
S/N: 3DS1–Up
S/N: 3ZS1–Up
S/N: 4BS1–Up
S/N: 4CS1–Up
S/N: 4GS1–Up

S/N: 4HS1–Up
S/N: 4JS1–Up
S/N: 4NS1–Up
S/N: 4PS1–Up
S/N: 4YS1–Up
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S/N: 5ES1–Up
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S/N: 9ZS1–Up
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S/N: ANT1–Up
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S/N: 96V1–Up
S/N: 1CW1–Up
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S/N: 6AW1–Up
S/N: 6EW1–Up
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S/N: 8XW1–Up
S/N: 9GW1–Up
S/N: A4W1–99999
S/N: AAW1–Up
S/N: ADW1–Up
S/N: AWW1–Up
S/N: AZW1–Up
S/N: FDW1–Up
S/N: 01X1–Up
S/N: 02X1–Up
S/N: 85X1–Up
S/N: 86X1–Up
S/N: 87X1–Up
S/N: AAX1–Up

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S/N: APX1–Up
S/N: ASX1–Up
S/N: AXX1–Up
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S/N: AWY1–Up
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S/N: AZZ1–Up
S/N: CBZ1–Up

Assembly Procedure

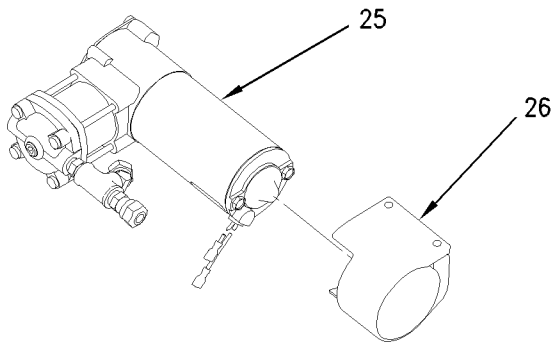


Illustration 141 g00891451

1. Install compressor assembly (25) to mount (26). Make sure that compressor assembly (25) is seated firmly in mount (26).

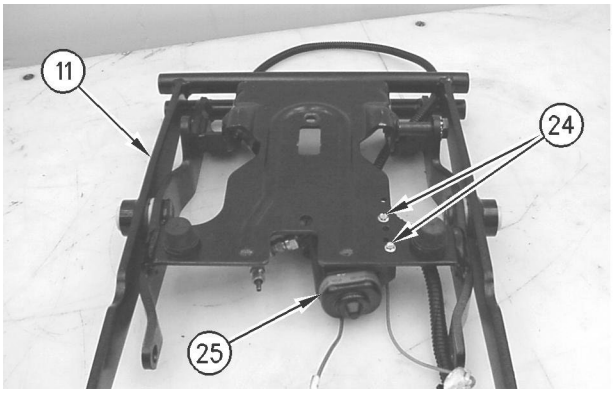


Illustration 142 g00872046

2. Install bolts (24) in order to attach compressor assembly (25) to scissor assembly (11).

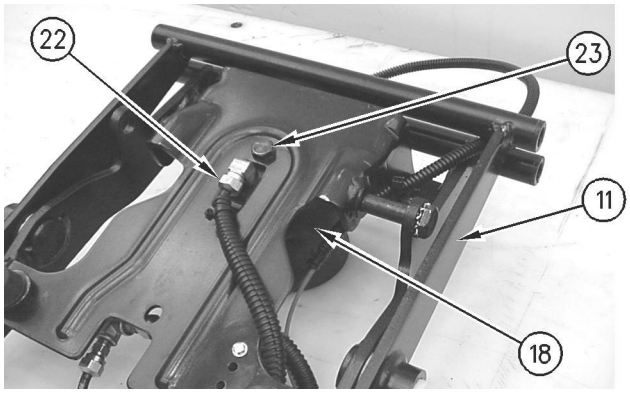


Illustration 143 g00872043

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

3. Install bolt (23) in order to attach spring assembly (18) to scissor assembly (11). Attach hose assembly (22) to spring assembly (18).

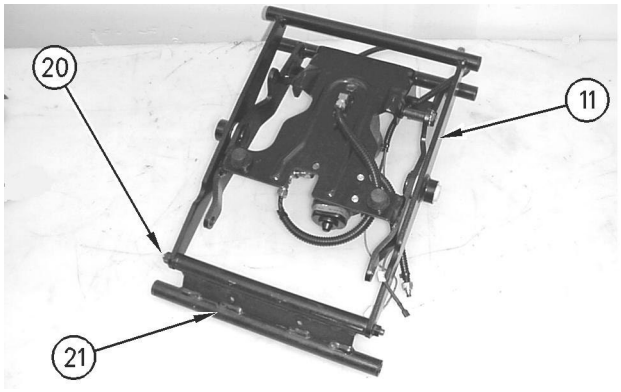


Illustration 144 g00872037

4. Install shaft (20) in order to attach toggle assembly (21) to scissor assembly (11). Tighten the two nuts for shaft (20) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).

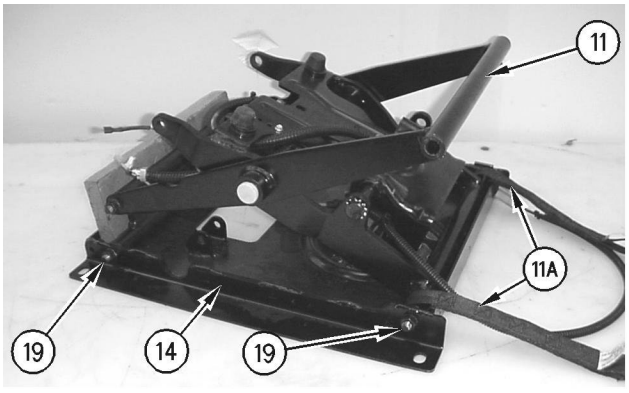


Illustration 145 g00872031

5. Install shaft assemblies (19) in order to attach tether straps (11A) and scissor assembly (11) to housing assembly (14). Tighten the nuts on shaft assemblies (19) to a torque of 20 ± 5 N·m (15 ± 4 lb ft). Install blocking in order to prevent scissor assembly (11) from falling.

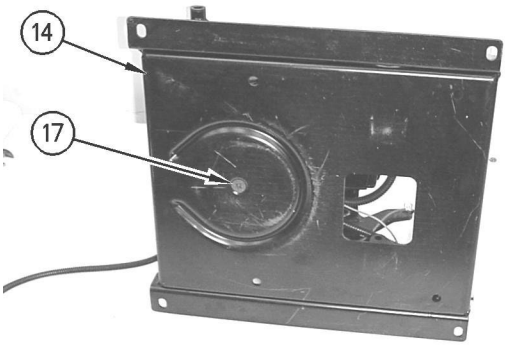


Illustration 146 g00872029

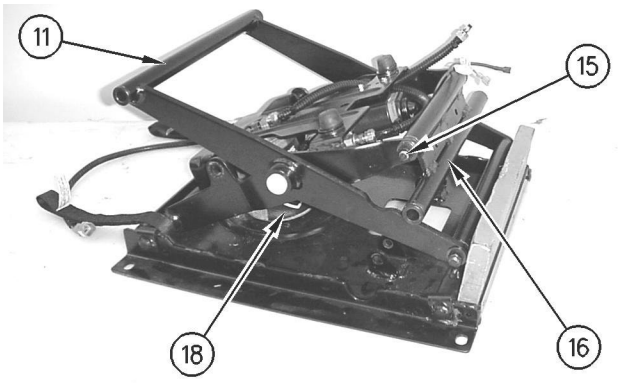


Illustration 147 g00872020

6. Install screw (17) in order to attach housing assembly (14) to spring assembly (18).

7. Install shaft (15) in order to attach toggle assembly (16) to scissor assembly (11). Tighten the two nuts for shaft (15) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).

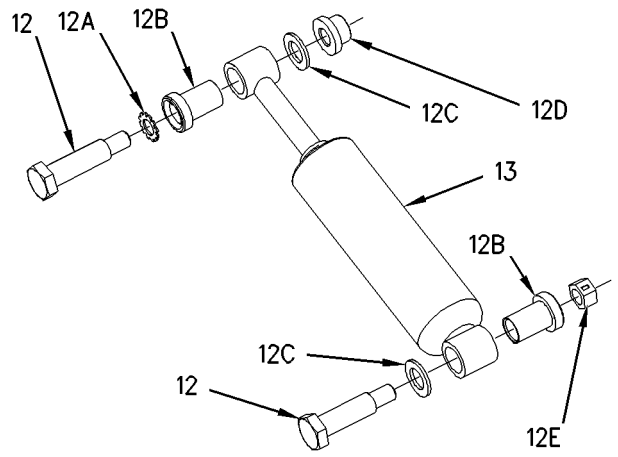


Illustration 148 g00897454

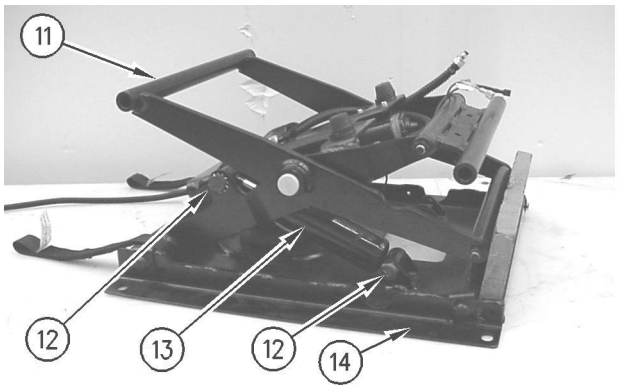


Illustration 149 g00872007

8. Install bearings (12B) to shock absorber (13).

9. Install bolts (12) in order to attach shock absorber (13) to scissor assembly (11) and housing assembly (14). Remove the blocking.

Note: Illustration 148 shows the location of lockwasher (12A), bearings (12B), washers (12C), nut (12D), and locknut (12E).

10. Repeat Steps 8 and 9 if the seat is equipped with a shock absorber on the opposite side.

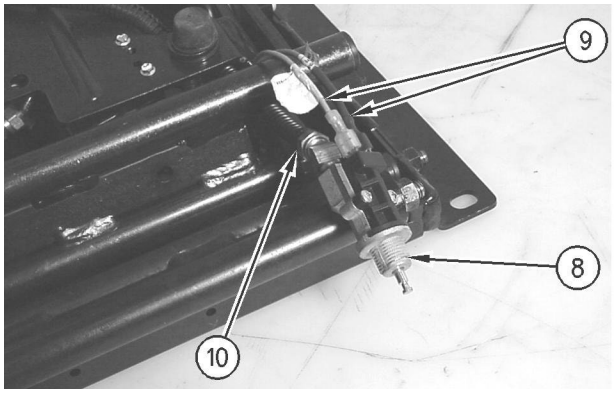


Illustration 150 g00871994

11. Connect harness assemblies (9) and hose assembly (10) to air valve (8).

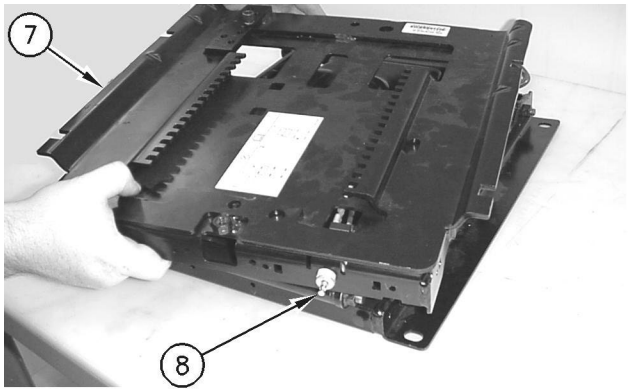


Illustration 151 g00871971

12. Position air valve (8) to upper housing assembly (7). Position upper housing assembly (7) to the seat.

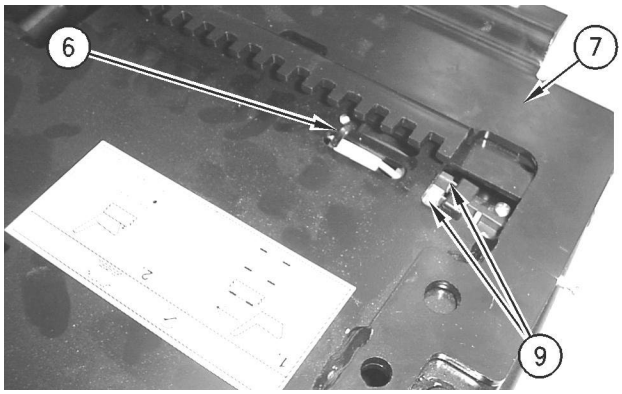


Illustration 152 g00871951

13. Install cable strap (6) in order to secure harness assemblies (9) to upper housing assembly (7).

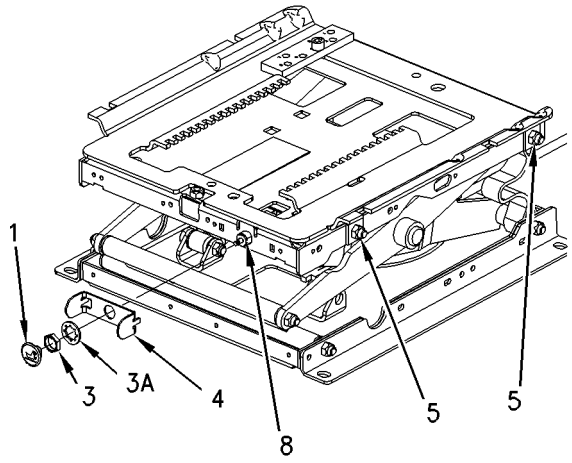


Illustration 153 g00876043

14. Install shaft assemblies (5). Tighten the nuts for shaft assemblies (5) to a torque of 20 ± 5 N·m (15 ± 4 lb ft).

15. Position plate (4) to the seat. Install lockwasher (3A) and nut (3) in order to secure air valve (8) to the seat. Tighten the setscrew in adjustment knob (1) in order to secure adjustment knob (1) to air valve (8).

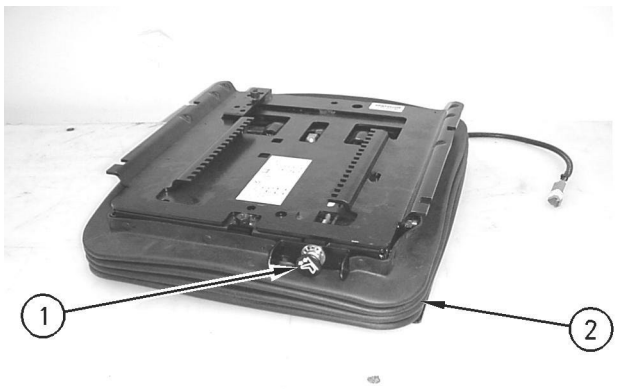


Illustration 154 g00871915

16. Install boot (2) to the seat.

i01518481

Air Suspension With System Air - Disassemble

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S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up

S/N: FDB1–Up

S/N: JJB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

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S/N: AXC1–Up

S/N: BEC1–Up

S/N: BNC1–Up

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S/N: 5FW1–Up
S/N: 5MW1–Up
S/N: 5YW1–Up
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S/N: 6EW1–Up
S/N: 6HW1–Up
S/N: 7BW1–Up
S/N: 8JW1–Up
S/N: 8XW1–Up
S/N: 9GW1–Up
S/N: A4W1–99999
S/N: AAW1–Up
S/N: ADW1–Up
S/N: AWW1–Up
S/N: AZW1–Up
S/N: FDW1–Up
S/N: 01X1–Up
S/N: 02X1–Up
S/N: 85X1–Up
S/N: 86X1–Up
S/N: 87X1–Up
S/N: AAX1–Up
S/N: AFX1–Up
S/N: APX1–Up
S/N: ASX1–Up
S/N: AXX1–Up
S/N: AZX1–99999
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S/N: AGY1–Up
S/N: ALY1–Up
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S/N: BMY1–Up
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S/N: 15Z1–Up
S/N: 16Z1–Up
S/N: 17Z1–Up
S/N: 18Z1–Up
S/N: 21Z1–Up
S/N: 26Z1–Up
S/N: 2HZ1–Up
S/N: 2KZ1–Up
S/N: 2PZ1–Up
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S/N: 3TZ1–Up
S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 5AZ1–Up
S/N: 5KZ1–Up

S/N: 6GZ1–Up

S/N: 6YZ1–Up

S/N: 74Z1–Up

S/N: 79Z1–Up

S/N: 7MZ1–Up

S/N: 7PZ1–Up

S/N: 80Z1–Up

S/N: 92Z1–Up

S/N: ADZ1–Up

S/N: ANZ1–Up

S/N: AZZ1–Up

S/N: CBZ1–Up

Disassembly Procedure

1. Remove the seat from the machine. Separate the seat from the air suspension.

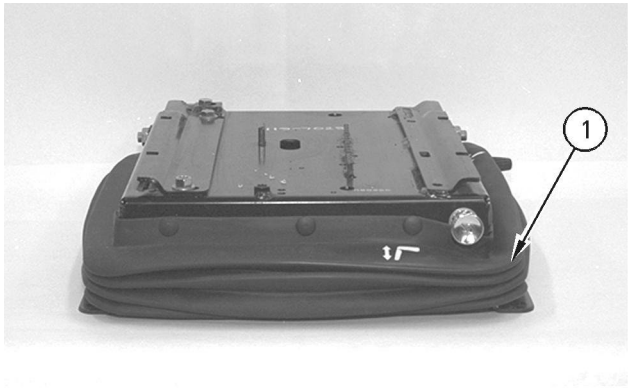


Illustration 155 g00275844

Typical Example

2. Remove boot (1).

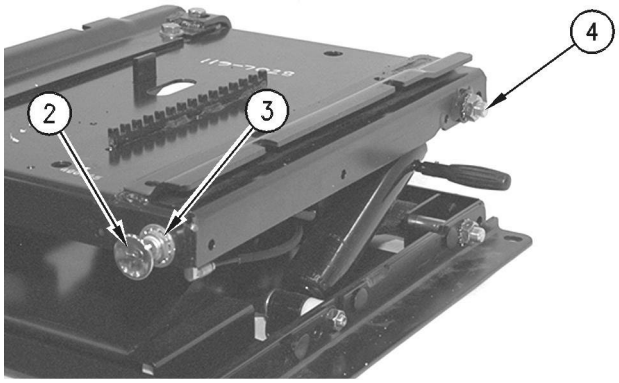


Illustration 156 g00275845

Typical Example

3. Loosen the setscrew on knob (2) and remove the knob. Remove nut (3) and the lock washer.

4. Remove locknut (4) and the lock washer. Remove the upper shaft assembly.

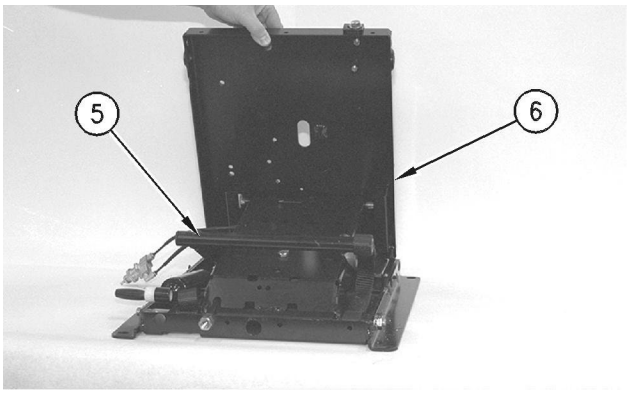


Illustration 157 g00275846

5. Tilt upper housing (6) forward. Slide the upper housing off scissor assembly (7).

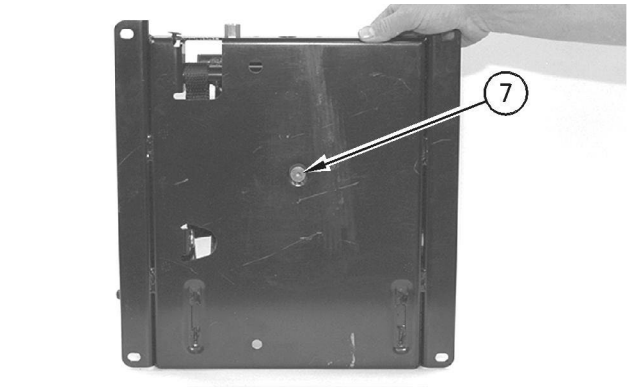


Illustration 158 g00275848

6. Remove screw (7) from the air spring, which is not shown.

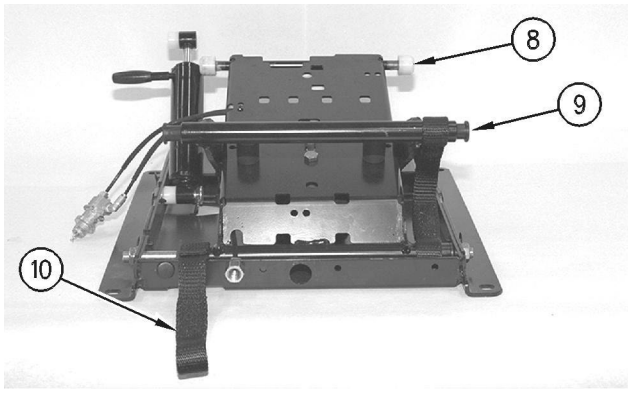


Illustration 159 g00275849

7. Disconnect two tether belts (10). Remove two bearings (9) and two rollers (9).

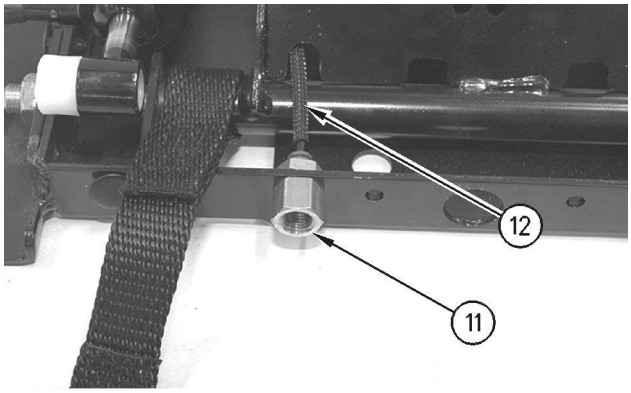


Illustration 160 g00275850

8. Disconnect tube (12) from fitting (11).

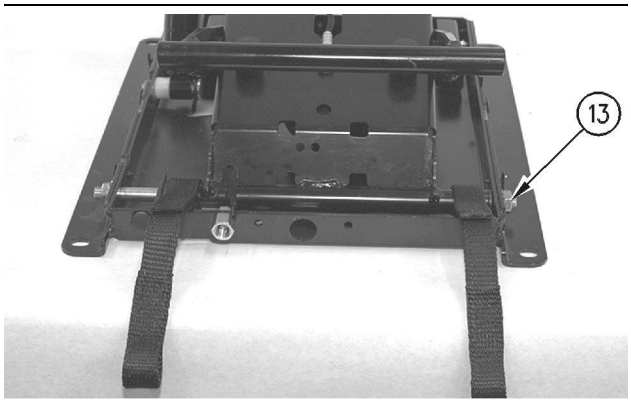


Illustration 161 g00275851

9. Remove locknut (13) and the lock washer. Remove the lower shaft assembly.

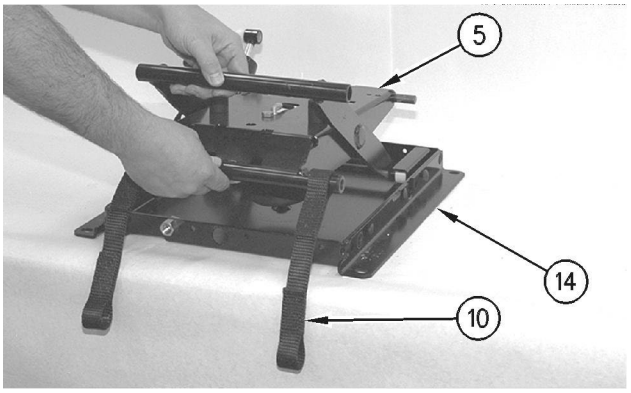


Illustration 162 g00275854

10. Remove two tether belts (10). Lift up scissor assembly (5) and slide the scissor assembly out of lower housing (14).

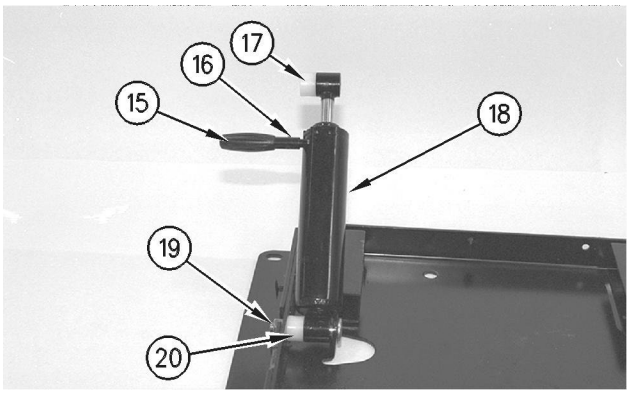


Illustration 163 g00275855
Typical Example

11. Remove cap (15) and shaft (16) from damper (18). Remove locknut (19), the pin, bearings (17) and (20), and damper (18).

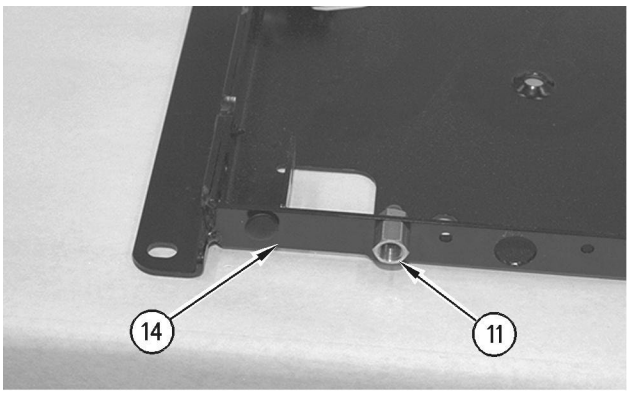


Illustration 164 g00275856

12. Remove fitting (11) from lower housing (14).

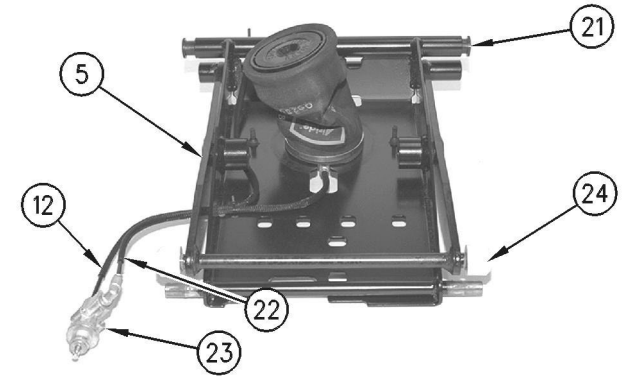


Illustration 165 g00275857

13. Remove two bearings (21) and two rollers (24) from scissor assembly (5). Disconnect tubes (22) and (12) from valve assembly (23).

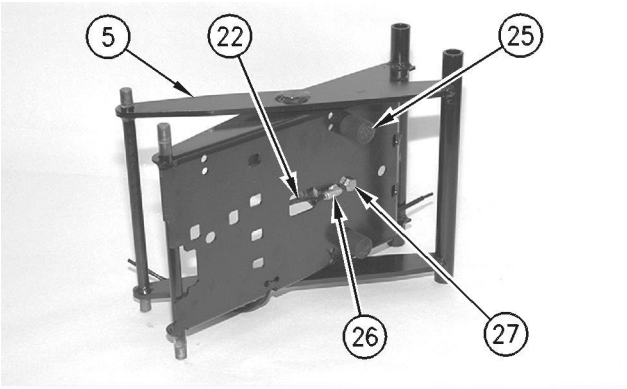


Illustration 166 g00275858

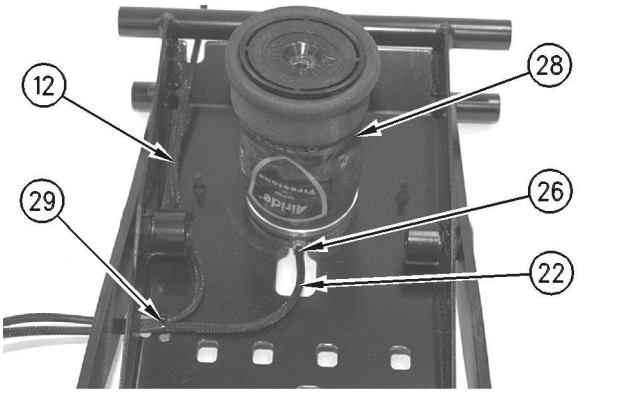


Illustration 167 g00275860

14. Remove two bumpers (25). Remove bolt (27) from air spring (28).

15. Disconnect tube (22) from fitting (26). Remove air spring (28) from scissor assembly (5).

16. Cut tie-wraps (29) that are holding tubes (22) and (12) to scissor assembly (5).

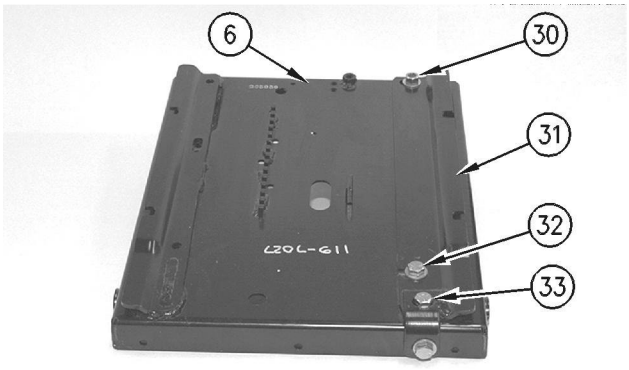


Illustration 168 g00275862
Typical Example

17. Remove two bolts (32) and the washers. Remove locknut (30) and the washer. Remove bolt (33). Remove slider track (31) from upper housing (6).

i07432502

Air Suspension With System Air - Assemble

SMCS Code: 7324-016-AJ

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up
S/N: FDB1–Up
S/N: JJB1–Up
S/N: 2AC1–Up
S/N: 3AC1–Up
S/N: 4RC1–Up
S/N: 6FC1–Up
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S/N: 7PC1–Up
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S/N: 9TC1–Up
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S/N: FDC1–Up
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S/N: ALR1–Up
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S/N: AXR1–Up
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S/N: BZR1–Up
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S/N: 9YS1–Up
S/N: 9ZS1–Up
S/N: ACS1–Up
S/N: AFS1–Up
S/N: AXS1–Up
S/N: JMS1–99999
S/N: AKT1–Up
S/N: ANT1–Up
S/N: 78V1–Up
S/N: 96V1–Up
S/N: 1CW1–Up
S/N: 1EW1–Up
S/N: 1HW1–Up
S/N: 1JW1–Up
S/N: 1KW1–Up
S/N: 1RW1–Up
S/N: 2BW1–Up
S/N: 2TW1–Up
S/N: 2XW1–Up
S/N: 2YW1–Up
S/N: 3JW1–Up
S/N: 3PW1–Up
S/N: 3SW1–Up
S/N: 4PW1–Up
S/N: 4WW1–Up
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S/N: 5MW1–Up
S/N: 5YW1–Up
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S/N: 64W1–Up
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S/N: 6EW1–Up
S/N: 6HW1–Up
S/N: 7BW1–Up
S/N: 8JW1–Up
S/N: 8XW1–Up
S/N: 9GW1–Up
S/N: A4W1–99999
S/N: AAW1–Up
S/N: ADW1–Up
S/N: AWW1–Up
S/N: AZW1–Up
S/N: FDW1–Up
S/N: 01X1–Up
S/N: 02X1–Up
S/N: 85X1–Up
S/N: 86X1–Up
S/N: 87X1–Up
S/N: AAX1–Up
S/N: AFX1–Up
S/N: APX1–Up
S/N: ASX1–Up
S/N: AXX1–Up
S/N: AZX1–99999
S/N: BTX1–Up
S/N: AGY1–Up
S/N: ALY1–Up
S/N: ANY1–Up
S/N: ATY1–Up
S/N: AWY1–Up

S/N: AXY1–Up
S/N: BMY1–Up
S/N: BXY1–Up
S/N: NYY1–Up
S/N: 06Z1–Up
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S/N: 17Z1–Up
S/N: 18Z1–Up
S/N: 21Z1–Up
S/N: 26Z1–Up
S/N: 2HZ1–Up
S/N: 2KZ1–Up
S/N: 2PZ1–Up
S/N: 32Z1–Up
S/N: 3TZ1–Up
S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 5AZ1–Up
S/N: 5KZ1–Up
S/N: 6GZ1–Up
S/N: 6YZ1–Up
S/N: 74Z1–Up
S/N: 79Z1–Up
S/N: 7MZ1–Up
S/N: 7PZ1–Up
S/N: 80Z1–Up
S/N: 92Z1–Up
S/N: ADZ1–Up
S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Assembly Procedure

Table 3

Tools Needed			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 243	1
B	-	Loctite LB 8632 Silicone Lubricant (1)	-
	-	Loctite LB 8104 Silicone Lubricant (2)	-
	-	Loctite LB 8801 Silicone Lubricant (3)	-
	-	Loctite LB Superlube (4)	-

(1) North America
(2) EAME
(3) Asia Pacific Division
(4) South America

1. Check the condition of all parts of the air suspension. If any of the parts are worn or damaged, install new parts.

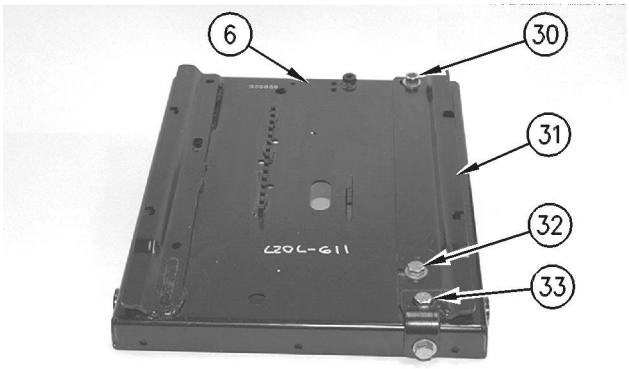


Illustration 169 g00275862
Typical Example

2. Position slider track (31) on upper housing (6). Install bolt (33), two bolts (32) and the washers. Tighten bolts (33) and (32) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Install locknut (30) and the washer. Tighten locknut (30) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

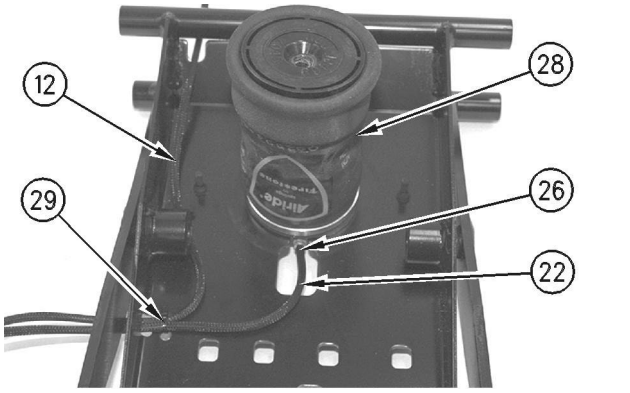


Illustration 170 g00275860

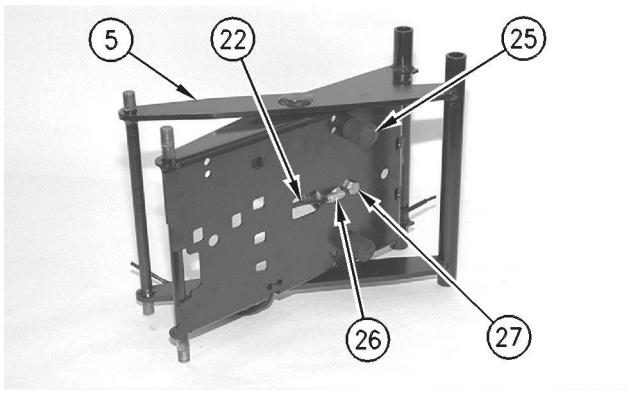


Illustration 171 g00275858

3. Position air spring (28) on scissor assembly (5). Apply Tooling (A) to the threads of bolt (27). Install bolt (27) that holds the air spring to scissor assembly (5). Tighten bolt (27) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

4. Position tubes (12) and (22) on scissor assembly (5). Install new tie-wraps (29) to secure the tubes to the scissor assembly.

5. Connect tube (22) to fitting (26) on air spring (28). Install two bumpers (25).

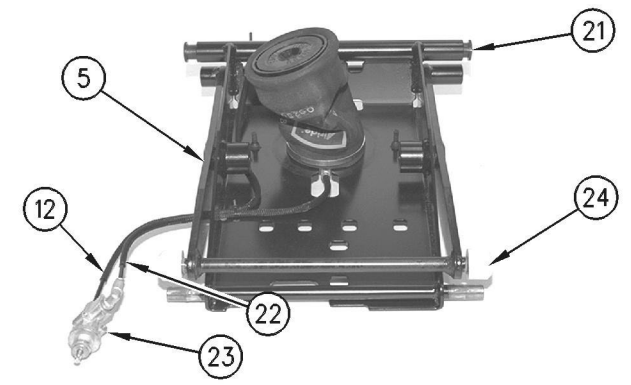


Illustration 172 g00275857

6. Apply Tooling (B) to scissor assembly (5) at the point of installation for two rollers (24). Install two rollers (24) and two bearings (21). Connect tubes (12) and (22) to valve assembly (23).

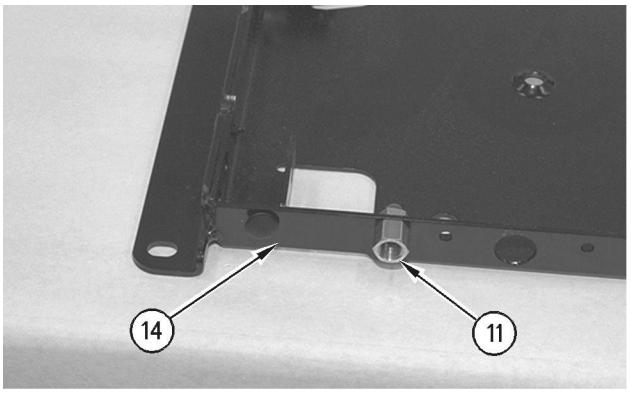


Illustration 173 g00275856

7. Install fitting (11) in lower housing (14).

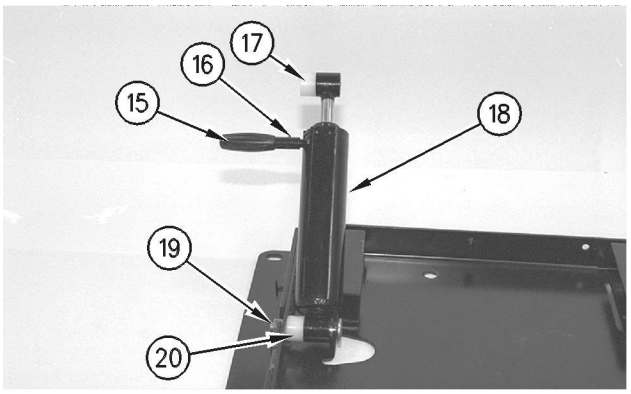


Illustration 174 g00275855
Typical Example

8. Install two bearings (17) and (20), damper (18), the pin and locknut (19). Tighten locknut (19) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Install shaft (7) and cap (15) on damper (18).

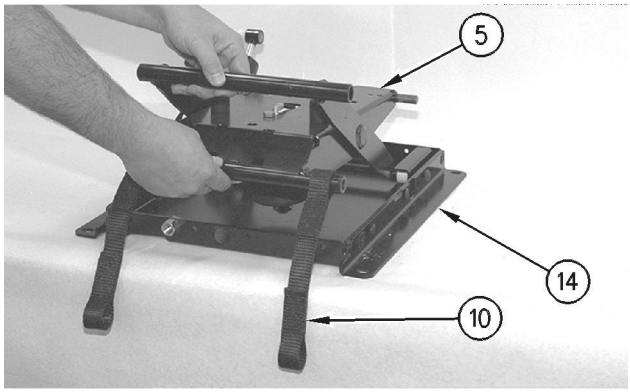


Illustration 175 g00275854

9. Install scissor assembly (5) into lower housing (14). Install two tether belts (10).

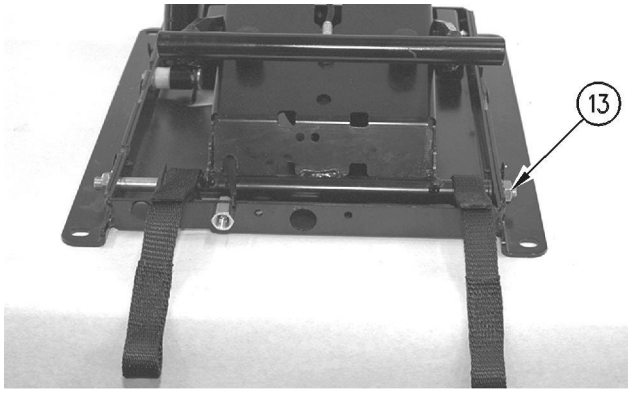


Illustration 176 g00275851

10. Install the lower shaft assembly. Install locknut (13) and the lock washer. Tighten locknut (13) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

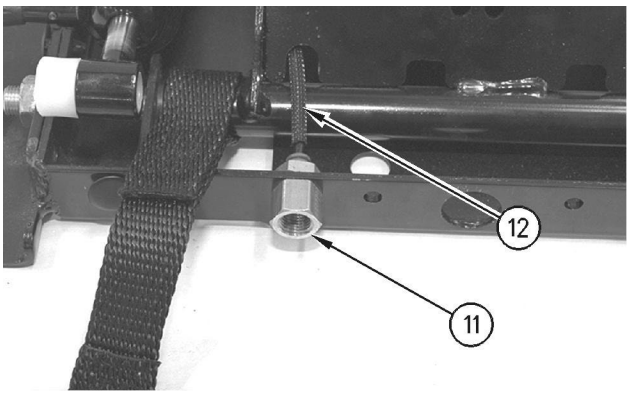


Illustration 177 g00275850

11. Connect tube (12) to fitting (11).

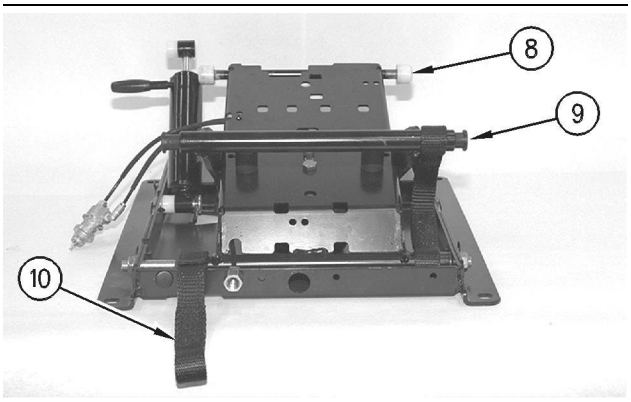


Illustration 178 g00275849
Typical Example

12. Install two tether belts (10) and two bearings (9). Apply Tooling (B) to the scissor assembly at the point of installation for rollers (8). Install rollers (8) on the scissor assembly.

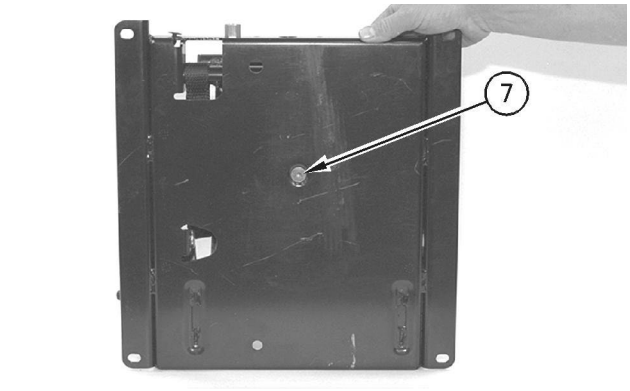


Illustration 179 g00275848

13. Apply Tooling (A) to the threads of screw (7). Install screw (7) to secure the air spring, which is not shown. Tighten the screw to a torque of 4.3 ± 1 N·m (38 ± 9 lb in).

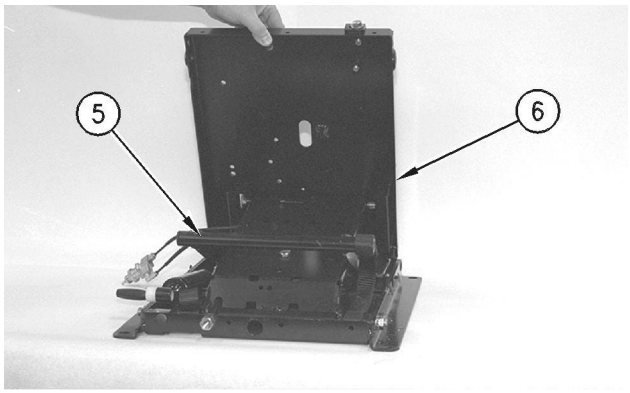


Illustration 180 g00275846

14. Install upper housing (6) on scissor assembly (5).

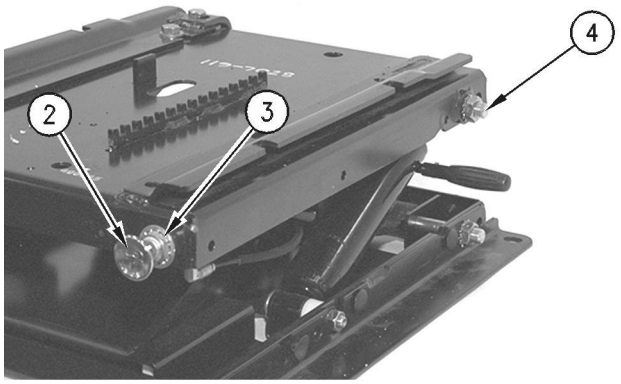


Illustration 181 g00275845
Typical Example

15. Install the upper shaft assembly, locknut (4), and the lock washer. Tighten the locknut to a torque of 40 ± 8 N·m (30 ± 6 lb ft). Install locknut (4) and the lock washer. Apply Tooling (A) to the setscrew of knob (2). Install knob (2) and the setscrew.

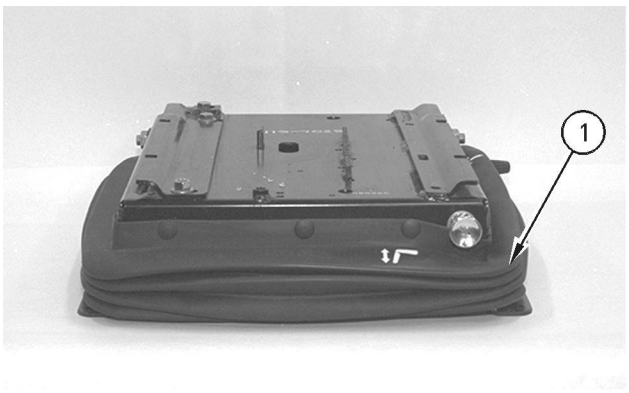


Illustration 182 g00275844
Typical Example

16. Install boot (1).

17. Install the seat on the air suspension. Install the seat in the machine.

i00644834

Mechanical Suspension With Fixed Damper - Disassemble

SMCS Code: 7324-015-ME

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up
S/N: AYB1–Up
S/N: BAB1–Up
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S/N: FDB1–Up
S/N: JJB1–Up
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S/N: 3AC1–Up
S/N: 4RC1–Up
S/N: 6FC1–Up
S/N: 7NC1–Up
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S/N: 2HS1–Up
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S/N: 2RS1–Up
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S/N: 2YS1–Up
S/N: 3AS1–Up
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S/N: 3DS1–Up
S/N: 3ZS1–Up
S/N: 4BS1–Up
S/N: 4CS1–Up
S/N: 4GS1–Up
S/N: 4HS1–Up
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S/N: 4NS1–Up
S/N: 4PS1–Up
S/N: 4YS1–Up
S/N: 5AS1–Up
S/N: 5ES1–Up
S/N: 5FS1–Up

S/N: 5KS1–Up
S/N: 5RS1–Up
S/N: 5SS1–Up
S/N: 6AS1–Up
S/N: 6NS1–Up
S/N: 6PS1–Up
S/N: 6WS1–Up
S/N: 6YS1–Up
S/N: 7BS1–Up
S/N: 7CS1–Up
S/N: 7LS1–Up
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S/N: 9BS1–Up
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S/N: 9RS1–Up
S/N: 9XS1–Up
S/N: 9YS1–Up
S/N: 9ZS1–Up
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S/N: AFS1–Up
S/N: AXS1–Up
S/N: JMS1–99999
S/N: AKT1–Up
S/N: ANT1–Up
S/N: 78V1–Up
S/N: 96V1–Up
S/N: 1CW1–Up
S/N: 1EW1–Up
S/N: 1HW1–Up
S/N: 1JW1–Up
S/N: 1KW1–Up
S/N: 1RW1–Up
S/N: 2BW1–Up
S/N: 2TW1–Up
S/N: 2XW1–Up
S/N: 2YW1–Up
S/N: 3JW1–Up
S/N: 3PW1–Up
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S/N: 8XW1–Up
S/N: 9GW1–Up
S/N: A4W1–99999
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S/N: ADW1–Up
S/N: AWW1–Up
S/N: AZW1–Up
S/N: FDW1–Up
S/N: 01X1–Up
S/N: 02X1–Up
S/N: 85X1–Up
S/N: 86X1–Up
S/N: 87X1–Up
S/N: AAX1–Up
S/N: AFX1–Up
S/N: APX1–Up
S/N: ASX1–Up
S/N: AXX1–Up
S/N: AZX1–99999
S/N: BTX1–Up
S/N: AGY1–Up
S/N: ALY1–Up

S/N: ANY1–Up
S/N: ATY1–Up
S/N: AWY1–Up
S/N: AXY1–Up
S/N: BMY1–Up
S/N: BXY1–Up
S/N: NYY1–Up
S/N: 06Z1–Up
S/N: 11Z1–Up
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S/N: 21Z1–Up
S/N: 26Z1–Up
S/N: 2HZ1–Up
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S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 5AZ1–Up
S/N: 5KZ1–Up
S/N: 6GZ1–Up
S/N: 6YZ1–Up
S/N: 74Z1–Up
S/N: 79Z1–Up
S/N: 7MZ1–Up
S/N: 7PZ1–Up
S/N: 80Z1–Up
S/N: 92Z1–Up
S/N: ADZ1–Up
S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Disassembly Procedure

Table 4

Tools Needed			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6613	Spring Compressor	1

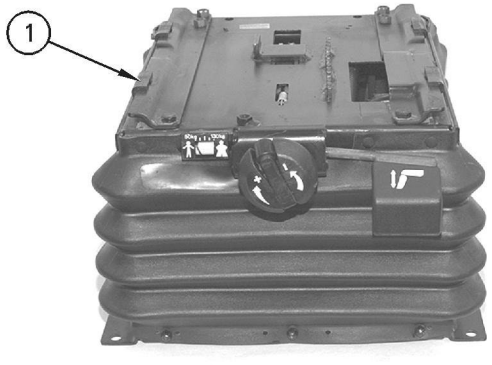


Illustration 183 g00288290

1. Remove four slider blocks (1).

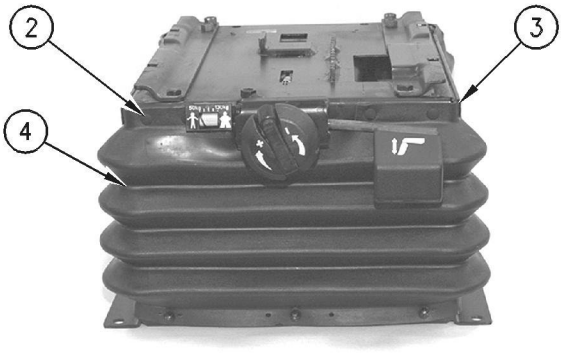


Illustration 184 g00288292

2. Remove fasteners (2). Remove two retainers (3) and boot (4).



Illustration 185 g00288293

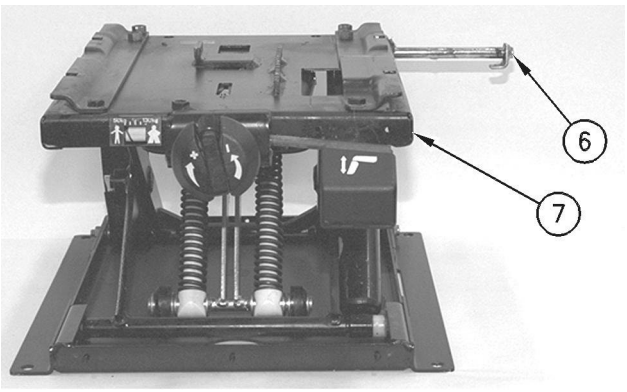


Illustration 186 g00288294

3. Remove locknut (5). Remove upper shaft assembly (6) from upper housing (7).

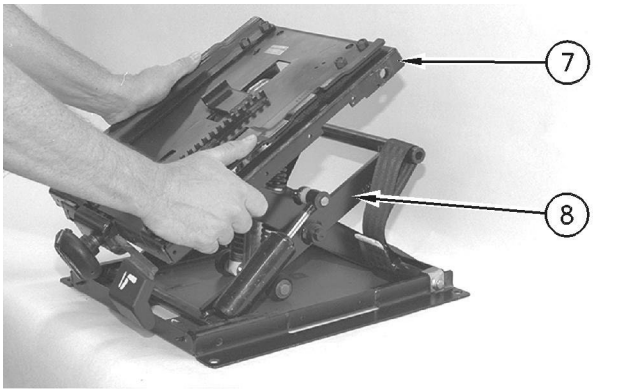


Illustration 187 g00288295

4. Tip upper housing (7) forward and slide the upper housing off scissor assembly (8).

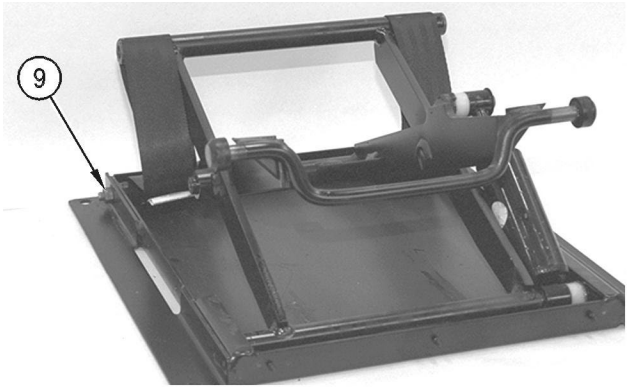


Illustration 188 g00288336

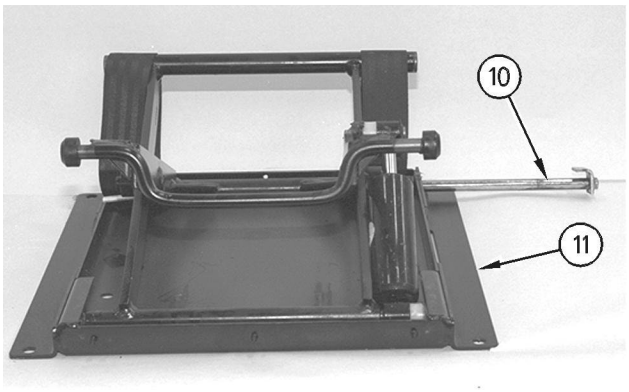


Illustration 189 g00288337

5. Remove locknut (9) from lower shaft assembly (10). Remove lower shaft assembly (10) from lower housing (11).

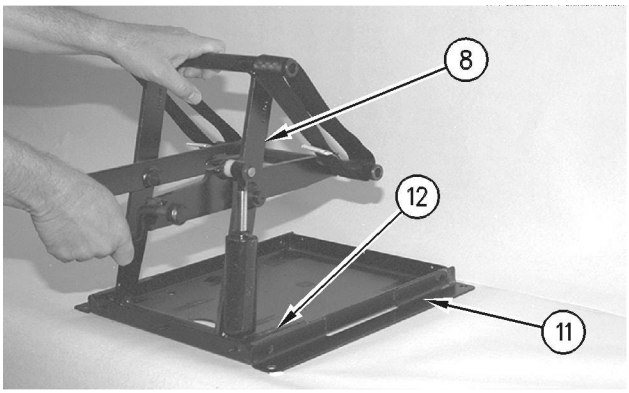


Illustration 190 g00288338

6. Remove scissor assembly (8) from lower housing (11). Lift the scissor assembly and slide the scissor assembly out of slider track (12).

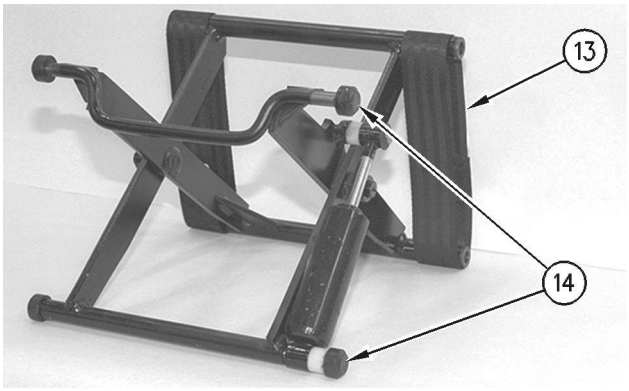


Illustration 191 g00288340

7. Remove four rollers (14) and two tether belts (13).

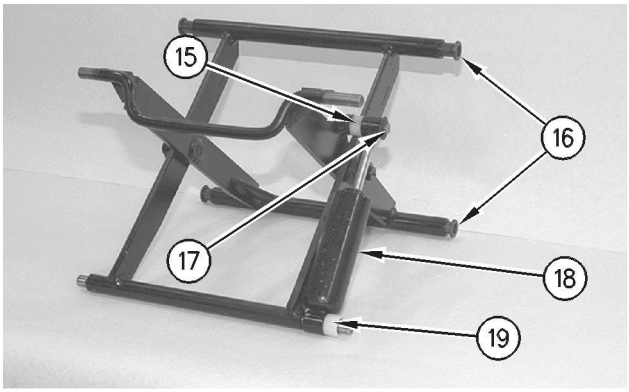


Illustration 192 g00288343

8. Remove four bearings (16). Remove retainer (17), two bearings (15) and (19), and damper (18).

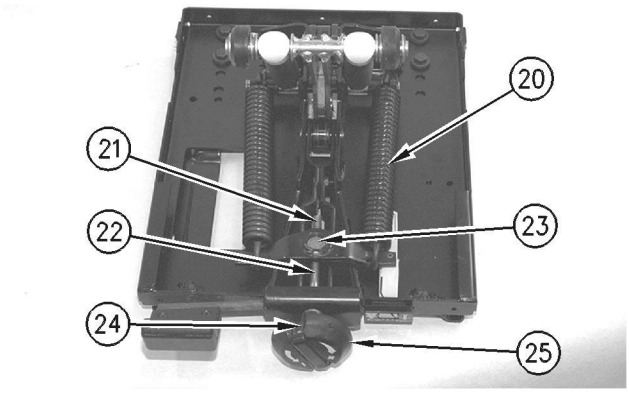


Illustration 193 g00288344

9. Remove pin (21) from the end of weight adjustment screw (22). Turn weight adjustment knob (25) in the negative (−) direction in order to relieve the tension on springs (20). Remove pin (24), weight adjustment knob (25), the thrust bearing, two races, weight adjustment screw (22) and nut (23).

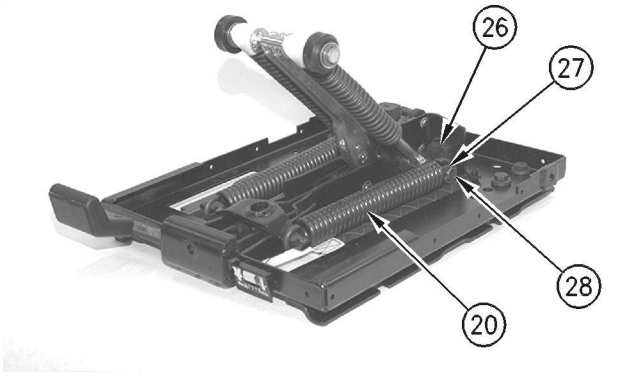


Illustration 194 g00288345

10. Remove retaining ring (27) from each side of height adjustment shaft (28). Remove two springs (20) and plastic bearings (26) from height adjustment shaft (28).

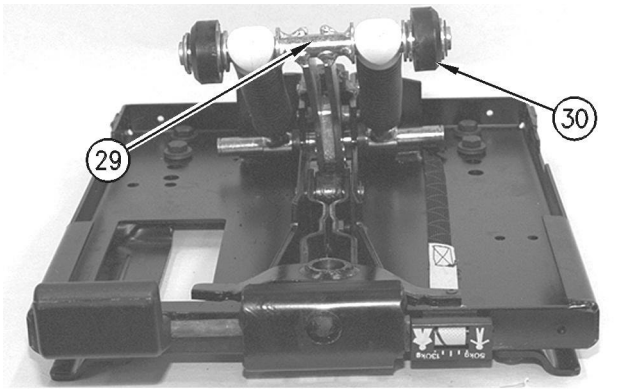


Illustration 195 g00288346

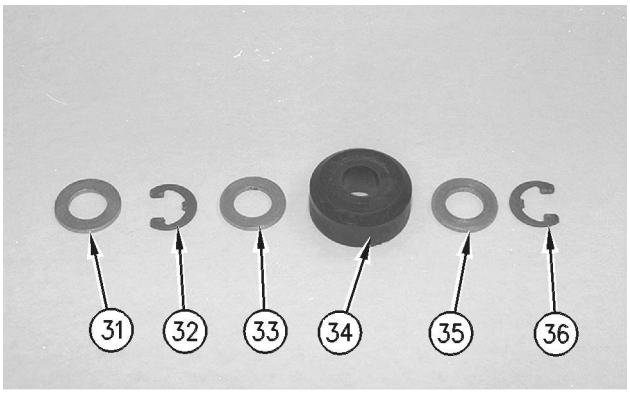


Illustration 196 g00288348

11. Remove roller assembly (30) from each side of suspension arm (29). Remove retaining rings (32) and (36), washers (31), (33) and (35), and rollers (34).

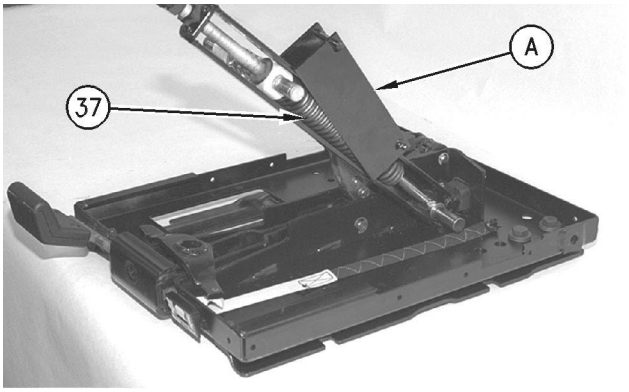


Illustration 197 g00288349

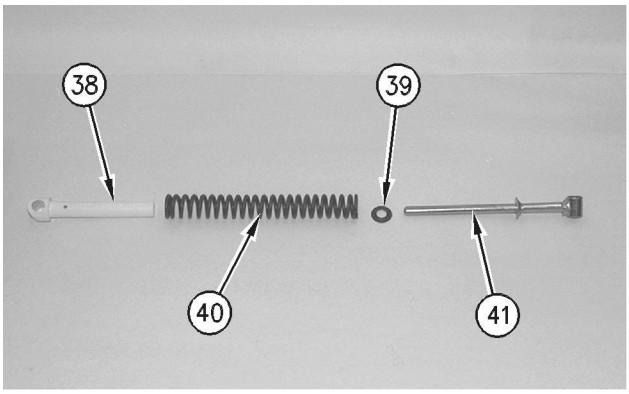


Illustration 198 g00288350

12. Attach Tool (A) to spring assembly (37), as shown. Use Tool (A) to remove the spring assembly from the shaft as a unit.

13. Use Tool (A) to slowly release the compression on spring assembly (37). Disassemble spring assembly (37). Remove guide bushing (38), spring (40), retainer (39) and rod assembly (41).

14. Repeat Steps 12 and 13 for the spring assembly on the other side of the suspension arm.

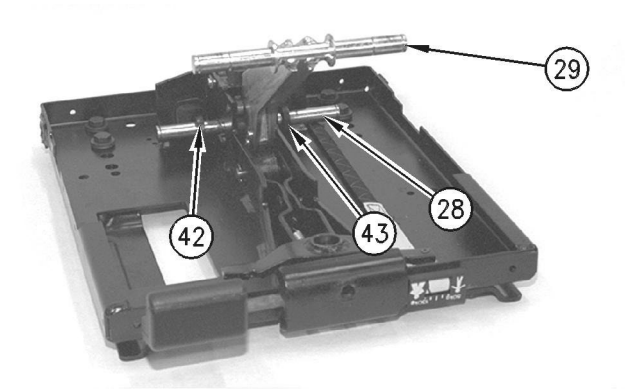


Illustration 199 g00288351

15. Remove spacers (42) and (43) from shaft (28). Remove the shaft and suspension arm (29).

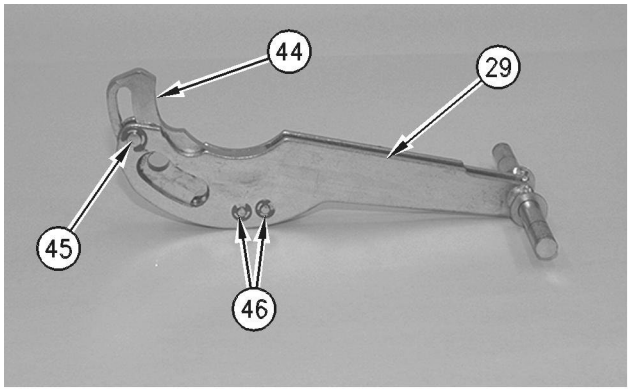


Illustration 200 g00288352

16. Remove retaining rings (45) and (46). Use a hammer and a punch to remove the pins. Remove cam (44) from suspension arm (29).

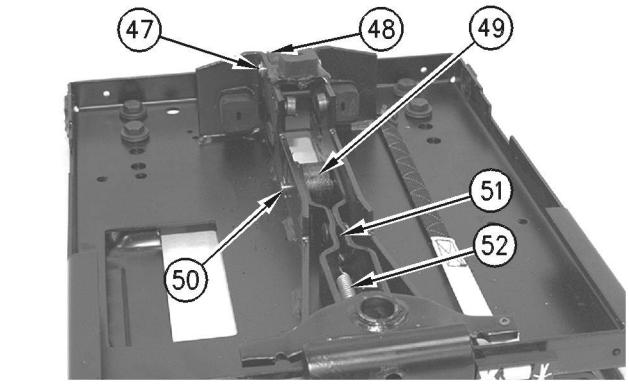


Illustration 201 g00288354

17. Remove retaining ring (50). Use a hammer and a punch to remove the pin. Remove roller (49). Remove retaining ring (47). Use a hammer and a punch to remove the pin. Remove roller (48) and two spacers. Remove spring (52) and arm assembly (51).

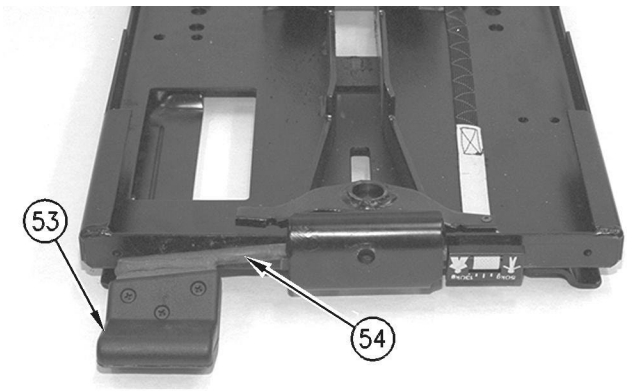


Illustration 202 g00288355

18. Remove the key for the height adjustment lever. (The key is not shown.) Remove handle (53) and height adjustment lever (54).

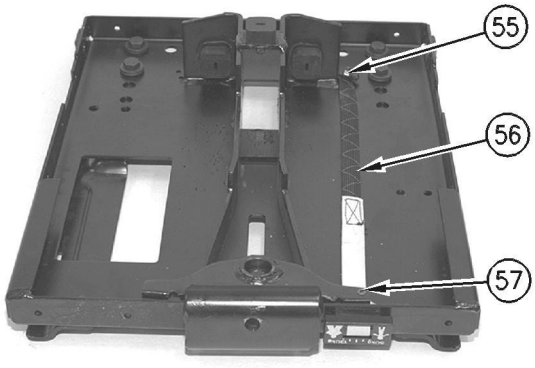


Illustration 203 g00288356

19. Remove pin (57) from the bracket. Cut tie-wraps (55). Remove indicator band (56).

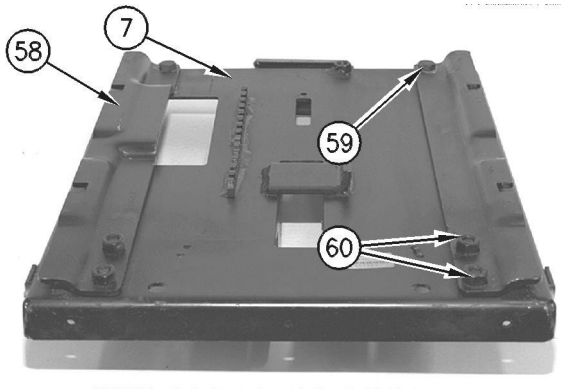


Illustration 204 g00288357

20. Remove four bolts (60), two bolts (59), the washers, and the locknuts from two brackets (58). Remove two brackets (58) from upper housing (7).

i07432498

Mechanical Suspension With Fixed Damper - Assemble

SMCS Code: 7324-016-ME

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up

S/N: FDB1–Up

S/N: JJB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: AAC1–Up

S/N: AEC1–Up

S/N: AGC1–Up

S/N: AXC1–Up

S/N: BEC1–Up

S/N: BNC1–Up

S/N: BPC1–Up

S/N: CFC1–Up

S/N: FDC1–Up

S/N: H4C1–Up

S/N: MCC1–Up

S/N: MJC1–Up

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S/N: 1JD1–Up

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S/N: A7D1–Up
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S/N: AYE1–Up
S/N: B9E1–Up
S/N: BLE1–Up
S/N: 2XF1–Up
S/N: 3ZF1–Up
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S/N: 3DN1–Up
S/N: 3WN1–Up
S/N: 3ZN1–Up
S/N: 4HN1–Up
S/N: 4JN1–Up
S/N: 4MN1–Up
S/N: 4RN1–Up
S/N: 4SN1–Up
S/N: 5FN1–Up
S/N: 5LN1–Up
S/N: 5TN1–Up
S/N: 6FN1–Up
S/N: 6GN1–Up
S/N: 6JN1–Up
S/N: 6RN1–Up
S/N: 7CN1–Up
S/N: 7FN1–Up
S/N: 7GN1–Up
S/N: 7KN1–Up
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S/N: 9TN1–Up
S/N: 9ZN1–Up
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S/N: AXN1–Up
S/N: BBN1–Up
S/N: BYN1–Up
S/N: CFN1–Up
S/N: JAN1–Up
S/N: AEP1–Up
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S/N: AMP1–Up
S/N: AWP1–Up
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S/N: DMP1–Up
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S/N: 2WR1–Up
S/N: 2ZR1–Up
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S/N: 3KR1–Up
S/N: 3PR1–Up
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S/N: 4ER1–Up
S/N: 4FR1–Up
S/N: 4JR1–Up
S/N: 4SR1–Up
S/N: 4TR1–Up
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S/N: 4HS1–Up
S/N: 4JS1–Up
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S/N: 96V1–Up
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S/N: 1KW1–Up
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S/N: 2YW1–Up
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S/N: FDW1–Up
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S/N: 02X1–Up
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S/N: AGY1–Up
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S/N: AWY1–Up
S/N: AXY1–Up
S/N: BMY1–Up
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S/N: 6YZ1–Up
S/N: 74Z1–Up
S/N: 79Z1–Up
S/N: 7MZ1–Up
S/N: 7PZ1–Up
S/N: 80Z1–Up

S/N: 92Z1–Up

S/N: ADZ1–Up

S/N: ANZ1–Up

S/N: AZZ1–Up

S/N: CBZ1–Up

Assembly Procedure

Table 5

Tools Needed			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6613	Spring Compressor	1
B	-	Loctite LB 8632 Silicone Lubricant (1)	-
	-	Loctite LB 8104 Silicone Lubricant (2)	-
	-	Loctite LB 8801 Silicone Lubricant (3)	-
	-	Loctite LB Superlube (4)	-

(1) North America
(2) EAME
(3) Asia Pacific Division
(4) South America

1. Check the condition of all parts of the mechanical suspension. If any of the parts are worn or damaged, install new parts.

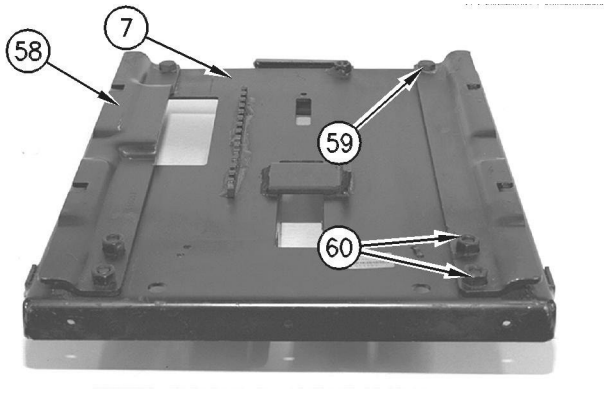


Illustration 205 g00288357

2. Install two brackets (58) on upper housing (7). Install the washers, four bolts (60), two bolts (59), and the locknuts on two brackets (58). Tighten the bolts to a torque of 25 ± 6 N·m (18 ± 4 lb ft).

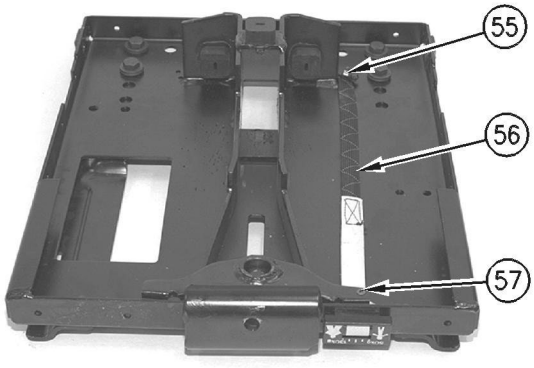


Illustration 206 g00288356

3. Install indicator band (56) and new tie-wraps (55). Install pin (57) in the bracket.

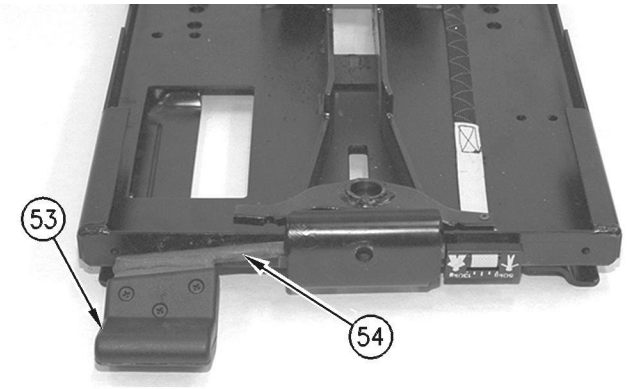


Illustration 207 g00288355

4. Install height adjustment lever (54) and handle (53). Install the key for the height adjustment lever.

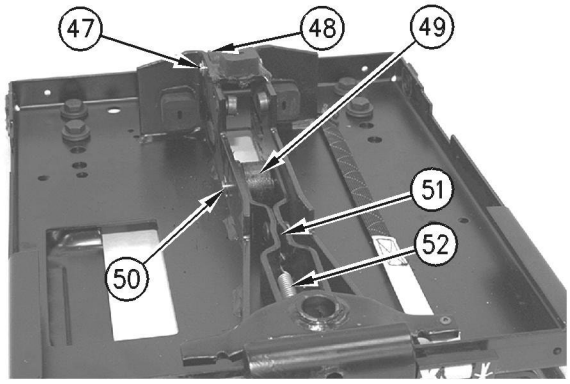


Illustration 208 g00288354

Note: Apply Tooling (B) to the roller shafts before installation.

5. Install arm assembly (51) and spring (52). Install roller (48), two spacers, and the pin. Install retaining ring (47). Install roller (49) and the pin. Install retaining ring (50). Make sure that the rollers do not bind.

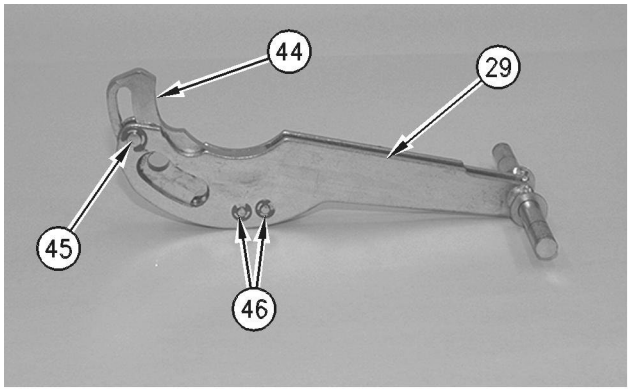


Illustration 209 g00288352

6. Install cam (44) in suspension arm (29). Install retaining rings (45) and (46) and the pins.

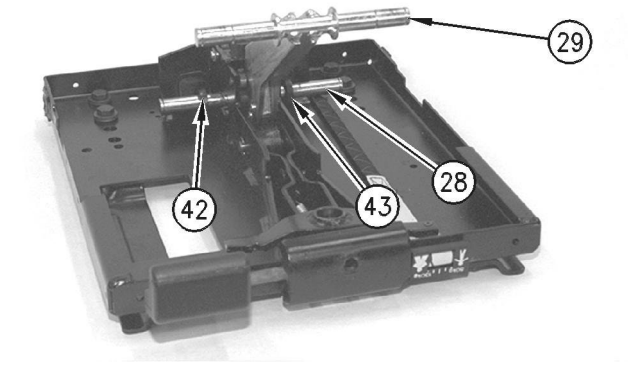


Illustration 210 g00288351

7. Install the shaft and suspension arm (29). Install spacers (42) and (43) on shaft (28).

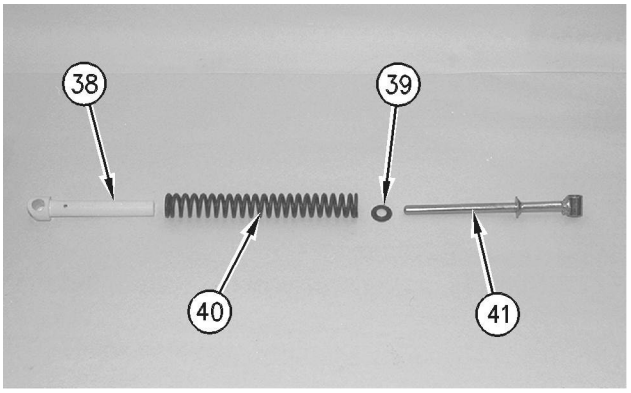


Illustration 211 g00288350

8. Install rod assembly (41), retainer (39), spring (40), and guide bushing (38). Assemble spring assembly (37).

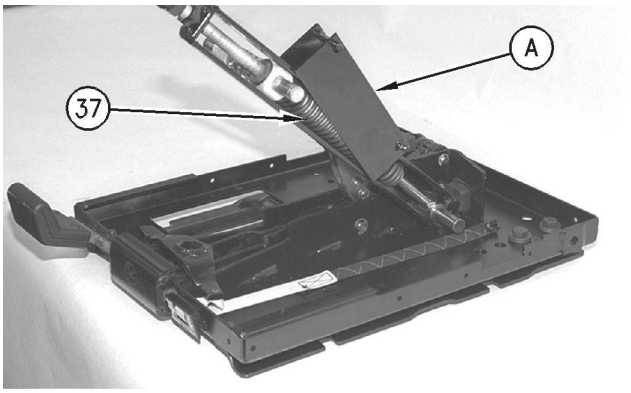


Illustration 212 g00288349

9. Attach Tool (A) to spring assembly (37), as shown. Slowly compress spring assembly (37). Use Tool (A) to install the spring assembly on the shaft.

10. Repeat Steps 8 and 9 for the spring assembly on the other side of the suspension arm.

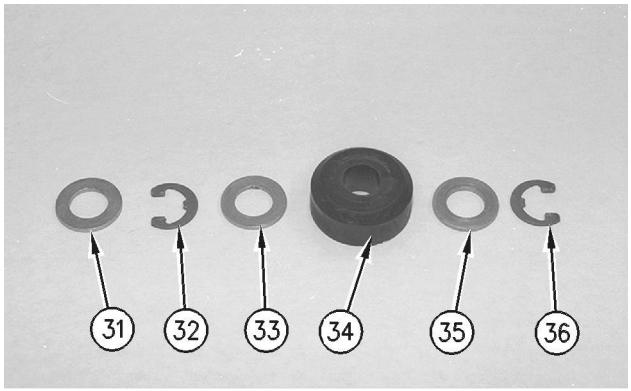


Illustration 213 g00288348

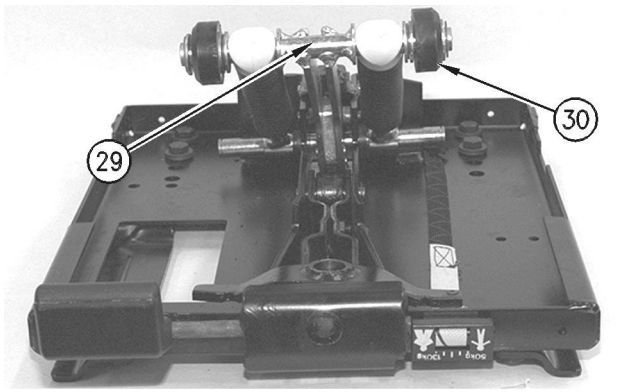


Illustration 214 g00288346

Note: Apply Tooling (B) to the roller shafts before installation.

11. Install retaining rings (32) and (36), washers (31), (33) and (35), and rollers (34). Install roller assembly (30) on each side of suspension arm (29). Make sure that the rollers do not bind.

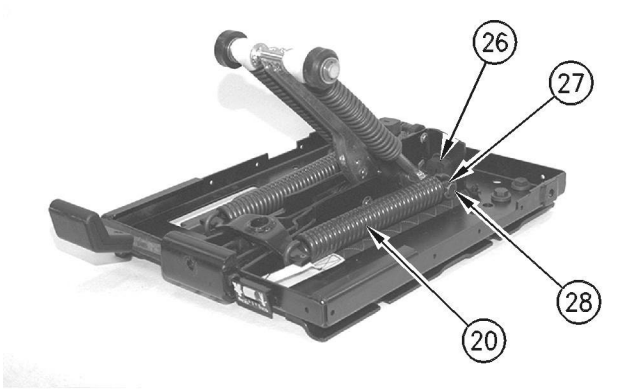


Illustration 215 g00288345

12. Install two springs (20) and plastic bearings (26) on height adjustment shaft (28). Install retaining ring (27) on each side of height adjustment shaft (28).

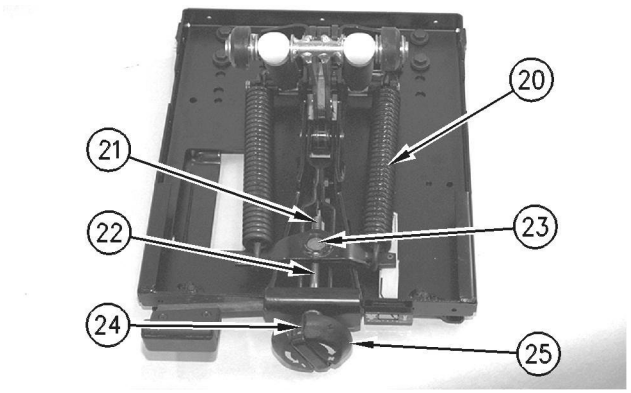


Illustration 216 g00288344

13. Install nut (23), weight adjustment screw (22), two races, the thrust bearing, weight adjustment knob (25) and pin (24). Turn weight adjustment knob (25) in the positive (+) direction to apply tension to springs (20). Install pin (21) in the end of weight adjustment screw (22).

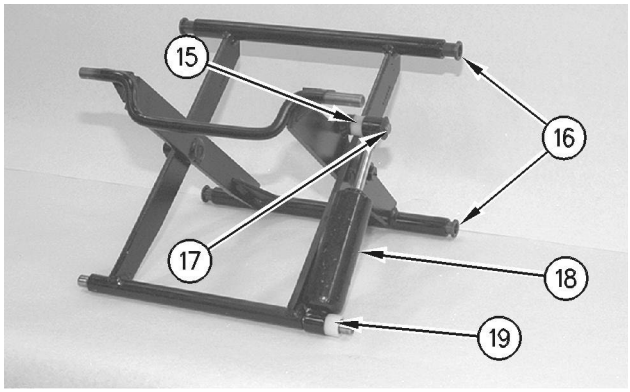


Illustration 217 g00288343

14. Install damper (18), two bearings (15) and (19), and retainer (17). Install four bearings (16).

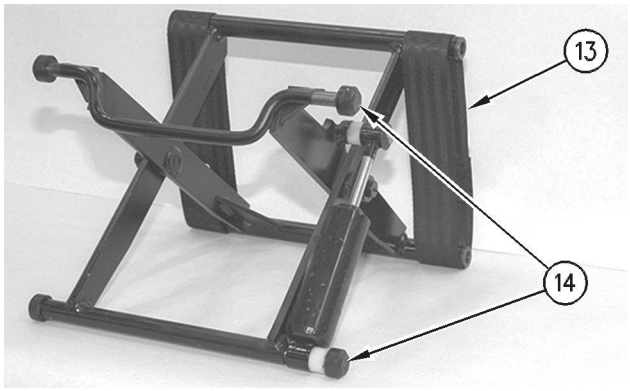


Illustration 218 g00288340

Note: Apply Tooling (B) to the roller shafts before installation.

15. Install four rollers (14) and two tether belts (13). Make sure that the rollers do not bind.

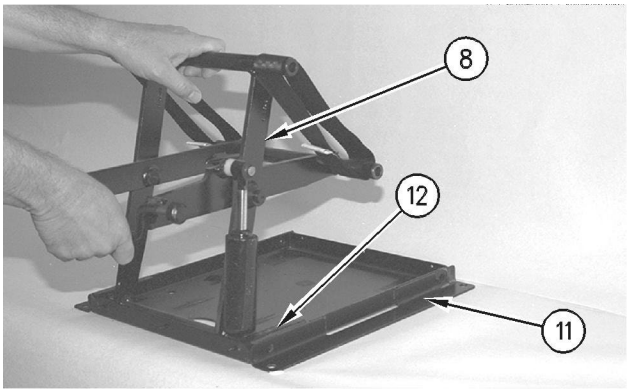


Illustration 219 g00288338

16. Install scissor assembly (8) on lower housing (11). Slide the scissor assembly into slider track (12).

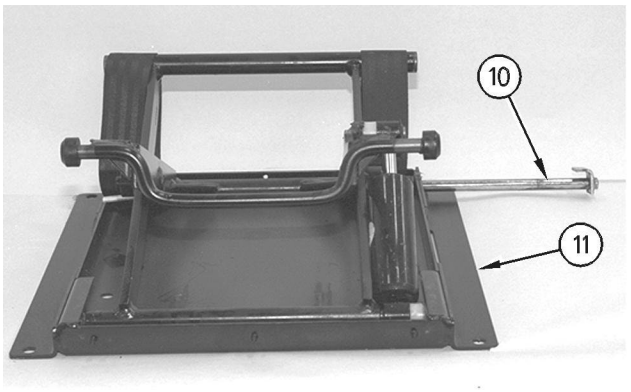


Illustration 220 g00288337

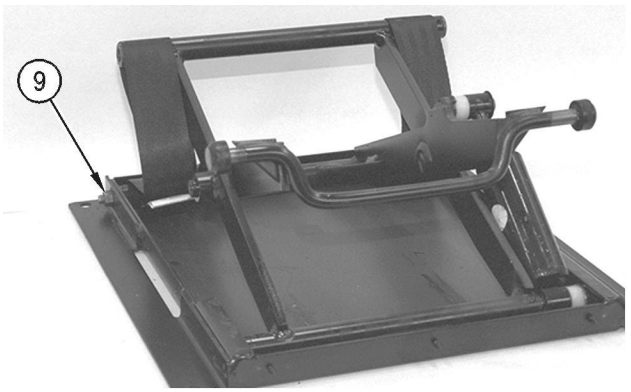


Illustration 221 g00288336

17. Install lower shaft assembly (10) in lower housing (11). Install locknut (9) on lower shaft assembly (10).

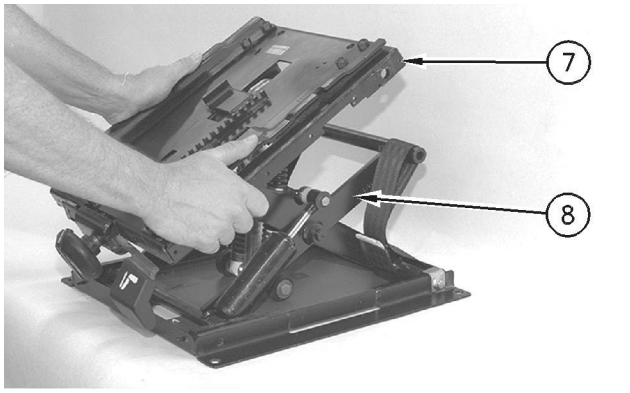


Illustration 222 g00288295

18. Tip upper housing (7) forward and slide the upper housing onto scissor assembly (8).

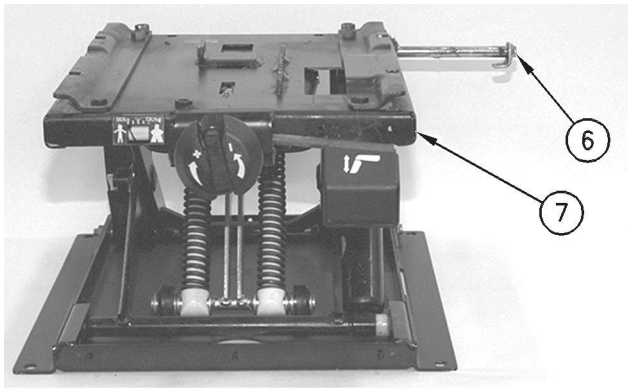


Illustration 223 g00288294



Illustration 224 g00288293

19. Install upper shaft assembly (6) in upper housing (7). Install locknut (5).

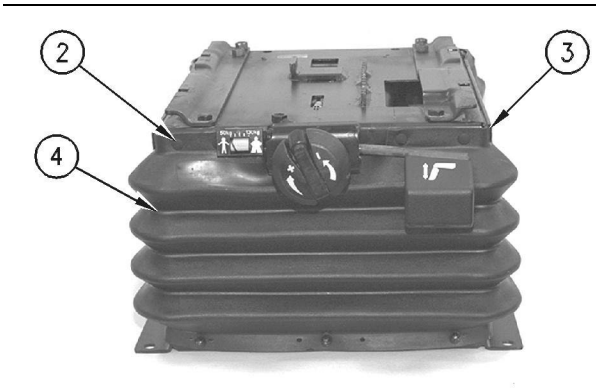


Illustration 225 g00288292

20. Remove fasteners (2). Install boot (4) and two retainers (3).

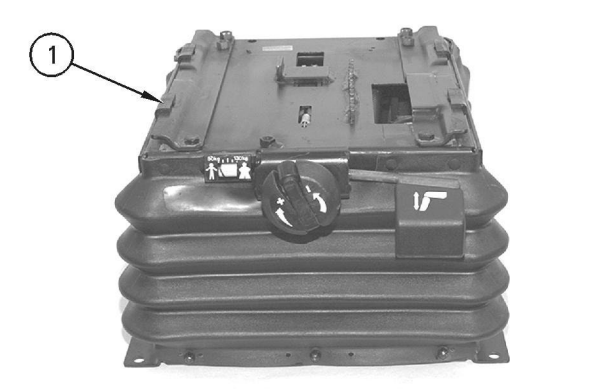


Illustration 226 g00288290

21. Install four slider blocks (1).

i00645520

Mechanical Suspension With Variable Damper - Disassemble

SMCS Code: 7324-015-ME

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up
S/N: N4A1–Up
S/N: 8GB1–Up
S/N: 8HB1–Up
S/N: 8KB1–Up
S/N: 8PB1–Up
S/N: 9DB1–Up
S/N: AXB1–Up
S/N: AYB1–Up
S/N: BAB1–Up
S/N: BBB1–Up
S/N: FDB1–Up
S/N: JJB1–Up
S/N: 2AC1–Up
S/N: 3AC1–Up
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S/N: 7NC1–Up
S/N: 7PC1–Up
S/N: 8FC1–Up
S/N: 8RC1–Up
S/N: 8YC1–Up
S/N: 9HC1–Up
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S/N: 2YD1–Up
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S/N: BLE1–Up
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S/N: AWF1–Up
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S/N: ACJ1–Up
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S/N: ADZ1–Up
S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Disassembly Procedure

Table 6

Tools Needed			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6613	Spring Compressor	1

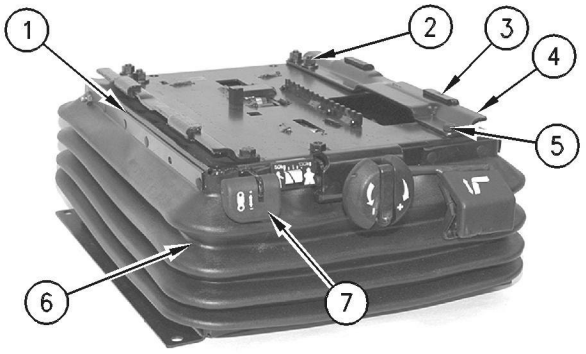


Illustration 227 g00288360

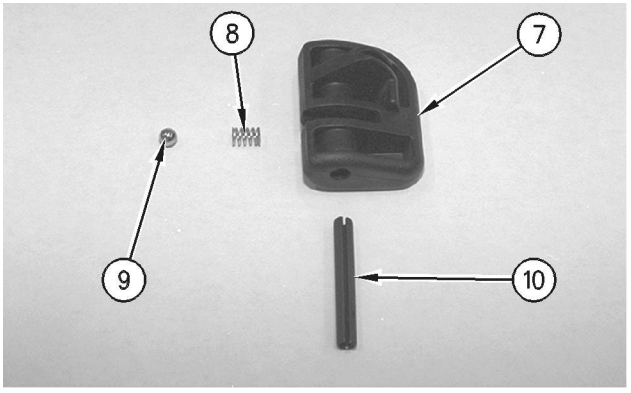


Illustration 228 g00288361

1. Remove four slider blocks (3). Remove four bolts (2), two bolts (5), the washers, and the locknuts from two brackets (4).

2. Remove boot (6) and two retainers (1). Use a hammer and a punch to remove pin (10). Remove knob (7), spring (8) and ball (9).

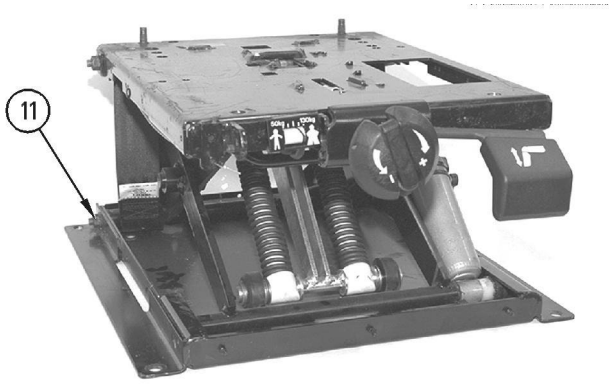


Illustration 229 g00288362

3. Remove locknut (11). Remove the lower shaft assembly.

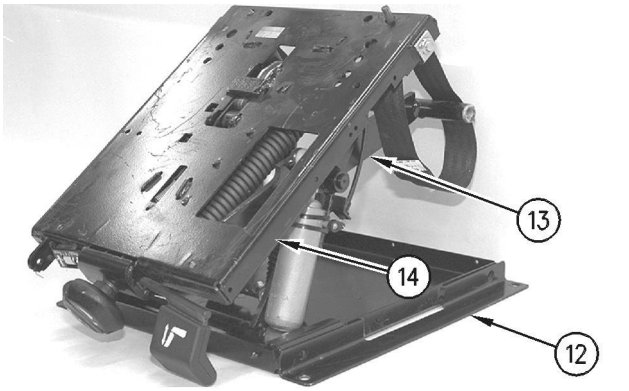


Illustration 230 g00288363

4. Lift up lower housing (12). Tilt the lower housing forward in order to remove the lower housing from scissor assembly (13) and from upper housing (14). Remove the tie-wraps that are holding the adjustable cable to upper housing (14).

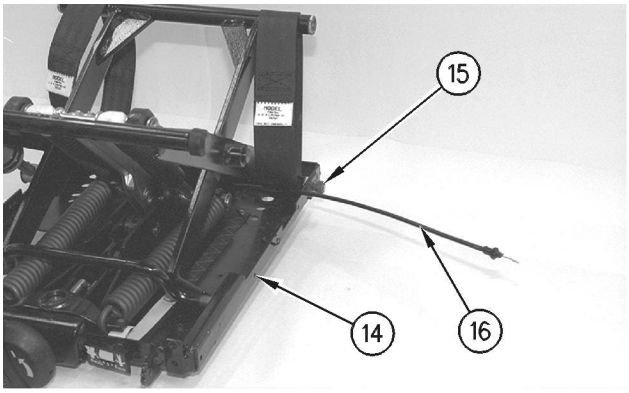


Illustration 231 g00288364

5. Remove locknut (15) from the upper shaft assembly. Remove the upper shaft assembly. Slide wire cable (16) from upper housing (14).

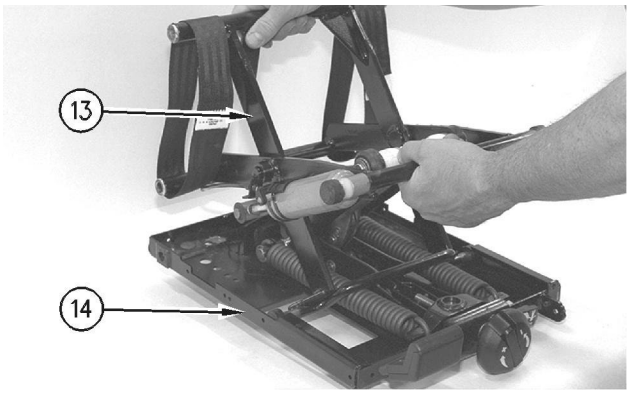


Illustration 232 g00288365

6. Lift up scissor assembly (13). Tilt the scissor assembly forward and remove the scissor assembly from upper housing (14).

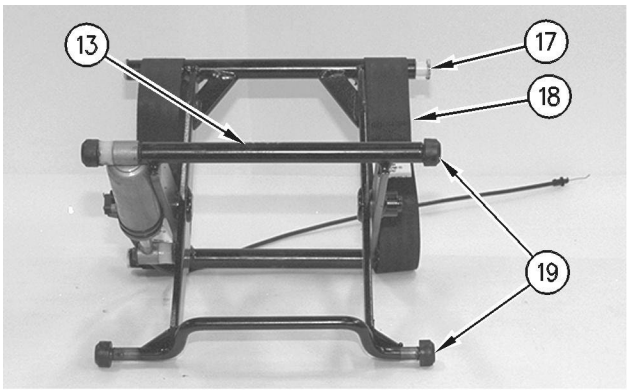


Illustration 233 g00288367

7. Remove two tether belts (18), four rollers (19) and four bearings (17) from scissor assembly (13).

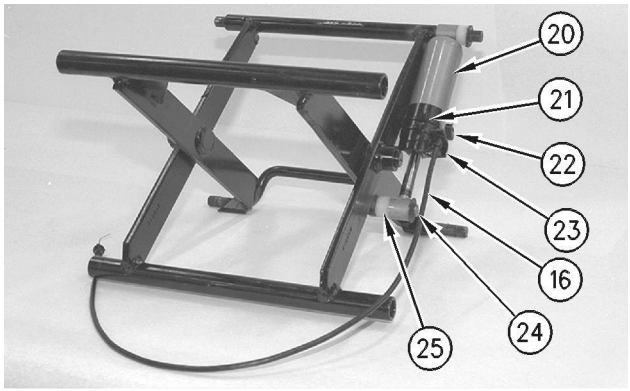


Illustration 234 g00288368

Note: During removal of the wire cable, the wire cable will be cut. The wire cable will not be reusable. A new wire cable must be installed during assembly of the mechanical suspension.

8. Cut wire cable (16) at the point of connection to bracket (23). Remove the wire cable from the variable damper. Use a hammer and a punch to remove the pin from arm (22). Remove adjustable bracket (21). Remove arm (22), bracket (23), two bearings (25), retainer (24) and variable damper (20).

Note: Adjustable bracket (21) must be replaced. The bracket will be damaged during the removal procedure.

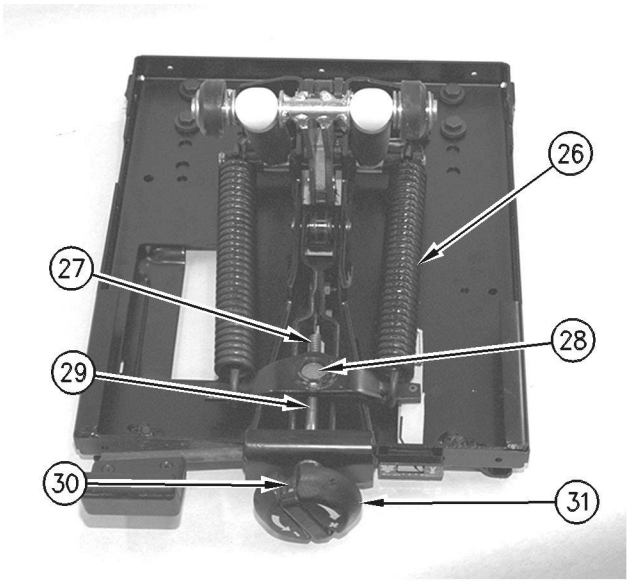


Illustration 235 g00288369

9. Remove pin (27) from the end of weight adjustment screw (29). Turn weight adjustment knob (31) in the negative (−) direction in order to relieve the tension on springs (26). Remove pin (30), weight adjustment knob (31), the thrust bearing, two races, weight adjustment screw (29) and nut (28).

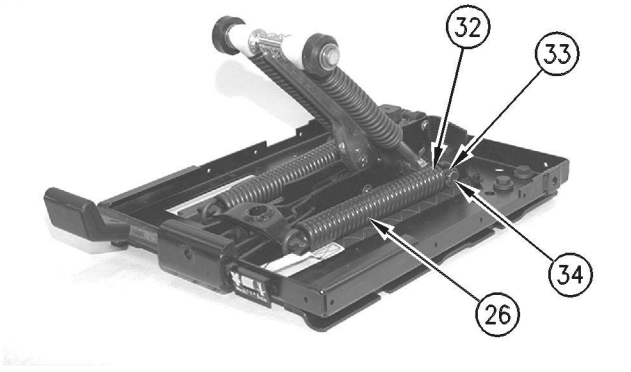


Illustration 236 g00288370

10. Remove retaining ring (33) from each side of height adjustment shaft (34). Remove two springs (26) and plastic bearings (32) from height adjustment shaft (34).

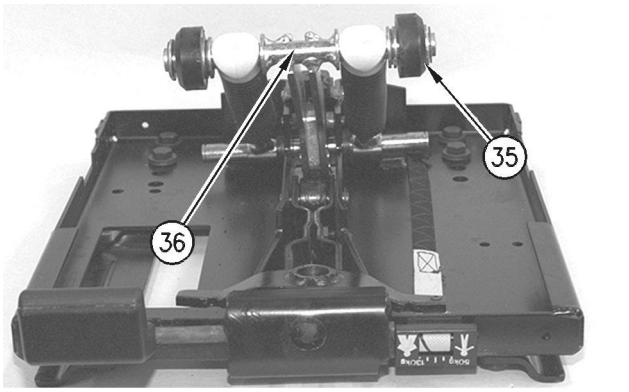


Illustration 237 g00288371

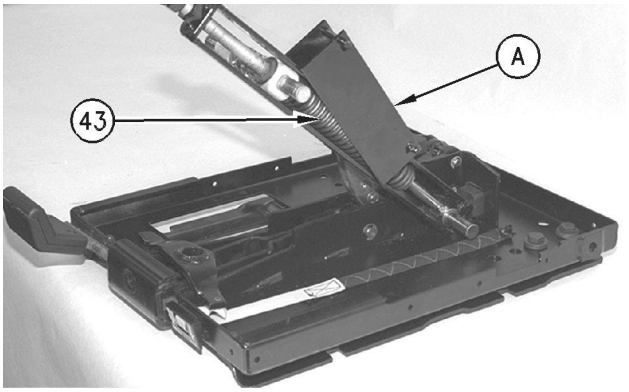


Illustration 239 g00288375

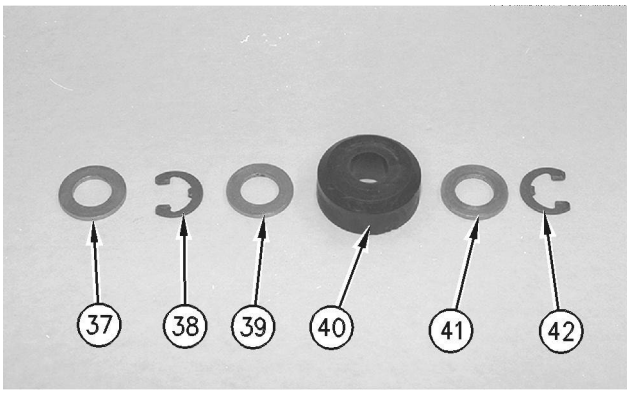


Illustration 238 g00288372

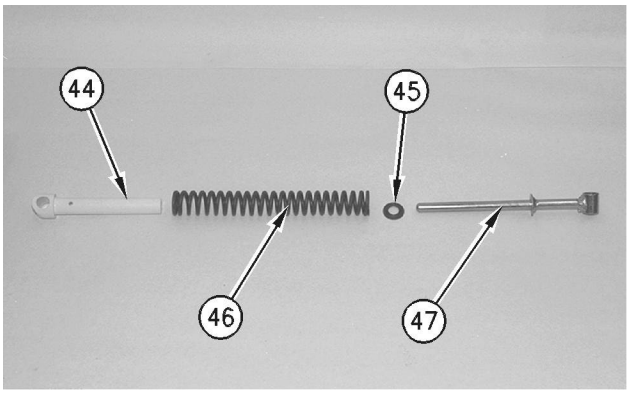


Illustration 240 g00288396

11. Remove roller assembly (35) from each side of suspension arm (36). Remove retaining rings (42) and (38), washers (41), (39) and (37), and rollers (40).

12. Attach Tool (A) to spring assembly (43), as shown. Use Tool (A) to remove the spring assembly from the shaft as a unit.

13. Use Tool (A) to slowly release the compression on spring assembly (43). Disassemble spring assembly (43). Remove guide bushing (44), spring (46), retainer (45) and rod assembly (47).

14. Repeat Steps 12 and 13 for the spring assembly on the other side of the suspension arm.

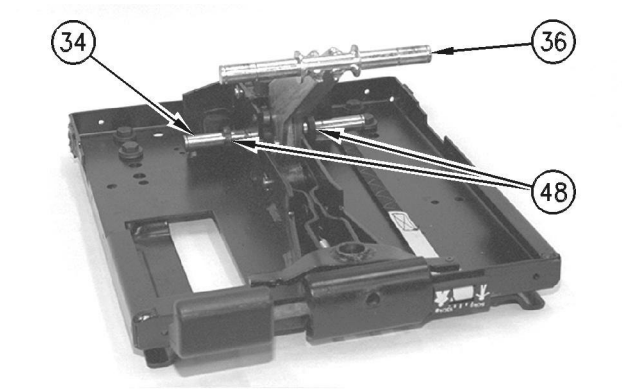


Illustration 241 g00288397

15. Remove two spacers (48) from shaft (34). Remove the shaft and suspension arm (36).

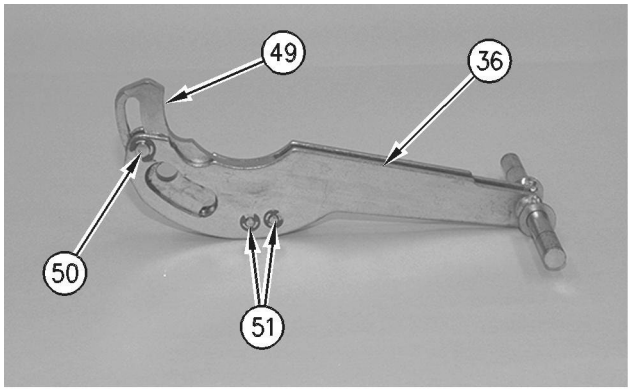


Illustration 242 g00288398

16. Remove retaining rings (50) and (51). Use a hammer and a punch to remove the pins. Remove cam (49) from suspension arm (36).

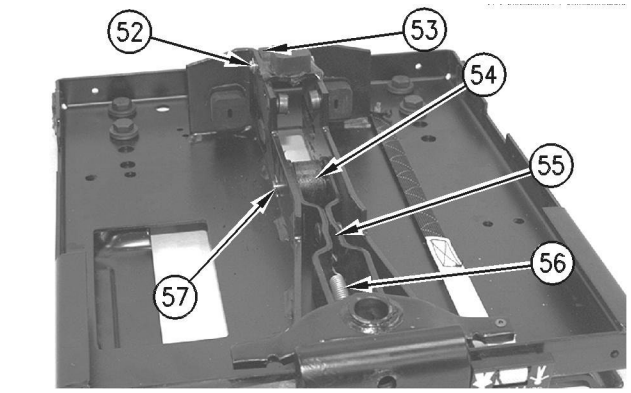


Illustration 243 g00288399

17. Remove retaining ring (57). Use a hammer and a punch to remove the pin. Remove roller (54). Remove retaining ring (52). Use a hammer and a punch to remove the pin. Remove roller (53) and two spacers. Remove spring (56) and arm assembly (55).

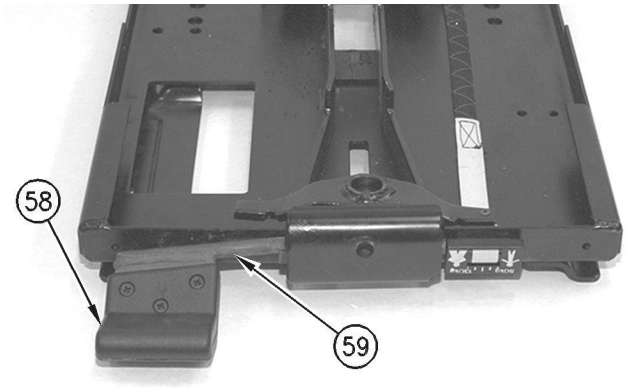


Illustration 244 g00288400

18. Remove the key for the height adjustment lever. (The key is not shown.) Remove handle (58) and height adjustment lever (59).

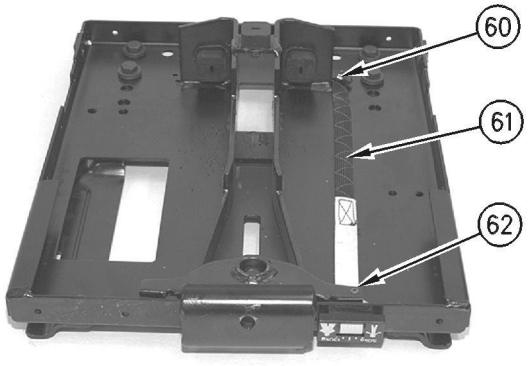


Illustration 245 g00288401

19. Remove pin (62) from the bracket. Cut tie-wraps (60). Remove indicator band (61).

i07432496

Mechanical Suspension With Variable Damper - Assemble

SMCS Code: 7324-016-ME

S/N: 2211–Up

S/N: M921–Up

S/N: SC61–Up

S/N: AKA1–Up

S/N: BAA1–Up

S/N: BCA1–Up

S/N: BDA1–Up

S/N: GTA1–Up

S/N: N1A1–Up

S/N: N4A1–Up

S/N: 8GB1–Up

S/N: 8HB1–Up

S/N: 8KB1–Up

S/N: 8PB1–Up

S/N: 9DB1–Up

S/N: AXB1–Up

S/N: AYB1–Up

S/N: BAB1–Up

S/N: BBB1–Up

S/N: FDB1–Up

S/N: JJB1–Up

S/N: 2AC1–Up

S/N: 3AC1–Up

S/N: 4RC1–Up

S/N: 6FC1–Up

S/N: 7NC1–Up

S/N: 7PC1–Up

S/N: 8FC1–Up

S/N: 8RC1–Up

S/N: 8YC1–Up

S/N: 9HC1–Up

S/N: 9TC1–Up

S/N: AAC1–Up

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S/N: AXC1–Up

S/N: BEC1–Up

S/N: BNC1–Up

S/N: BPC1–Up

S/N: CFC1–Up

S/N: FDC1–Up

S/N: H4C1–Up

S/N: MCC1–Up

S/N: MJC1–Up

S/N: 1DD1–Up

S/N: 1JD1–Up

S/N: 1KD1–Up

S/N: 1MD1–Up

S/N: 1YD1–Up

S/N: 2KD1–Up

S/N: 2SD1–Up

S/N: 2YD1–Up

S/N: 3ED1–Up

S/N: 3MD1–Up

S/N: 4KD1–Up

S/N: A6D1–Up

S/N: A7D1–Up

S/N: AKD1–Up

S/N: BAD1–Up

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S/N: JAD1–Up
S/N: ADE1–Up
S/N: AYE1–Up
S/N: B9E1–Up
S/N: BLE1–Up
S/N: 2XF1–Up
S/N: 3ZF1–Up
S/N: 4YF1–Up
S/N: 5BF1–Up
S/N: 5HF1–Up
S/N: 6CF1–Up
S/N: 6ZF1–Up
S/N: 7ZF1–Up
S/N: 8TF1–Up
S/N: 8ZF1–Up
S/N: 9RF1–Up
S/N: 9YF1–Up
S/N: AAF1–Up
S/N: APF1–Up
S/N: AWF1–Up
S/N: CFF1–Up
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S/N: 2TG1–Up
S/N: 3YG1–Up
S/N: 4FG1–Up
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S/N: 4LG1–Up
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S/N: AFG1–Up
S/N: AGG1–Up
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S/N: M1G1–Up
S/N: M3G1–Up
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S/N: 1XJ1–Up
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S/N: 3RL1–Up
S/N: 4CL1–Up

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S/N: AWW1–Up
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S/N: 02X1–Up
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S/N: AGY1–Up
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S/N: 2PZ1–Up
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S/N: 3TZ1–Up
S/N: 48Z1–Up
S/N: 4GZ1–Up
S/N: 5AZ1–Up
S/N: 5KZ1–Up
S/N: 6GZ1–Up
S/N: 6YZ1–Up
S/N: 74Z1–Up
S/N: 79Z1–Up
S/N: 7MZ1–Up
S/N: 7PZ1–Up
S/N: 80Z1–Up
S/N: 92Z1–Up
S/N: ADZ1–Up
S/N: ANZ1–Up
S/N: AZZ1–Up
S/N: CBZ1–Up

Assembly Procedure

Table 7

Tools Needed			
Tool	Part Number	Part Description	Qty
A	9U-6613	Spring Compressor	1
B	-	Loctite LB 8632 Silicone Lubricant (1)	-
	-	Loctite LB 8104 Silicone Lubricant (2)	-
	-	Loctite LB 8801 Silicone Lubricant (3)	-
	-	Loctite LB Superlube (4)	-

(1) North America
(2) EAME
(3) Asia Pacific Division
(4) South America

1. Check the condition of all parts of the mechanical suspension. If any of the parts are worn or damaged, install new parts.

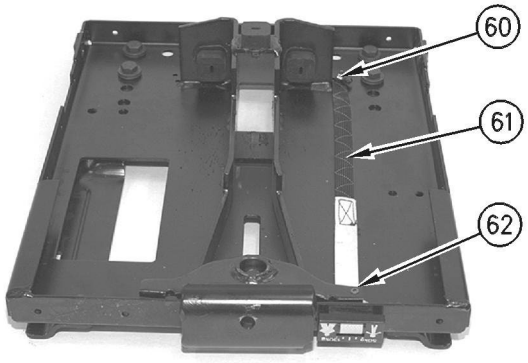


Illustration 246 g00288401

2. Install indicator band (61) and new tie-wraps (60). Install pin (62) in the bracket.

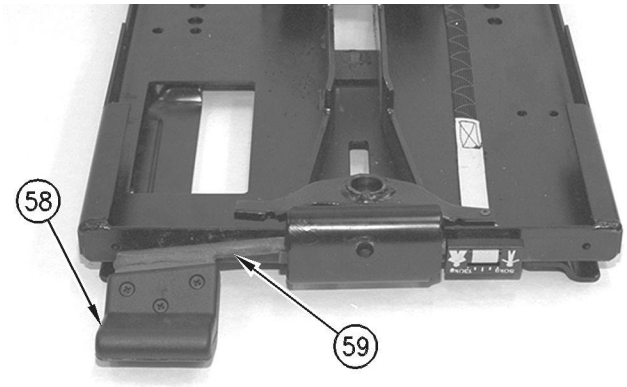


Illustration 247 g00288400

3. Install height adjustment lever (59) and handle (58). Install the key for the height adjustment lever.

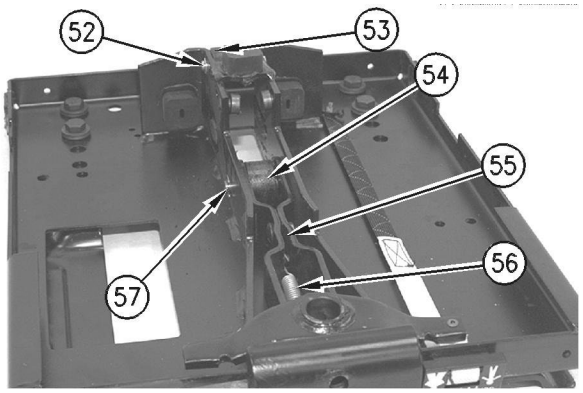


Illustration 248 g00288399

Note: Apply Tooling (b) to the roller shafts before installation.

4. Install arm assembly (55) and spring (57). Install roller (53) and two spacers. Install retaining ring (52). Install roller (54) and the pin. Install retaining ring (57). Make sure that the rollers do not bind.

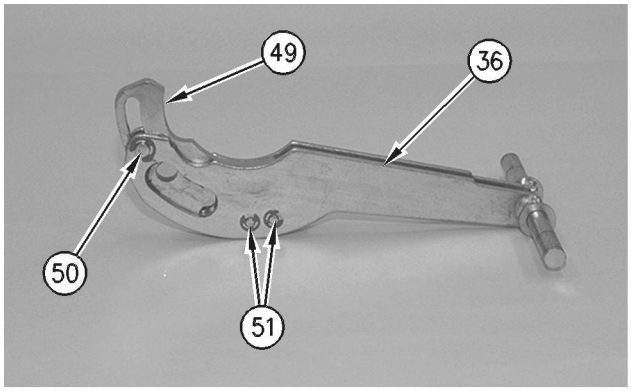


Illustration 249 g00288398

5. Install cam (49) in suspension arm (36). Install retaining rings (51) and (50) and the pins.

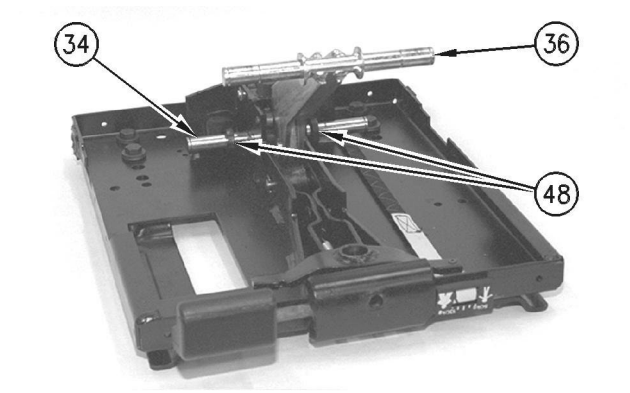


Illustration 250 g00288397

6. Install the shaft and suspension arm (36). Install two spacers (48) on shaft (34).

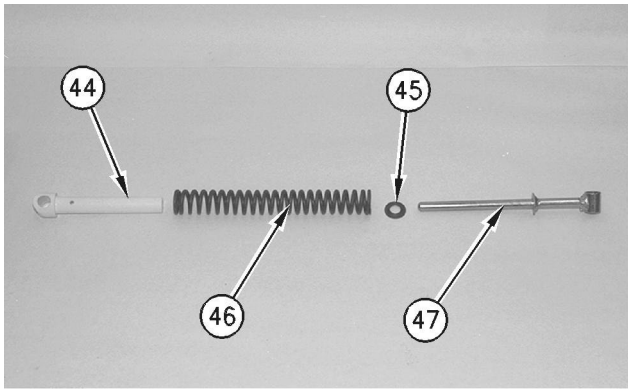


Illustration 251 g00288396

7. Assemble the spring assembly. Install rod assembly (47), retainer (45), spring (46), and guide bushing (44).

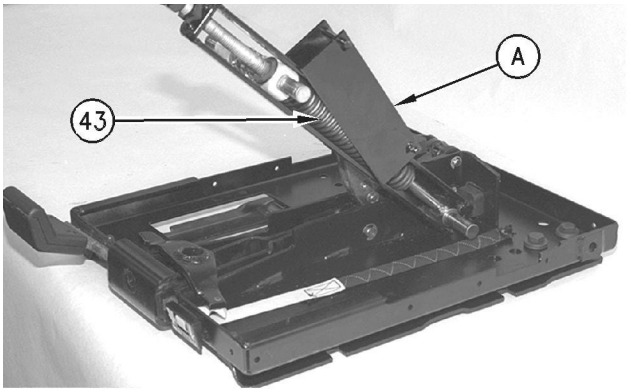


Illustration 252 g00288375

8. Attach Tool (A) to spring assembly (43), as shown. Slowly compress spring assembly (43). Use Tool (A) to install the spring assembly on the shaft as a unit.

9. Repeat Steps 7 and 8 for the spring assembly on the other side of the suspension arm.

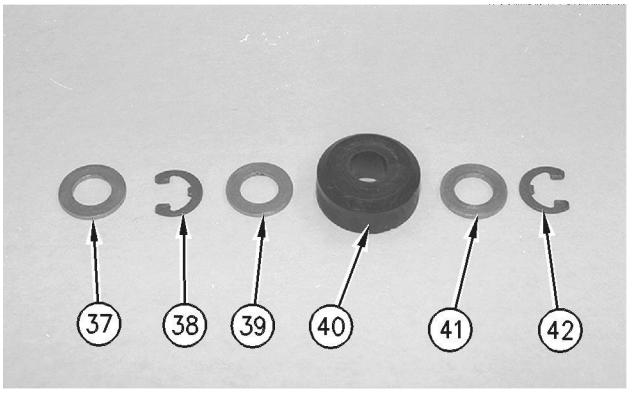


Illustration 253 g00288372

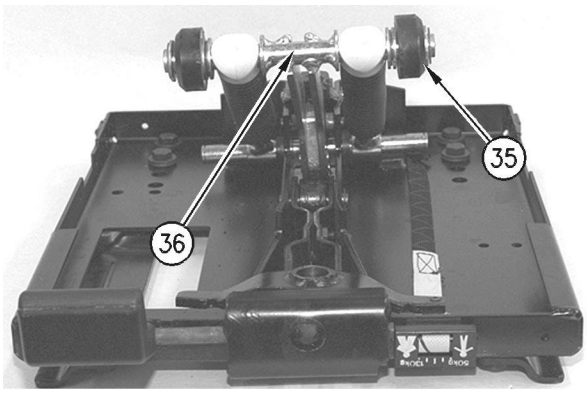


Illustration 254 g00288371

Note: Apply Tooling (B) to the roller shafts before installation.

10. Install retaining rings (42) and (38), washers (41), (39) and (37), and rollers (40). Install roller assembly (35) on each side of suspension arm (36). Make sure that the rollers do not bind.

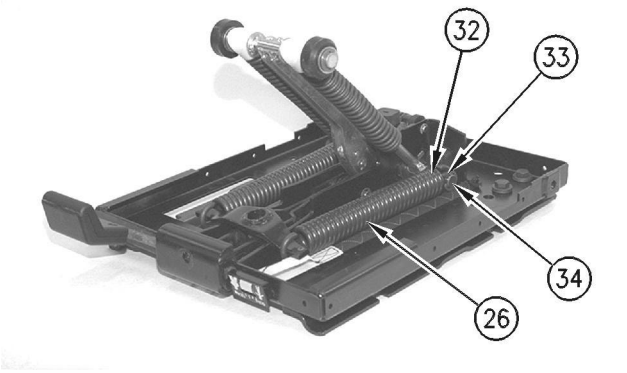


Illustration 255 g00288370

11. Install two springs (26) and plastic bearings (32) on height adjustment shaft (34). Install retaining ring (33) on each side of height adjustment shaft (34).

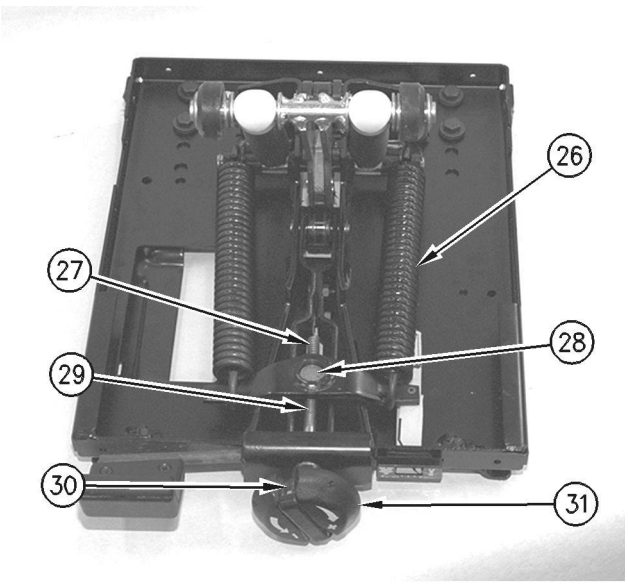


Illustration 256 g00288369

12. Install nut (28), weight adjustment screw (29), two races, the thrust bearing, weight adjustment knob (31) and pin (30). Turn weight adjustment knob (25) in the positive (+) direction to apply tension to springs (26). Install pin (27) in the end of weight adjustment screw (29).

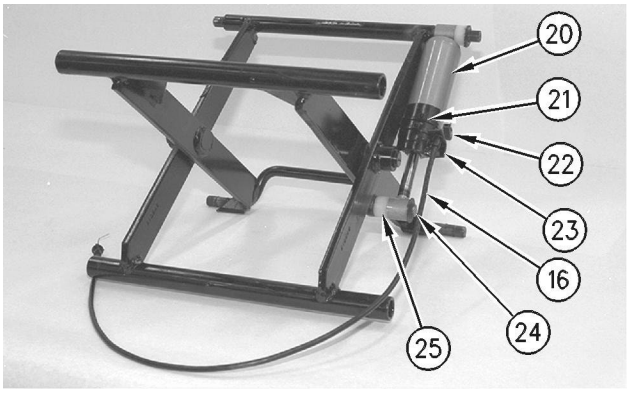


Illustration 257 g00288368

Note: During removal of the wire cable, the wire cable will be cut. The wire cable will not be reusable. A new wire cable must be installed during assembly of the mechanical suspension.

13. Install variable damper (20), retainer (24), two bearings (25), bracket (23) and arm (22). Install new adjustable bracket (21). Install the pin in arm (22). Install a new wire cable in the variable damper. Connect wire cable (16) to bracket (23).

Note: Adjustable bracket (21) must be replaced. The bracket will be damaged during the removal procedure.

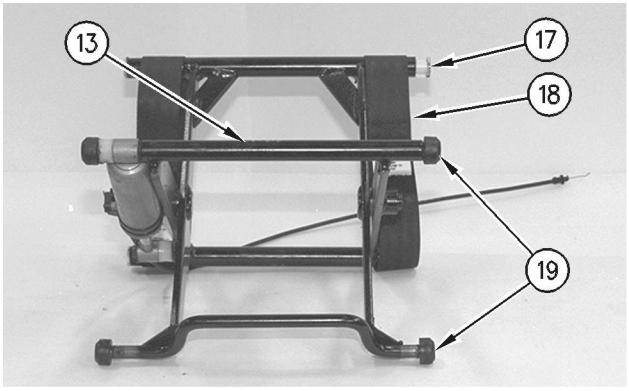


Illustration 258 g00288367

Note: Apply Tooling (B) to the roller shafts before installation.

14. Install four rollers (19), two tether belts (18) and four bearings (17). Make sure that the rollers do not bind.

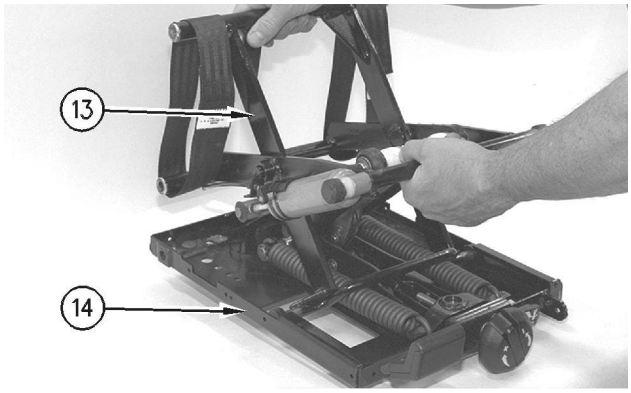


Illustration 259 g00288365

15. Install scissor assembly (13) on upper housing (14).

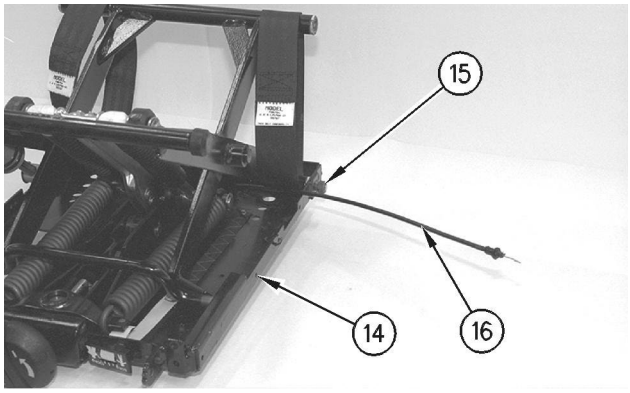


Illustration 260 g00288364

16. Slide wire cable (16) into upper housing (14). Install the upper shaft assembly. Install locknut (15) on the upper shaft assembly.

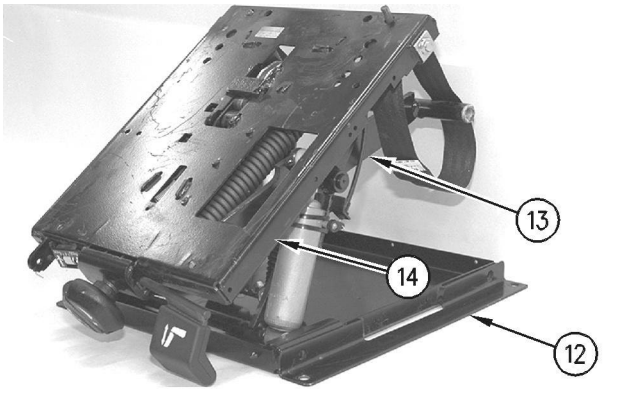


Illustration 261 g00288363

17. Install the tie-wraps to hold the adjustable cable to upper housing (14). Tilt the lower housing forward and slide the lower housing onto scissor assembly (13) and onto upper housing (14).

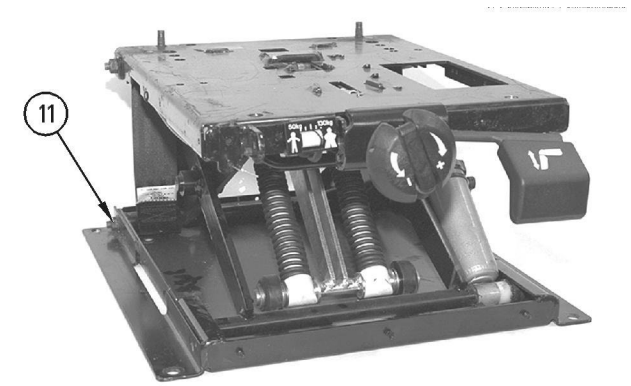


Illustration 262 g00288362

18. Install the lower shaft assembly. Install locknut (11).

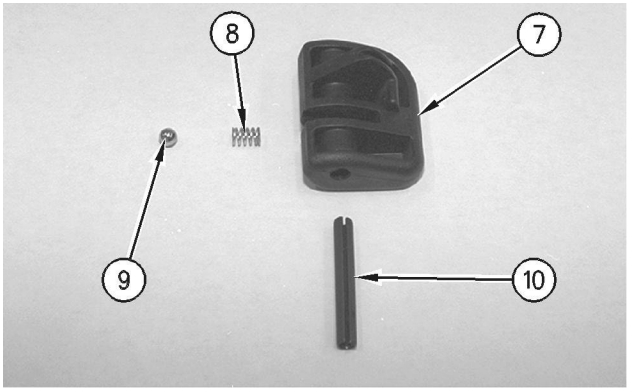


Illustration 263 g00288361

19. Install ball (9), spring (8), and knob (7). Install pin (10).

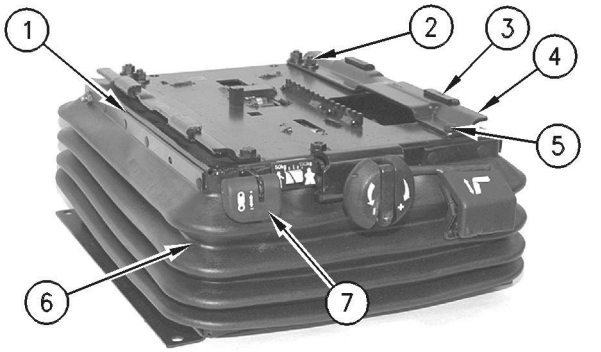


Illustration 264 g00288360

20. Install two retainers (1) and boot (6).

21. Install two brackets (4), the locknuts on two brackets (4), the washers, two bolts (5) and four bolts (2). Tighten the bolts to a torque of 25 ± 6 N·m (18 ± 4 lb ft). Install four slider blocks (3).

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RENR8839-02 (en-us)
August 2018

Disassembly and Assembly

844H Wheel Dozer
Machine Systems

BTW 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

Disassembly and Assembly Section

i02468992

Steering Frame Lock - Separate and Connect

SMCS Code: 7506-029

Connection Procedure

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine. Secure clevis pin with locking pin.

Before operating the machine, fasten the steering frame lock link into the stored position and secure the clevis pin with locking pin.

Failure to lock into the stored position before operating can result in loss of steering.

1. Move the machine to a hard, level surface. Park the machine in the straight ahead position and engage the parking brake.

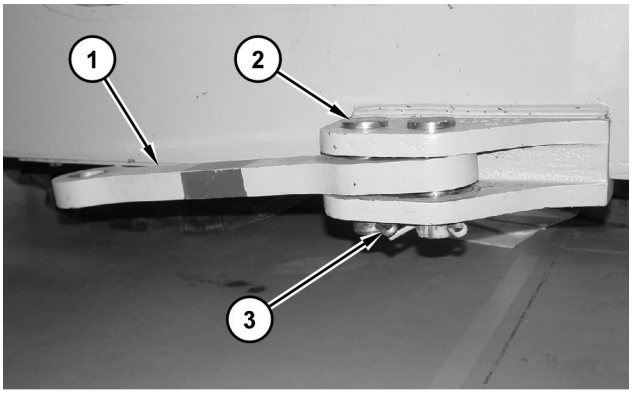


Illustration 1 g01231240

2. Remove cotter pin (3) from pin (2).

3. Remove pin (2) from the rear frame.

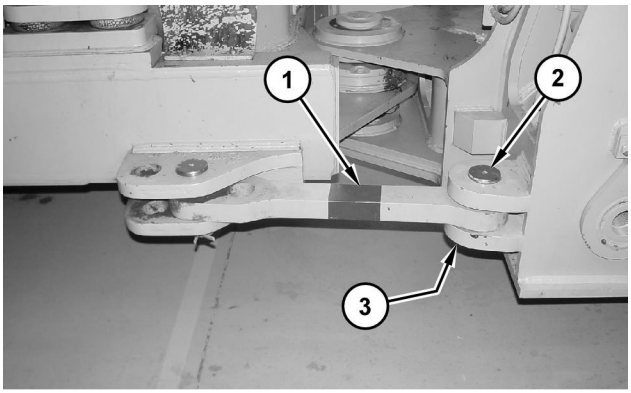


Illustration 2 g01231236

4. Move steering frame lock (1) in position to the front frame. Install pin (2) and cotter pin (3).

Note: In order to align the pin bores, steer the machine left or steer the machine right.

Separation Procedure

⚠ WARNING

Personal injury or death can result from machine articulation or movement.

Machine frames can move and a person can be crushed.

Connect the steering frame lock link between the front and rear frames before working on machine. Secure clevis pin with locking pin.

Before operating the machine, fasten the steering frame lock link into the stored position and secure the clevis pin with locking pin.

Failure to lock into the stored position before operating can result in loss of steering.

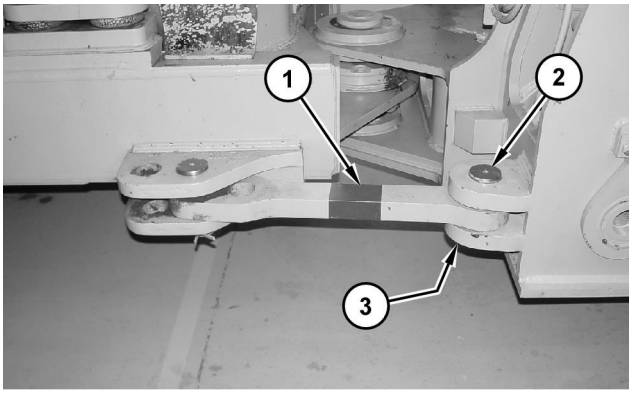


Illustration 3 g01231236

1. Remove cotter pin (3) and pin (2).

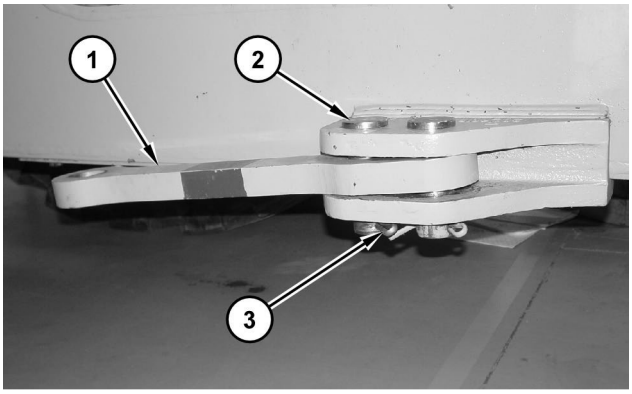


Illustration 4 g01231240

2. Move steering frame lock (1) to the storage position.

3. Install pin (2) and cotter pin (3).

i04166051

System Pressure - Release

SMCS Code: 4250-553-PX; 4300-553-PX; 5050-553-PX

Release Procedure (Implement System)

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

1. If the machine is equipped with a ride control system, move the ride control switch to the ON position.

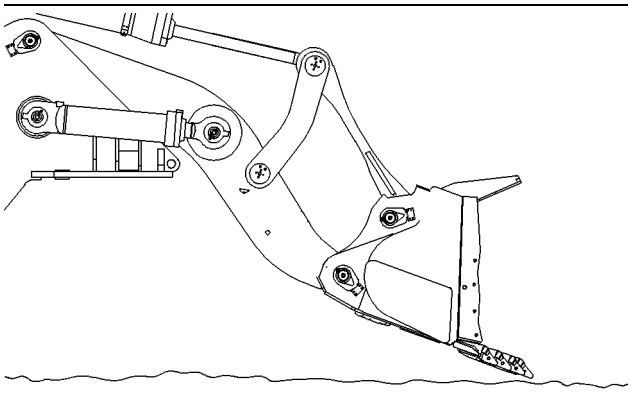


Illustration 5 g02009358

2. Position the bucket or the work tool just above the ground at a slight downward angle in order to ensure that the head end of the lift cylinders is pressurized.

3. Turn the engine start switch to the OFF position.

4. When the engine has stopped, turn the engine start switch back to the ON position so the pilot oil can reach the main valve.

5. Move the implement lockout switch to the UNLOCKED position.

6. Move the lift control lever to the FLOAT position and the tilt control lever to the TILT BACK position at the same time. This action allows the bucket or the work tool to tilt back while the boom is lowered.

The bottom of the bucket or the work tool should rest flat on the ground and the weight of the linkage should be supported by the ground. The pressure from the head end of the lift cylinders and from the ride control accumulator is now vented to the hydraulic tank.

7. When the bucket or the work tool has settled to the ground, move both control levers to the HOLD position. Then, cycle the control levers through all positions in order to purge any remaining pressure from the implement hydraulic system.

8. Turn the engine start switch to the OFF position.

9. Slowly loosen the hydraulic tank filler cap in order to release the pressure from the hydraulic tank.

10. After all of the pressure has been released, tighten the hydraulic tank filler cap. The hydraulic system pressure has now been released. Hydraulic lines and components can now be removed.

Release Procedure (Steering System and Braking System)

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

Note: Make sure that the parking brake is engaged.

1. Straighten the machine and install the steering link.

2. Lower the bucket to the ground and stop the engine.

3. Move the STIC steering and transmission lock control to the LOCKED position.

4. In order to release the pressure from steering cylinders, the machine must not be operated for a minimum of 1 hour. This will allow sufficient time for the pressure in the steering system to dissipate.

5. Depress the brake pedal repeatedly in order to release any pressure in the braking system.

6. Slowly loosen the hydraulic tank filler cap in order to release the pressure from the hydraulic tank.

7. After all of the pressure has been released, tighten the hydraulic tank filler cap. The hydraulic system pressure has now been released. Hydraulic lines and components can now be removed.

Dead Electronics

1. If the electronics fail, it may not be possible to relieve all stored hydraulic oil pressure. The following precautions should be taken.

2. Turn the engine OFF.

3. The machine should be secured with a lockout.

4. Use the appropriate stand or blocks to prevent undesired drift of implements.

5. Barriers should be used in order to prevent personnel from entering areas that implement drift or movement could be hazardous.

6. To lower lift arms and the ripper onto the ground or onto the appropriate supports, open the 112-1817 Manual Valve Gp.

7. Do not open or disassemble any hydraulic circuits until the electronic controls are required to relieve stored hydraulic pressure.

i02481638

Hydraulic Tank (Implement, Brake) - Remove

SMCS Code: 5056-011-II; 5056-011-BRK

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	2

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: The hydraulic tank (Implement and Brake) is located on the right side of the machine.

1. Drain the oil from the hydraulic oil tank into a suitable container for storage or proper disposal. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Brake) - Change”.

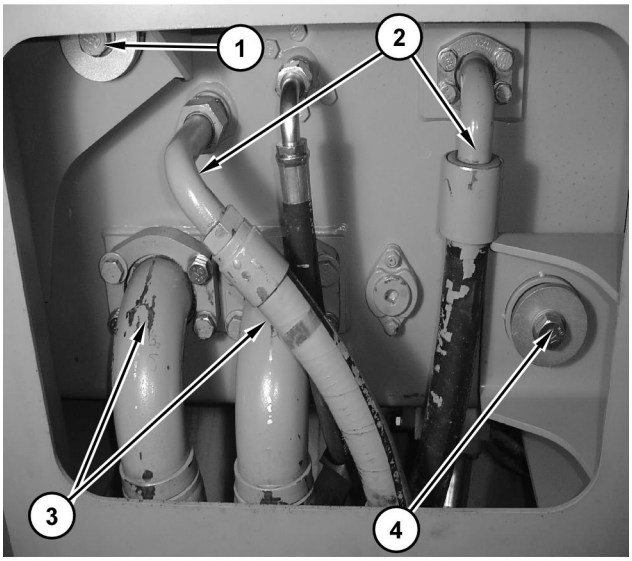


Illustration 6 g01239638

2. Disconnect hose assemblies (2) and (3). Remove bolts (1) and (4) and the washers.

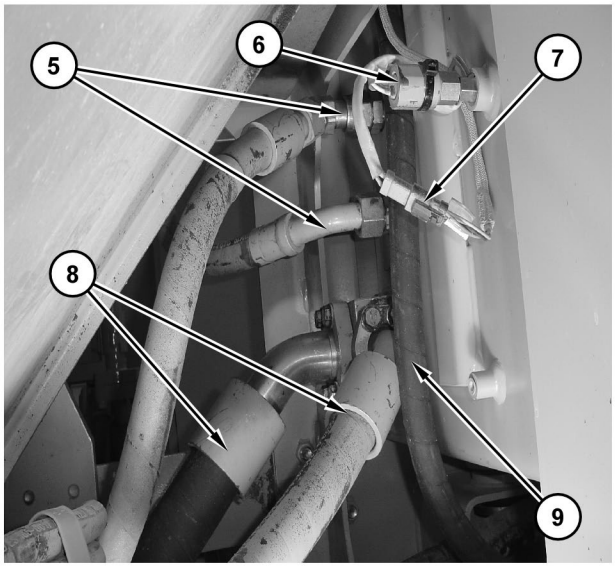


Illustration 7 g01239640

3. Remove hose assembly (9). Disconnect harness assembly (7). Remove switch assembly (6). Disconnect hose assemblies (5) and (8).

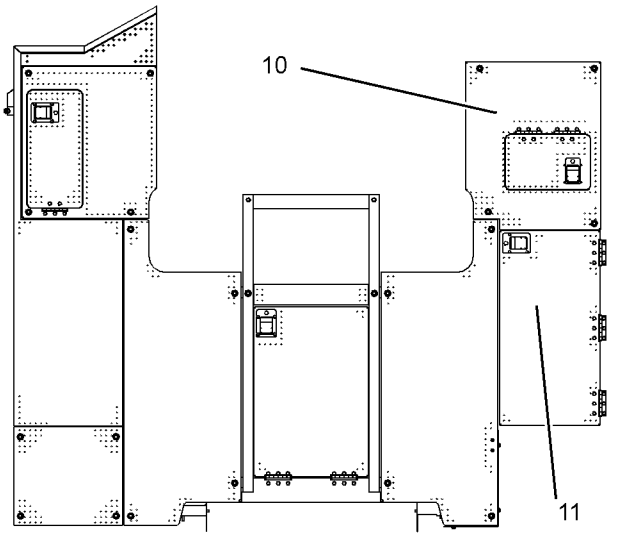


Illustration 8 g01239840

4. Use two people in order to remove panel assembly (10). The weight of panel assembly (10) is approximately 27 kg (60 lb). Open access door (11).

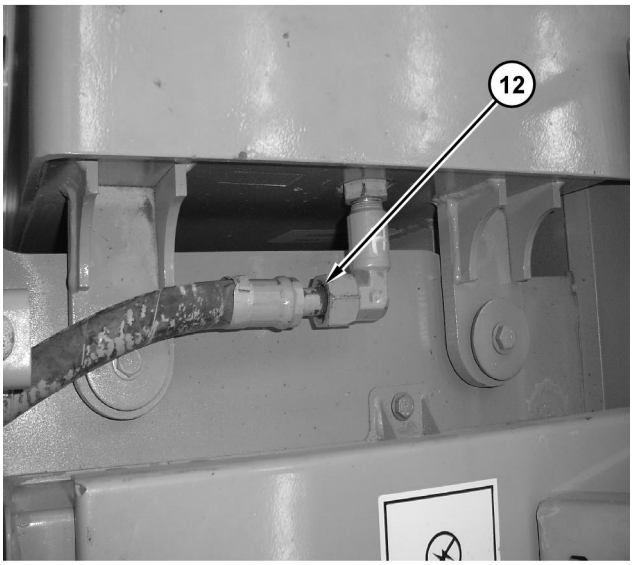


Illustration 9 g01239647

5. Disconnect hose assembly (12).

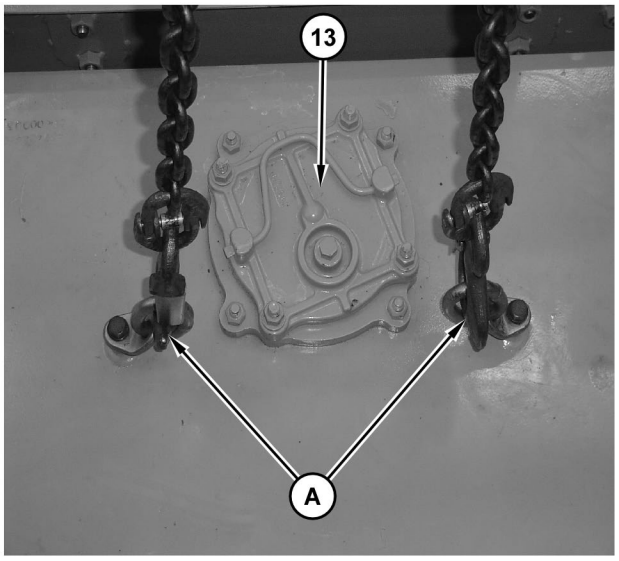


Illustration 10 g01239648

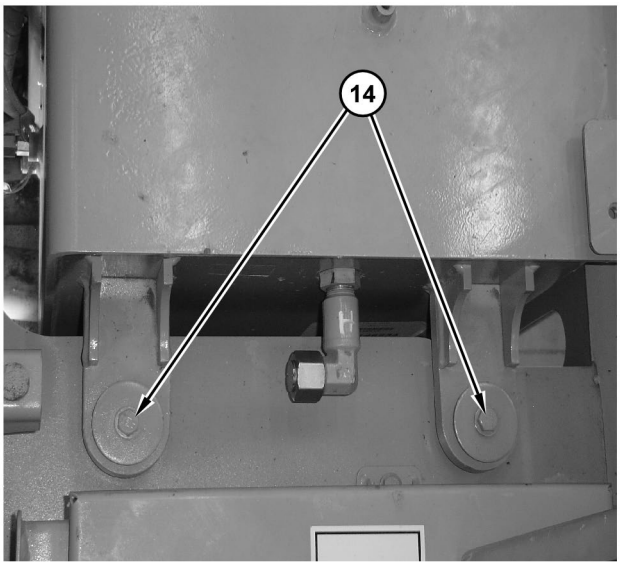


Illustration 11 g01239821

6. Attach Tooling (A) and a suitable lifting device to hydraulic tank assembly (13). Remove bolts (14) and the washers. Remove hydraulic tank assembly (13). The weight of hydraulic tank assembly (13) is 283 kg (625 lb).

i02482530

Hydraulic Tank (Implement, Brake) - Disassemble

SMCS Code: 5056-015-II; 5056-015-BRK

Disassembly Procedure

Start By:

a. Remove the Hydraulic Tank. Refer to Disassembly and Assembly , "Hydraulic Tank - Remove".

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

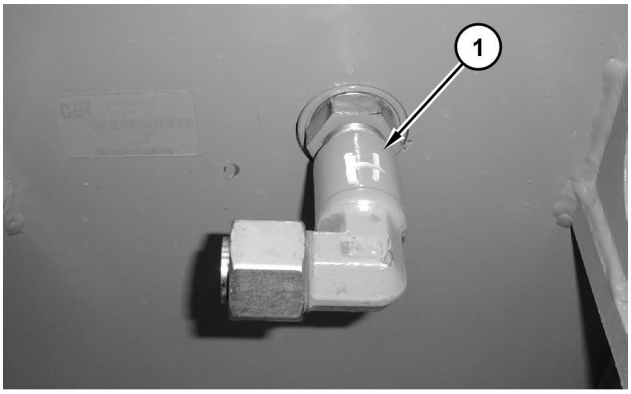


Illustration 12 g01240133

1. Remove elbow assembly (1).

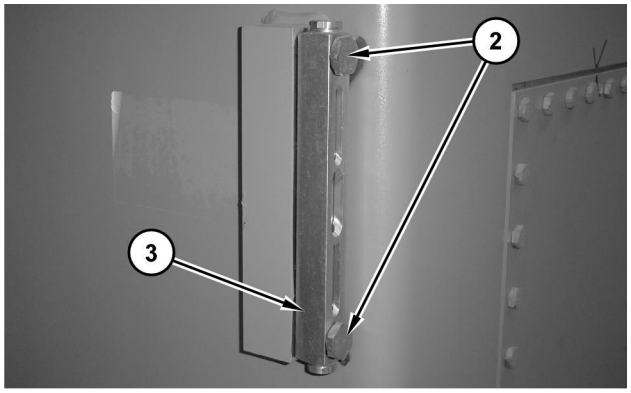


Illustration 13 g01240134

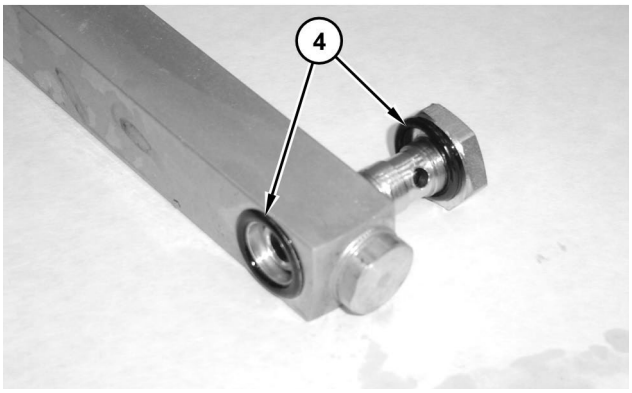


Illustration 14 g01240136

2. Remove bolts (2), gauge assembly (3), and O-ring seals (4).

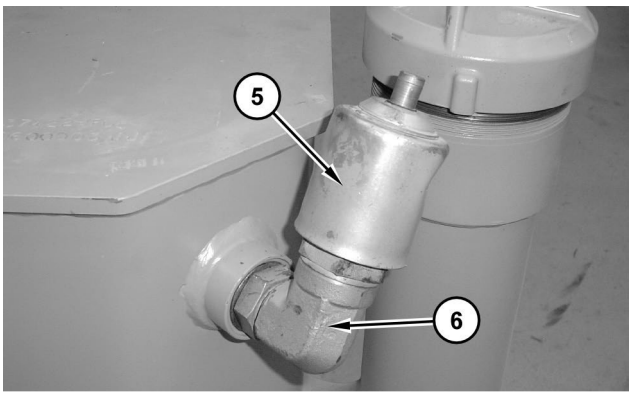


Illustration 15 g01240137

3. Remove valve assembly (5) and elbow assembly (6).

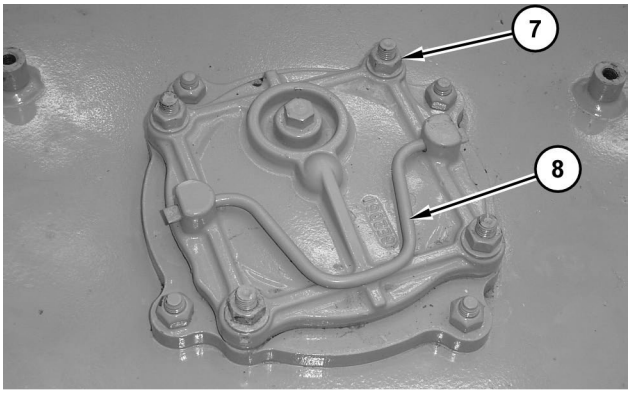


Illustration 16 g01240139

4. Remove nuts (7). Remove filter assembly (8).

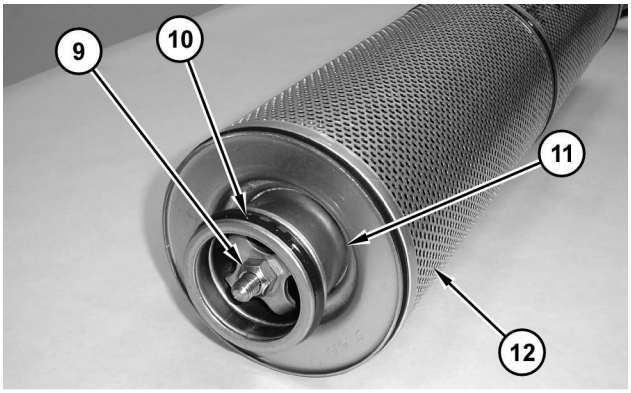


Illustration 17 g01240142

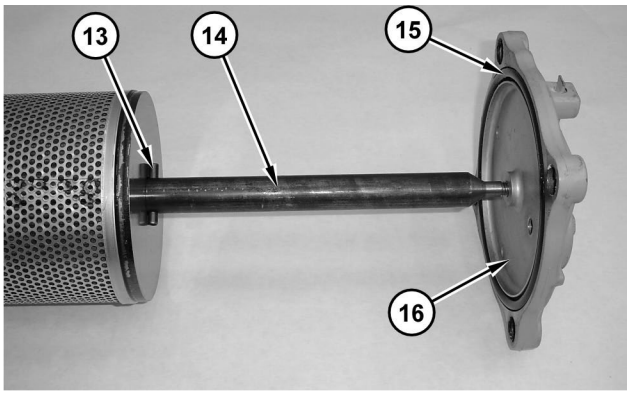


Illustration 18 g01240143

5. Remove nut (9), O-ring seals (10), retainer (11), filter elements (12), pin (13), stud (14), and O-ring seals (15) from cover assembly (16).

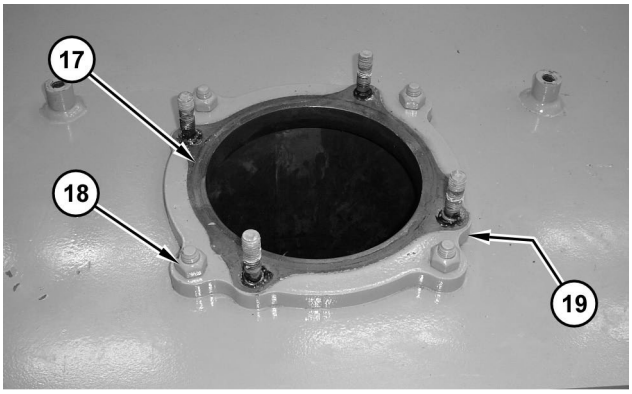


Illustration 19 g01240144

6. Remove nuts (18), tube assembly (17), and O-ring seals (19).

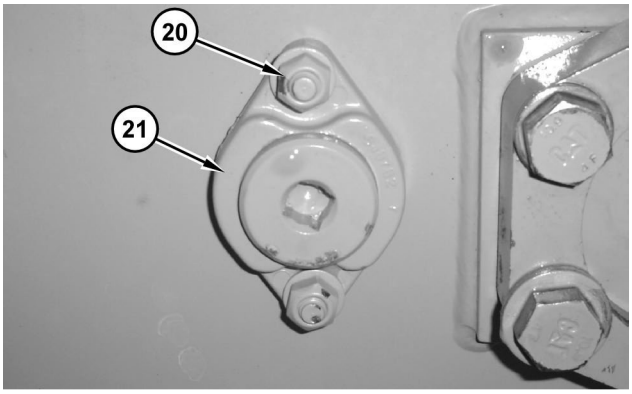


Illustration 20 g01240145

7. Remove nuts (20) and drain valve body (21).

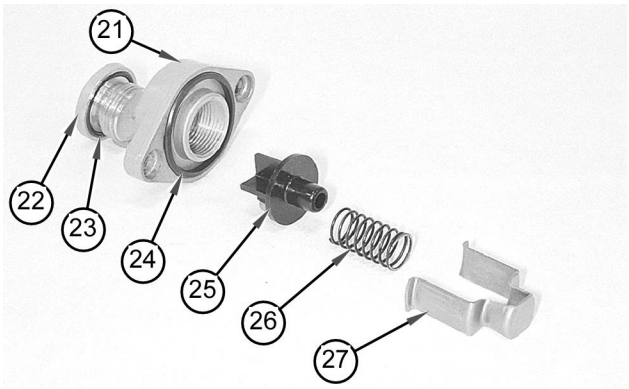


Illustration 21 g01240148

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

8. Remove plug (22) from drain valve body (21). Remove O-ring seals (23) from plug (22). Remove O-ring seals (24), valve guide (27), spring (26), and valve (25) from drain valve body (21).

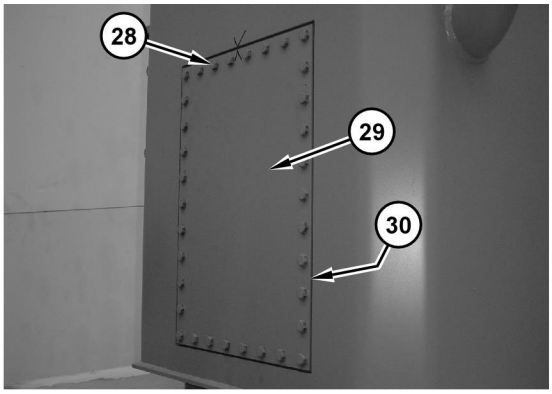


Illustration 22 g01240150

9. Remove bolts (28), cover (29), and gasket (30).

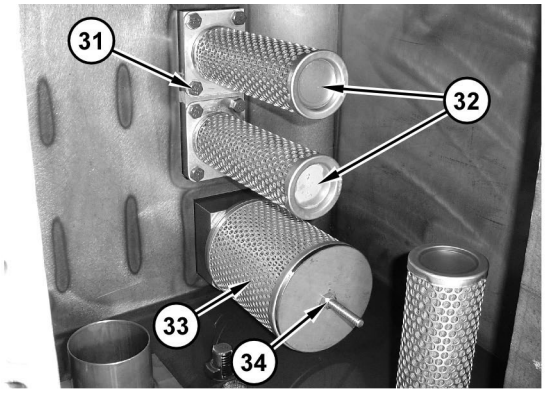


Illustration 23 g01240152

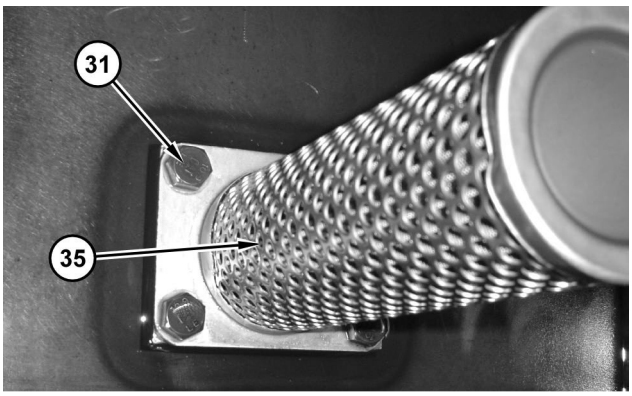


Illustration 24 g01240157

10. Remove bolts (31) and (34). Remove screens (32) and (35). Remove nuts (34) and screen assembly (33).

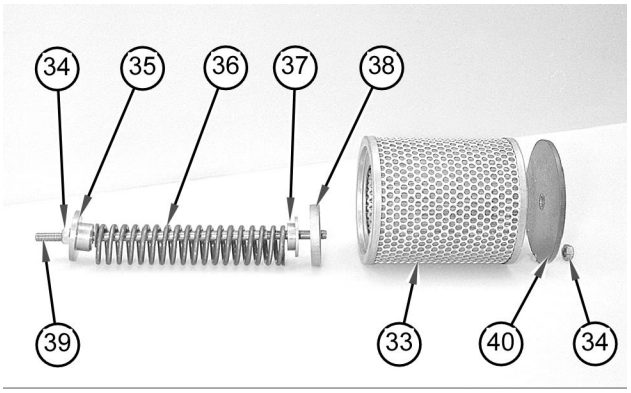


Illustration 25 g01240158

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

11. Remove plate (40), screen (33), retainer (38), valve (37), spring (36), and valve (35) from rod (39).

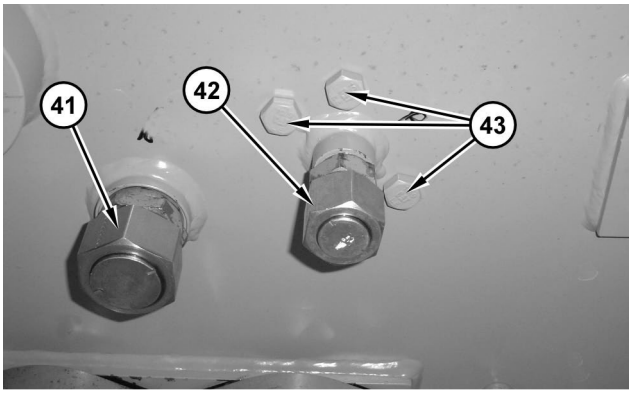


Illustration 26 g01240159

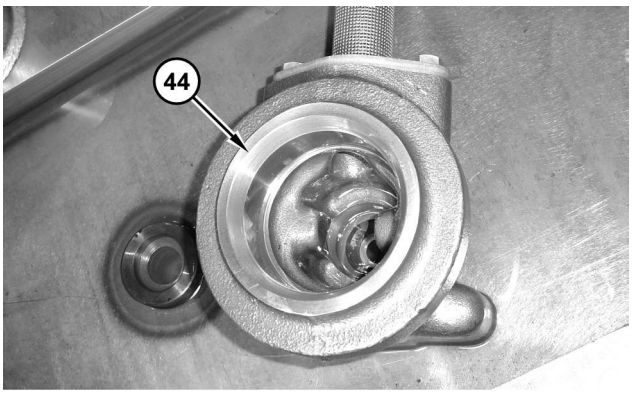


Illustration 27 g01240160

12. Remove fittings (41) and (42). Remove bolts (43) and filter base (44).

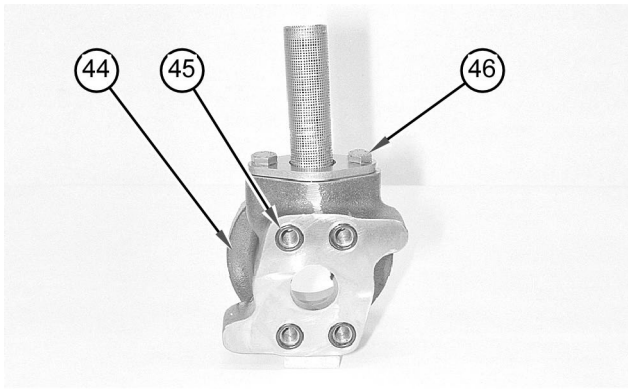


Illustration 28 g01240132

13. Remove O-ring seals (45) and bolts (46) from filter base (44).

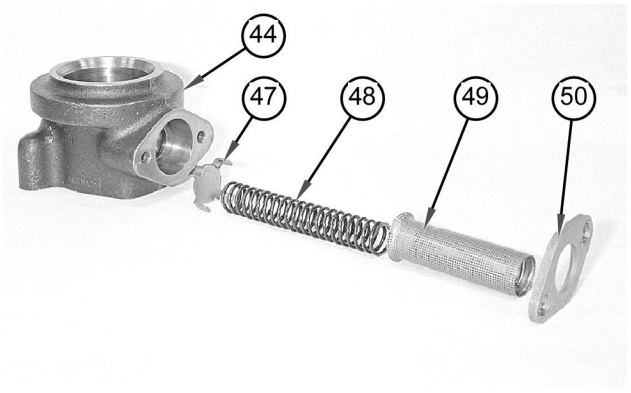


Illustration 29 g01240130

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

14. Remove flange (50), tube assembly (49), spring (48), and valve (47) from filter base (44).

i02482532

Hydraulic Tank (Implement, Brake) - Assemble

SMCS Code: 5056-016-II; 5056-016-BRK

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

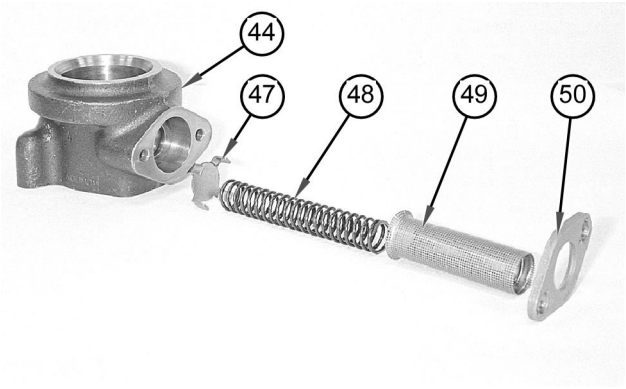


Illustration 30 g01240130

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

1. Install valve (47), spring (48), tube assembly (49), and flange (50) to filter base (44).

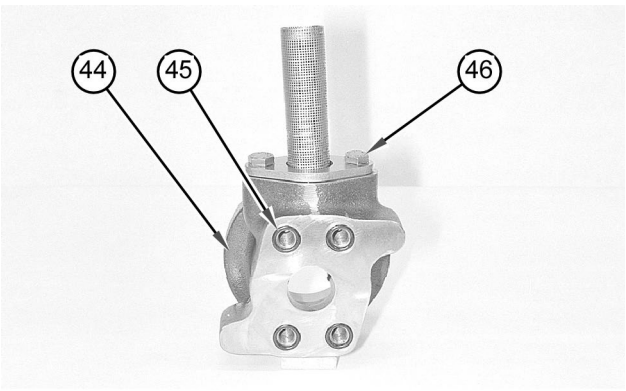


Illustration 31 g01240132

2. Install O-ring seals (45) and bolts (46) to filter base (44).

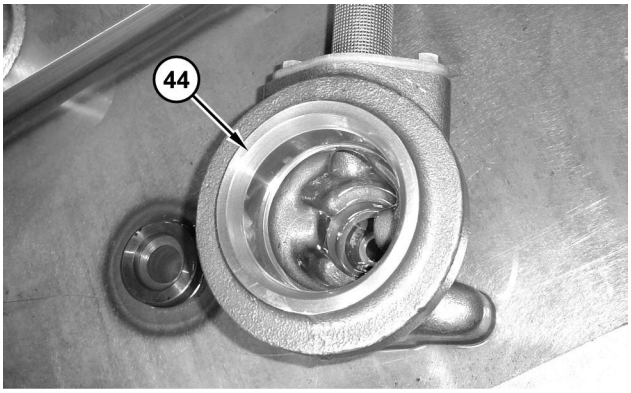


Illustration 32 g01240160

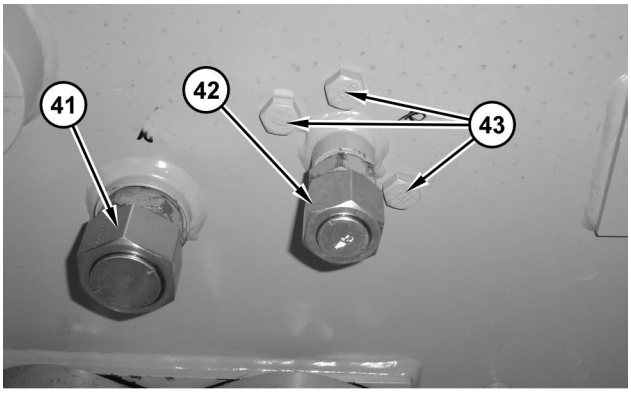


Illustration 33 g01240159

3. Install filter base (44) and bolts (43). Install fittings (41) and (42).

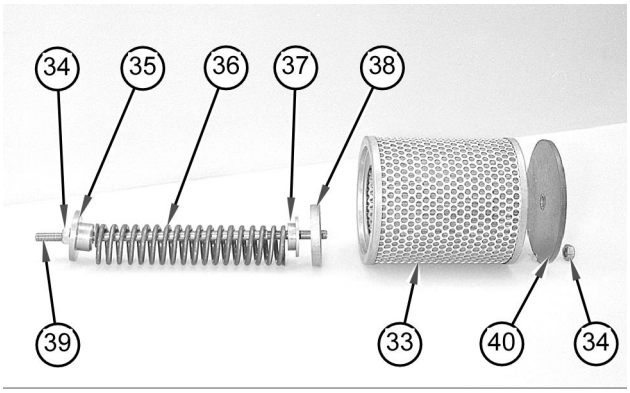


Illustration 34 g01240158

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

4. Install valve (35), spring (36), valve (37), retainer (38), screen (33), and plate (40) to rod (39).

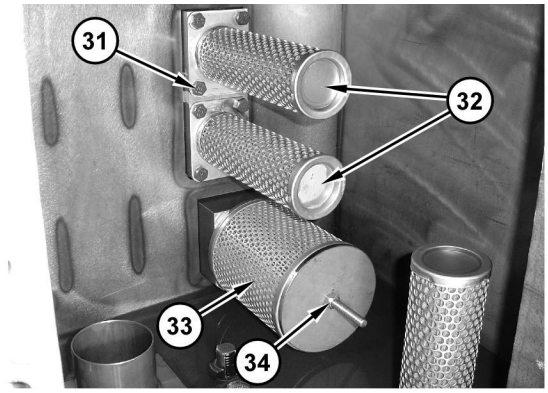


Illustration 35 g01240152

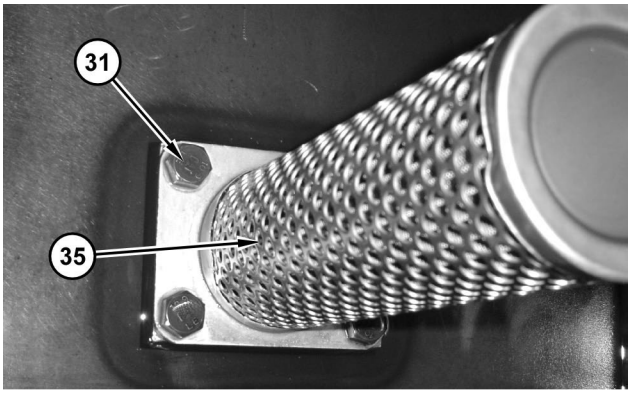


Illustration 36 g01240157

5. Position screen assembly (33) and install nuts (34). Install screens (32) and (35). Install bolts (31).

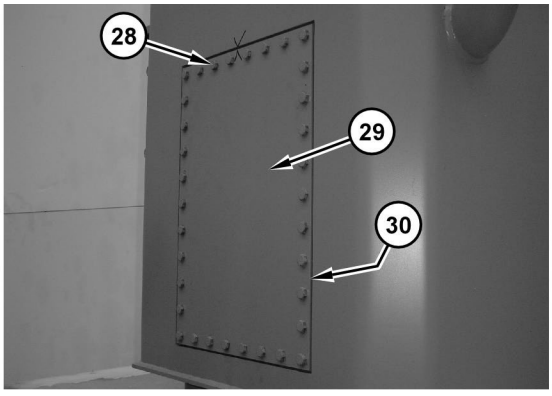


Illustration 37 g01240150

6. Position gasket (30) and cover (29). Install bolts (28).

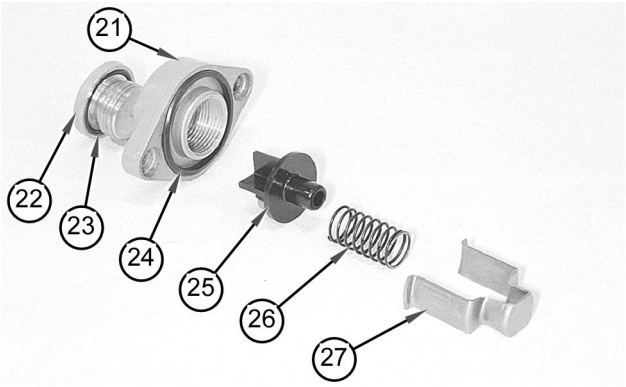


Illustration 38 g01240148

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

7. Install O-ring seals (24), valve (25), spring (26), and valve guide (27) to drain valve body (21). Install O-ring seals (23) to plug (22). Install plug (22) to a torque of 68 ± 7 N·m (50 ± 5 ft) to drain valve body (21).

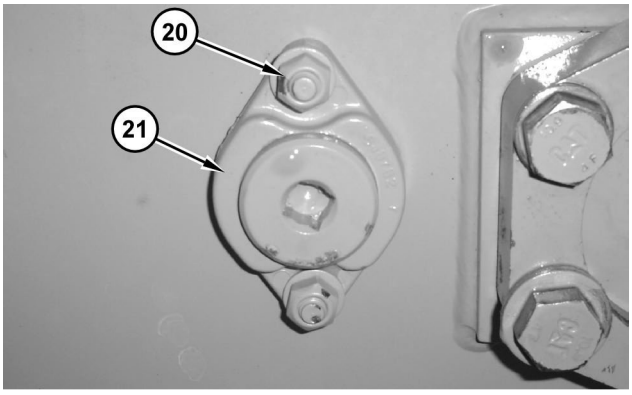


Illustration 39 g01240145

8. Position drain valve body (21) and install nuts (20).

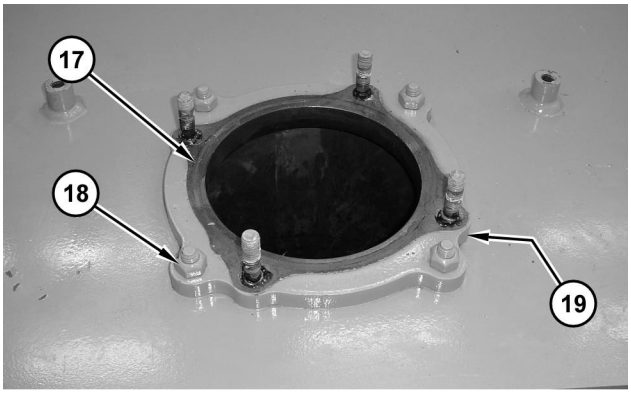


Illustration 40 g01240144

9. Install O-ring seals (19) to tube assembly (17). Position tube assembly (17) and install nuts (18).

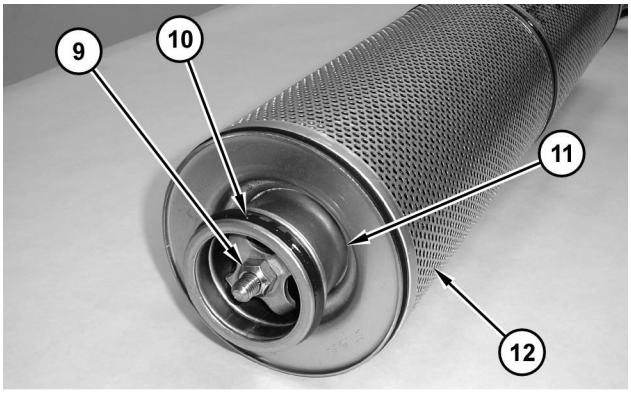


Illustration 41 g01240142

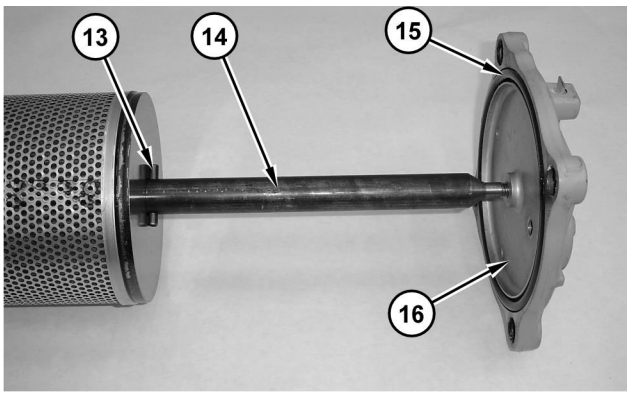


Illustration 42 g01240143

10. Install O-ring seals (15), stud (14) to a torque of 35 ± 5 N·m (25 ± 3 lb ft), pin (13), filter elements (12), retainer (11), O-ring seals (10), and nut (9) to a torque of 20 ± 2 N·m (14 ± 1 lb ft) to cover assembly (16).

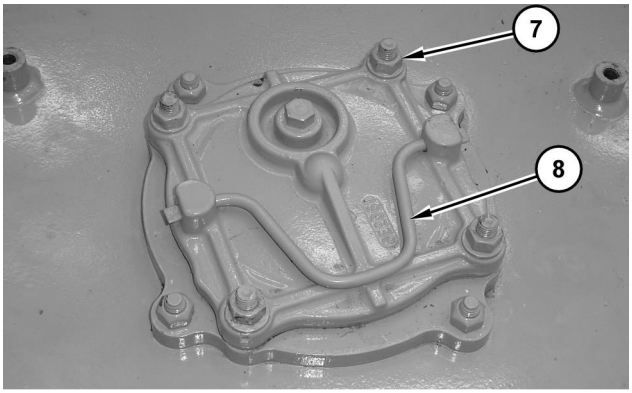


Illustration 43 g01240139

11. Position filter assembly (8) and install nuts (7).

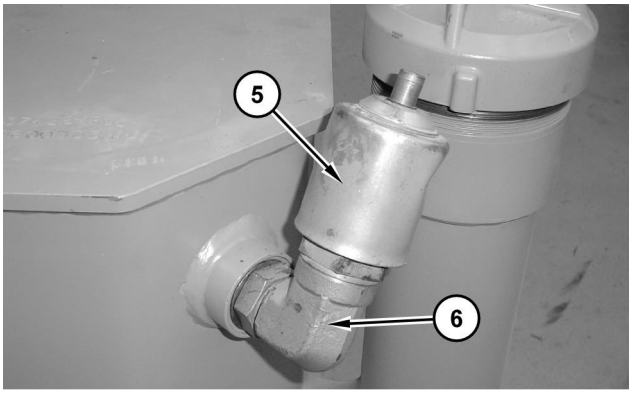


Illustration 44 g01240137

12. Install elbow assembly (6) and valve assembly (5).

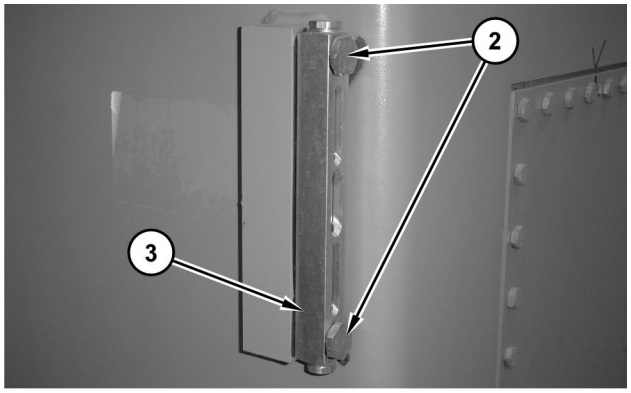


Illustration 45 g01240134

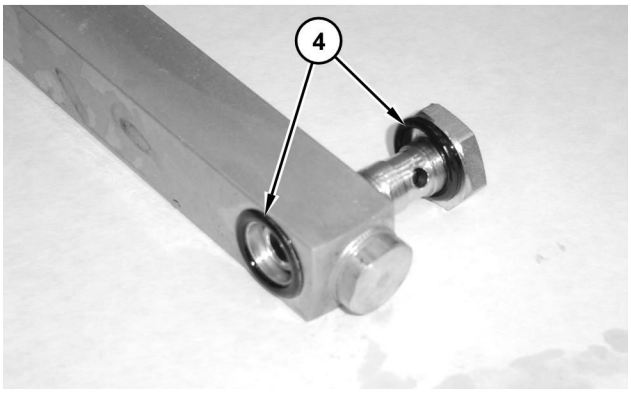


Illustration 46 g01240136

13. Position gauge assembly (3). Install O-ring seals (4) and bolts (2) to a torque of 7 ± 1 N·m (61 ± 8 lb in).

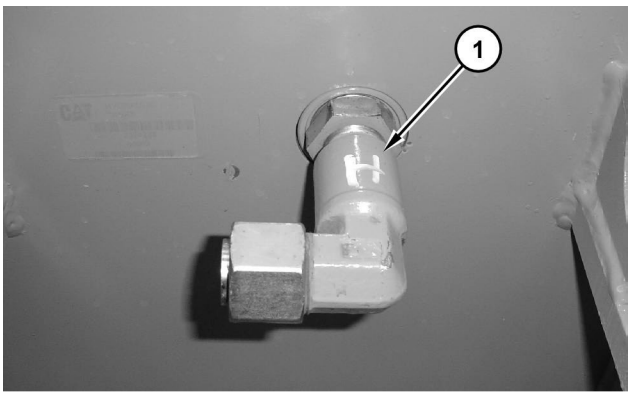


Illustration 47 g01240133

14. Install elbow assembly (1).

End By:

a. Install the hydraulic tank. Refer to Disassembly and Assembly , “Hydraulic Tank - Remove”.

i02482217

Hydraulic Tank (Implement, Brake) - Install

SMCS Code: 5056-012-II; 5056-012-BRK

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	2

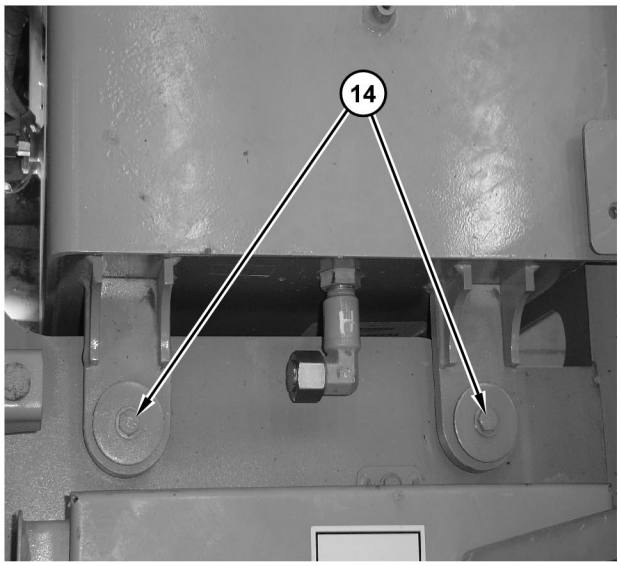


Illustration 48 g01239821

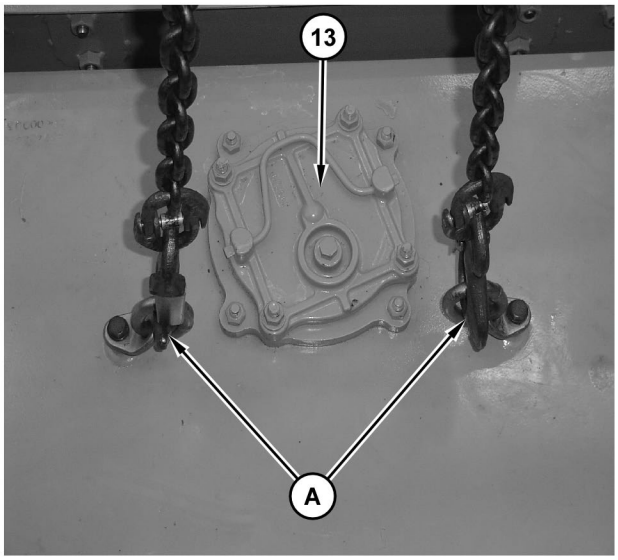


Illustration 49 g01239648

1. Attach Tooling (A) and a suitable lifting device to hydraulic tank assembly (13). Install hydraulic tank assembly (13). The weight of hydraulic tank assembly (13) is 283 kg (625 lb). Install bolts (14) and the washers.

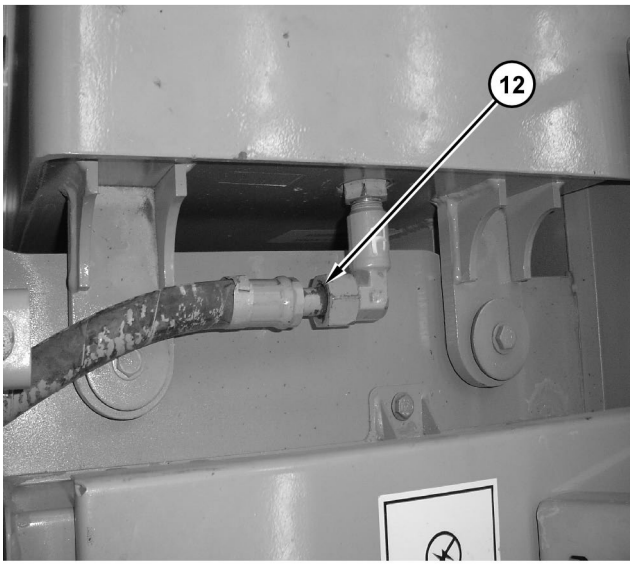


Illustration 50 g01239647

2. Connect hose assembly (12).

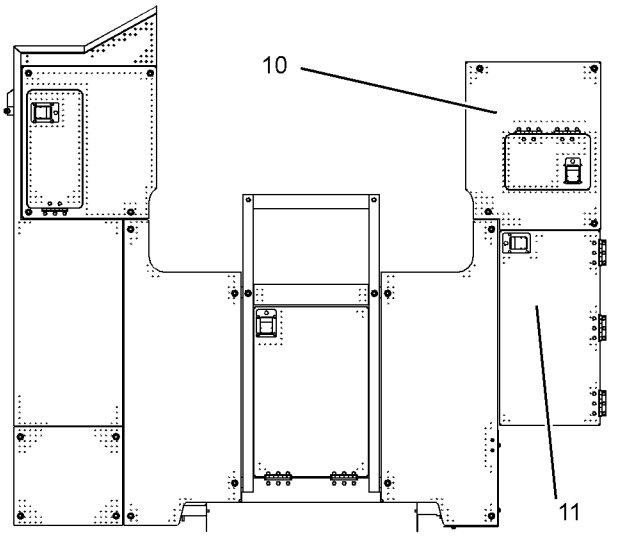


Illustration 51 g01239840

3. Use two people in order to install panel assembly (10). The weight of panel assembly (10) is approximately 27 kg (60 lb). Close access door (11).

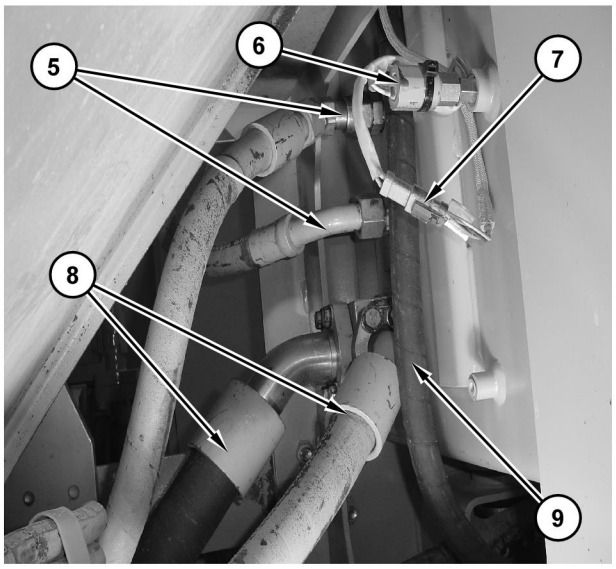


Illustration 52 g01239640

4. Connect hose assemblies (5) and (8). Install switch assembly (6). Install switch assembly (6). Connect harness assembly (7). Install hose assembly (9).

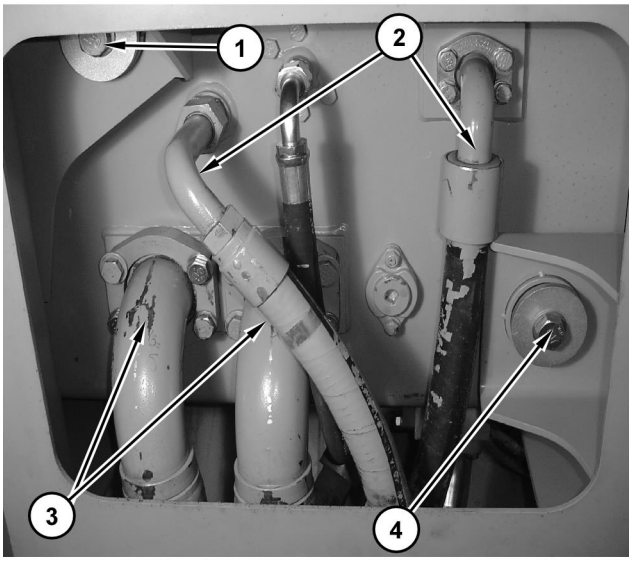


Illustration 53 g01239638

5. Install bolts (1) and (4) and the washers. Connect hose assemblies (2) and (3).

6. Fill the hydraulic oil tank. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Brake) - Change”.

i02482525

Hydraulic Tank (Steering, Hydraulic Fan) - Remove

SMCS Code: 5056-011-HFN; 5056-011-ZH

Removal Procedure

Table 3

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	3

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “Hydraulic System Pressure - Release”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

1. Drain the oil from the hydraulic oil tank into a suitable container for storage or proper disposal. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Steering and Hydraulic Fan) - Change”.

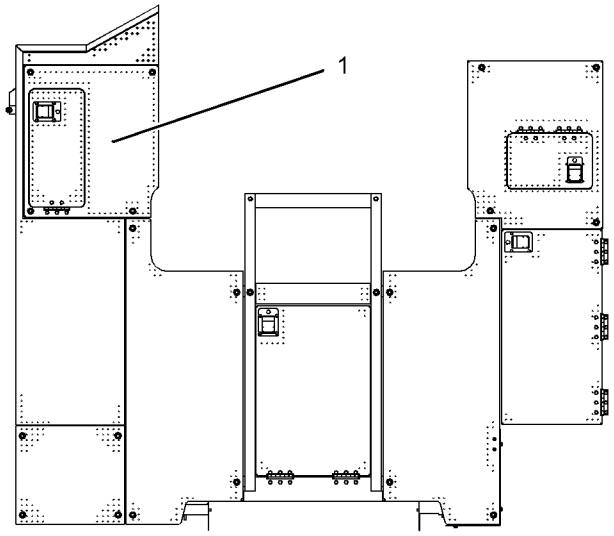


Illustration 54 g01240726

2. Use two people in order to remove panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).



Illustration 55 g01240215

3. Remove panel assembly (2).

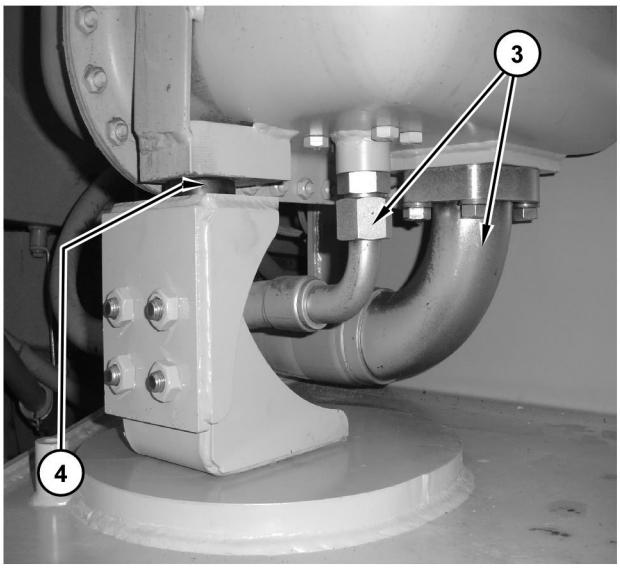


Illustration 56 g01240206

4. Disconnect hose assemblies (3). Remove bolt (4).

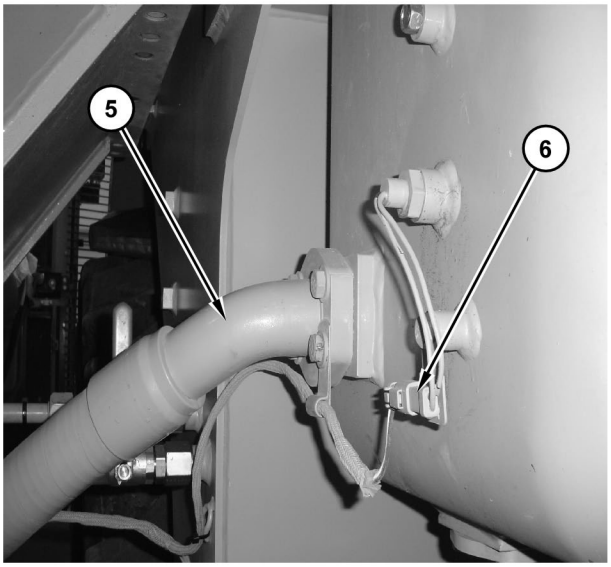


Illustration 57 g01240209

5. Disconnect hose assembly (5). Disconnect harness assembly (6).

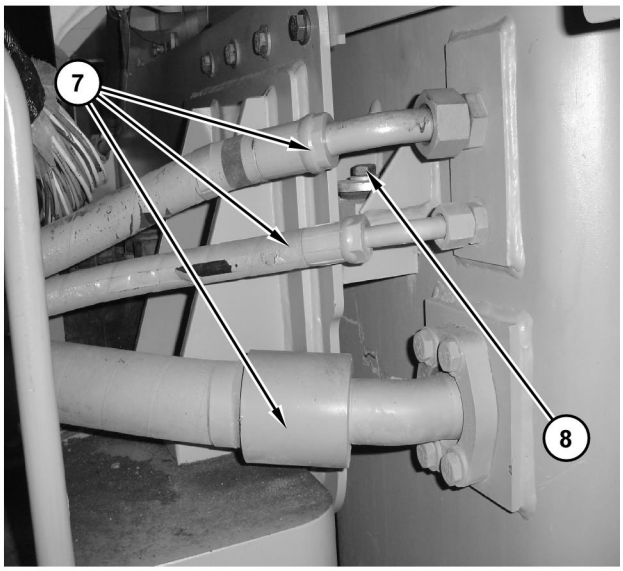


Illustration 58 g01240211

6. Disconnect hose assemblies (7). Remove bolt (8).

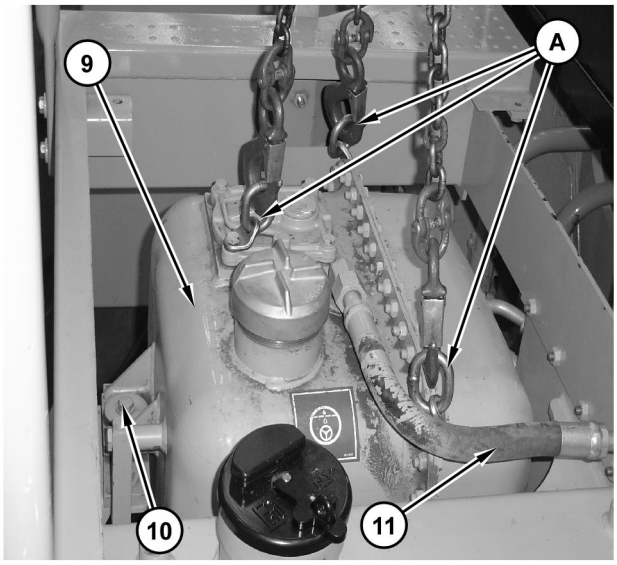


Illustration 59 g01240336

7. Attach Tooling (A) and a suitable lifting device to hydraulic tank assembly (9). The weight of hydraulic tank assembly (9) is approximately 283 kg (625 lb). Disconnect hose assembly (11). Remove bolt (10) and the washer. Remove hydraulic tank assembly (9).

i02517753

Hydraulic Tank (Steering, Hydraulic Fan) - Disassemble

SMCS Code: 5056-015-ZH; 5056-015-HFN

Disassembly Procedure

Table 4

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2

Start By:

a. Remove the left side hydraulic oil tank for the steering system and the hydraulic fan. Refer to Disassembly and Assembly, “Hydraulic Tank (Steering and Hydraulic Fan) - Remove” .

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

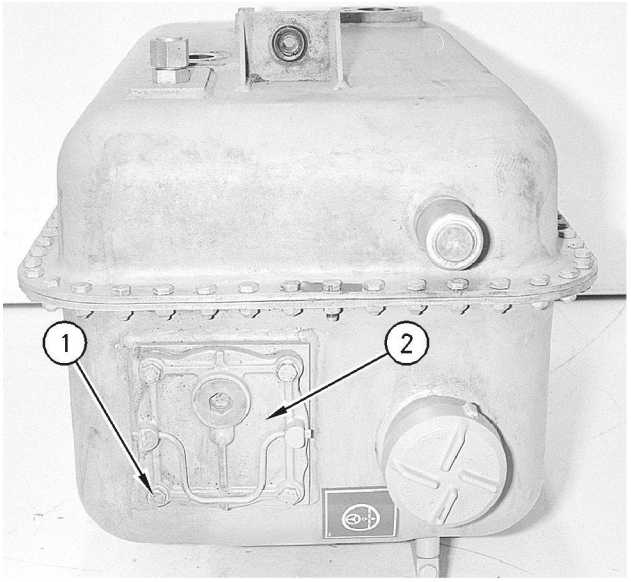


Illustration 60 g00867865

1. Remove bolts (1), the washers, and filter assembly (2) .

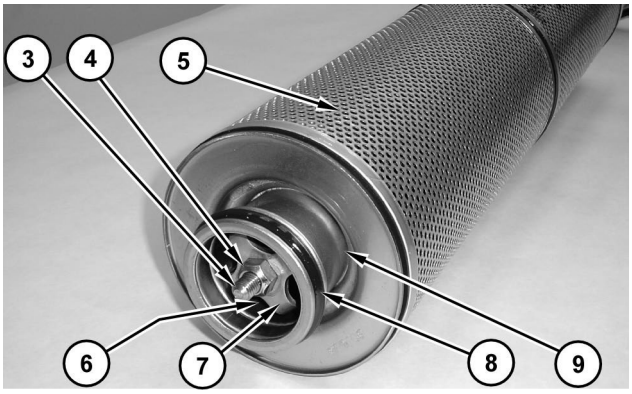


Illustration 61 g01240367

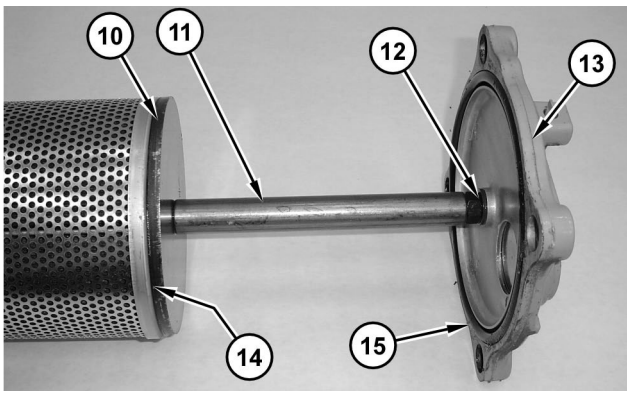


Illustration 62 g01240368

2. Remove nut (4), spring (7), nut (6), O-ring seals (8), retainer (9), and filters (5) from rod (3). Remove spacer (14), plate (10), spacer (11), rod (3), and nut (12) from cover assembly (13). Remove O-ring seals (15) from filter assembly (13).

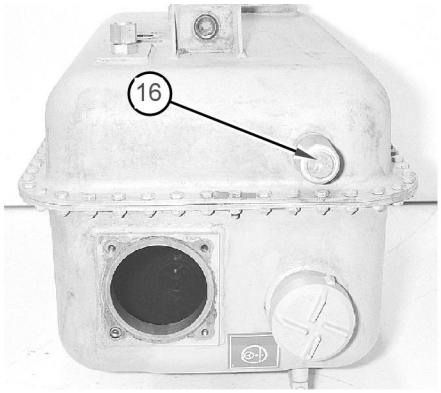


Illustration 63 g01240334

3. Remove breaker relief valve (16).

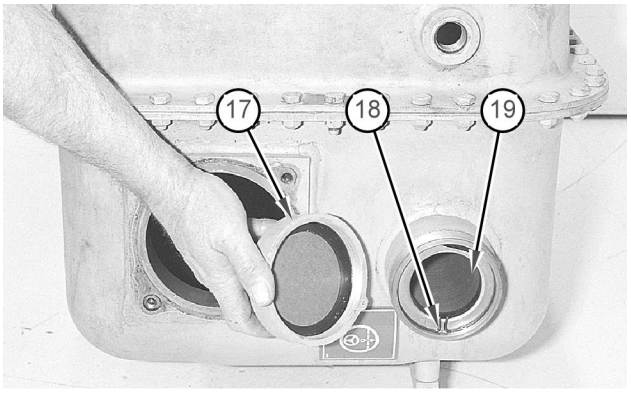


Illustration 64 g01240335

4. Remove filler cap (17), lock ring (18), and strainer assembly (14).

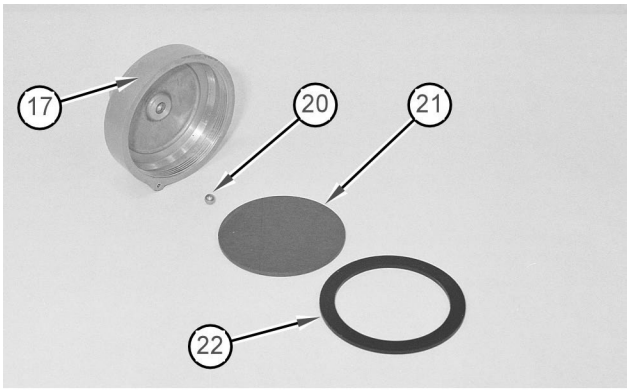


Illustration 65 g01240366

5. Remove gasket (22), plate (21), and ball (20) from filler cap (17).

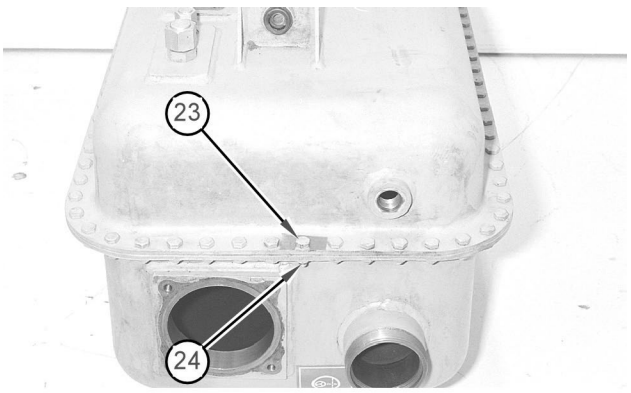


Illustration 66 g01240364

6. Remove bolts (23) and locknuts (24).

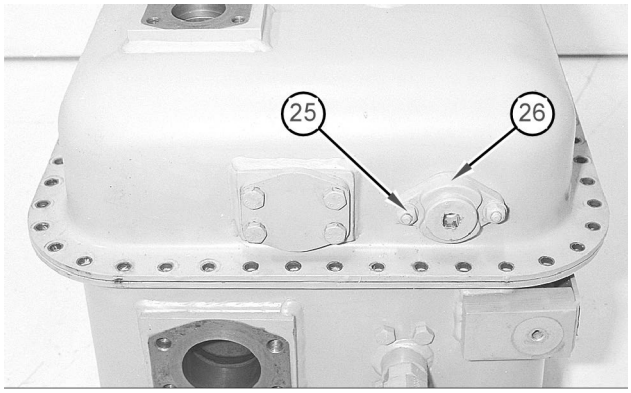


Illustration 67 g01240363

7. Remove locknuts (25) and the washers from drain valve body (26). Remove drain valve body (26).

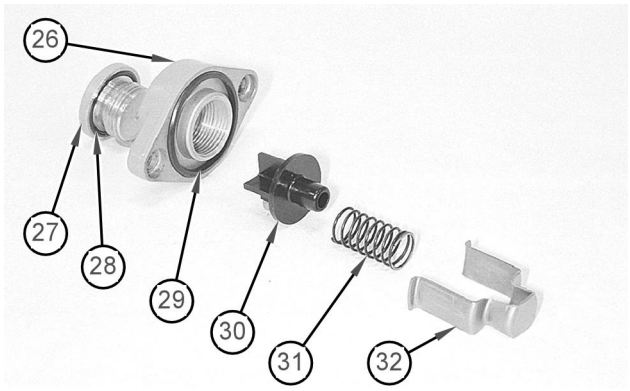


Illustration 68 g01240362

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

8. Remove plug (27) from drain valve body (26). Remove O-ring seal (28) from plug (27).

9. Remove seal (29), valve (30), spring (31), and valve guide (32) from drain valve body (26).

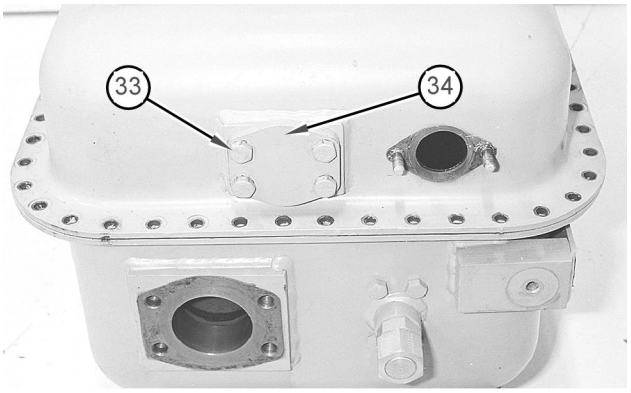


Illustration 69 g01240360

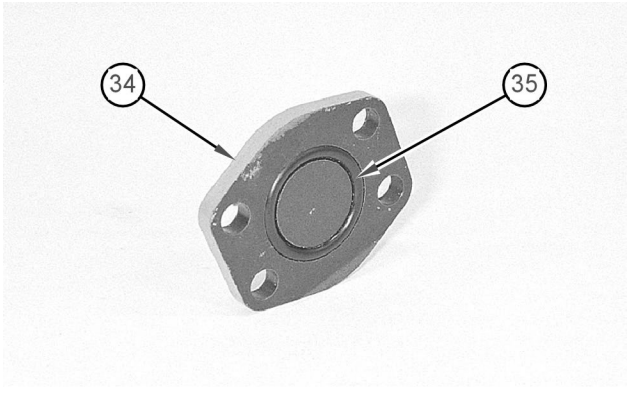


Illustration 70 g01240359

10. Remove bolts (33) and O-ring seal (35) from cover (34).

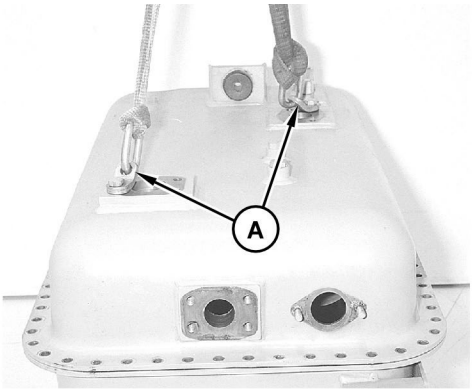


Illustration 71 g01240358

11. Use Tooling (A) and a suitable lifting device in order to remove the top half of the hydraulic oil tank. The weight of the top half of the hydraulic oil tank is approximately 68 kg (150 lb).

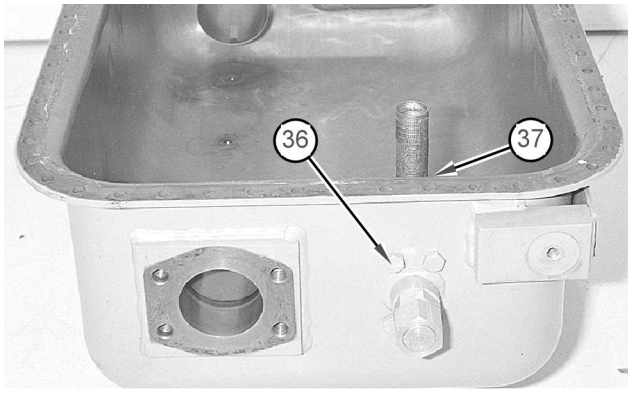


Illustration 72 g01240356

12. Remove bolts (36) and filter base assembly (37).

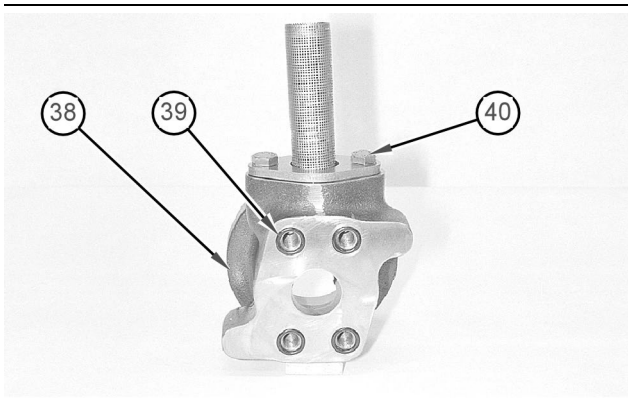


Illustration 73 g01240351

13. Remove O-ring seals (39) and bolts (40) from filter base (38).

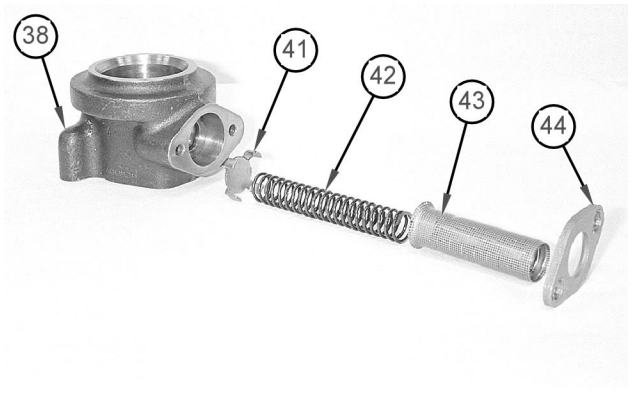


Illustration 74 g01240349

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

14. Remove flange (44), tube assembly (43), spring (42), and valve (41) from filter base (38).

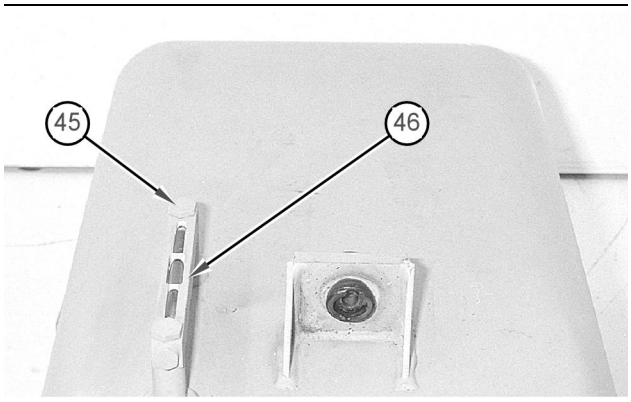


Illustration 75 g01240348

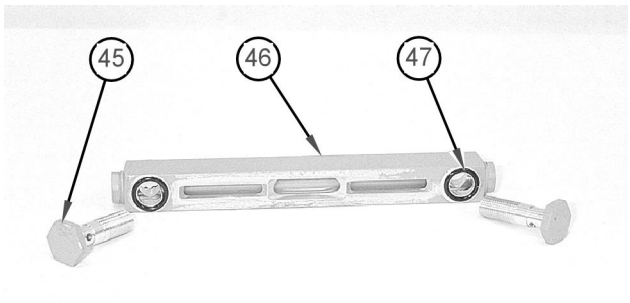


Illustration 76 g01240346

15. Remove two bolts (45) from oil level gauge (46). Remove oil level gauge (46).

16. Remove four O-ring seals (47).

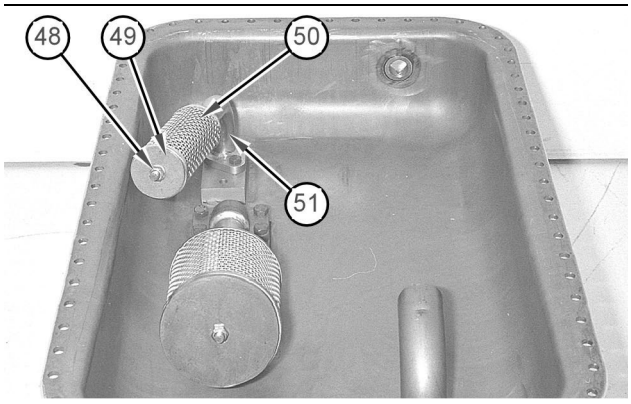


Illustration 77 g01240345

17. Remove locknut (48), the washer, plate (49), and screen assembly (50) from strainer assembly (51).

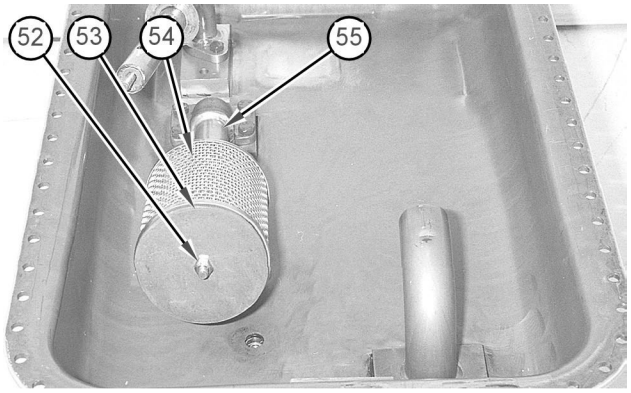


Illustration 78 g01240344

18. Remove locknut (52), plate (53), and screen assembly (54) from strainer assembly (55).

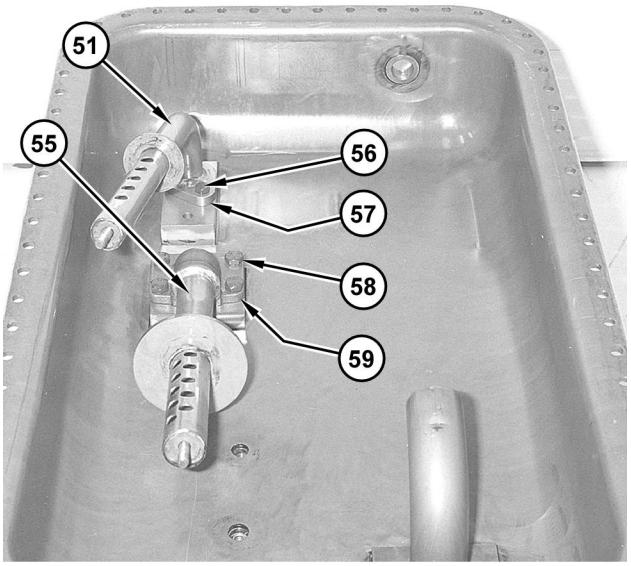


Illustration 79 g01240343

19. Remove bolts (56).

20. Remove strainer assembly (51) and seal (57).

21. Remove bolts (58).

22. Remove strainer assembly (55) and seal (59).

i02517754

Hydraulic Tank (Steering, Hydraulic Fan) - Assemble

SMCS Code: 5056-016-HFN; 5056-016-ZH

Assembly Procedure

Table 5

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
B	3G-4090	Sealant	1

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

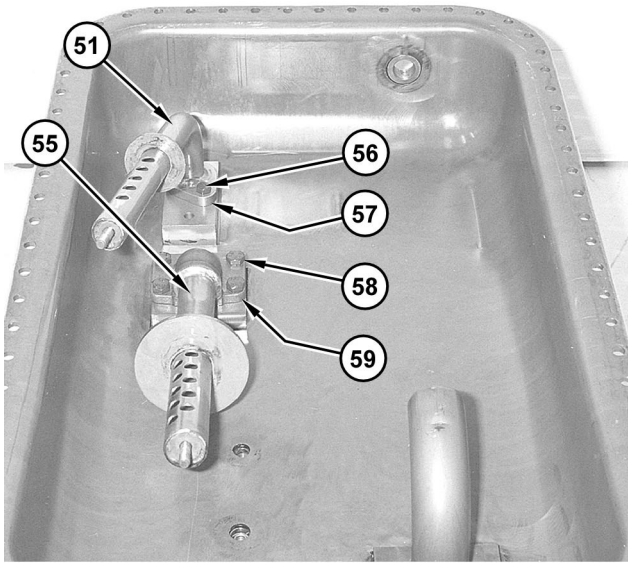


Illustration 80 g01240343

1. Install seal (57), strainer assembly (51), and bolts (56).

2. Install seal (59), strainer assembly (55), and bolts (58).

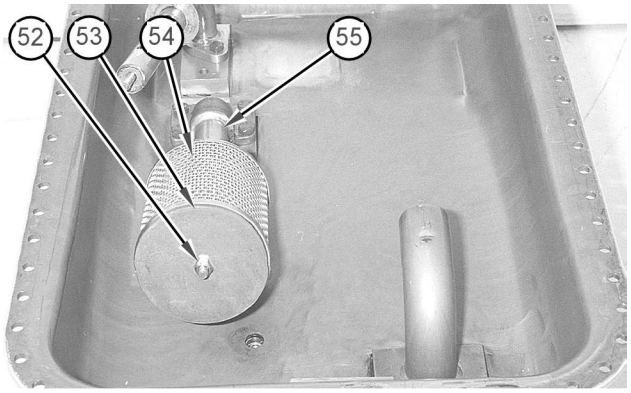


Illustration 81 g01240344

3. Install screen assembly (54), plate (53), and nut (52) to strainer assembly (55).

4. Tighten nut (52) to a torque of 20 ± 5 N·m (15 ± 4 lb ft).

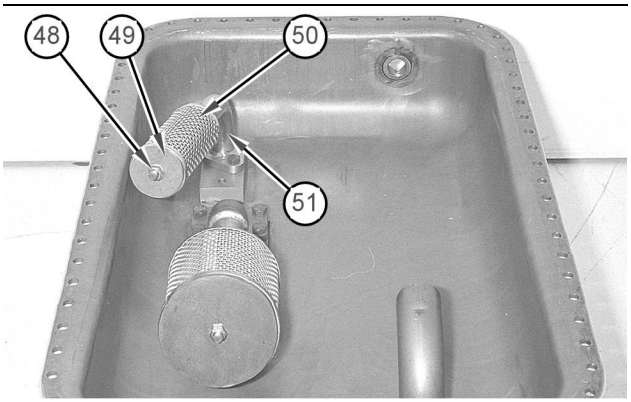


Illustration 82 g01240345

5. Install screen assembly (50), plate (49), nut (48), and the washer to strainer assembly (51).

6. Tighten nut (48) to a torque of 20 ± 5 N·m (15 ± 4 lb ft).

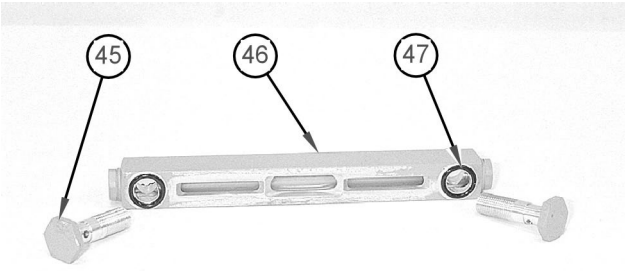


Illustration 83 g01240346

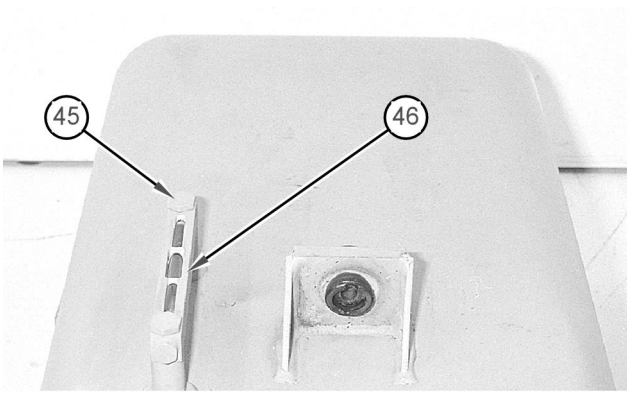


Illustration 84 g01240348

7. Install O-ring seals (47) into oil level gauge (46). Install oil level gauge (46) and bolts (45). Tighten the bolts (45) to a torque of 7 ± 1 N·m (5 ± 1 lb ft).

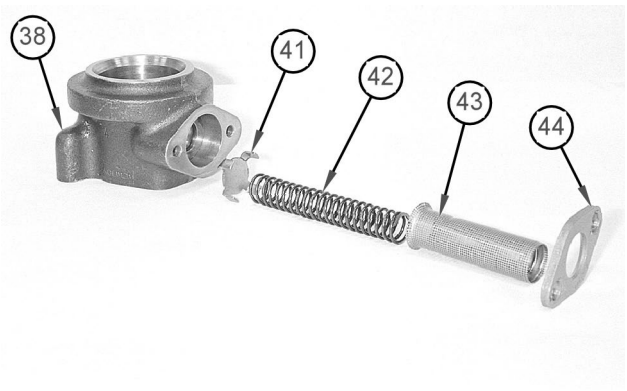


Illustration 85 g01240349

8. Install valve (41), spring (42), tube assembly (43), and flange (44) into filter base (38).

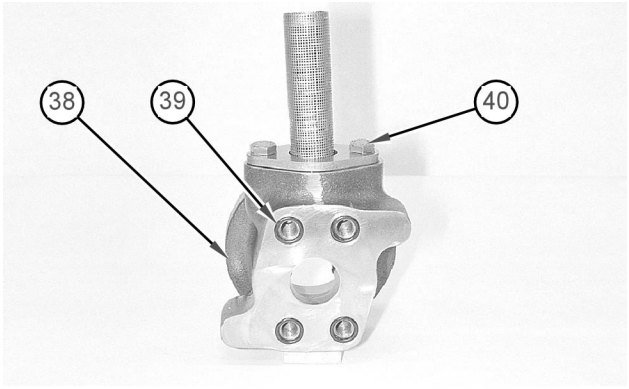


Illustration 86 g01240351

9. Install bolts (40) and O-ring seals (39) to filter base (38).

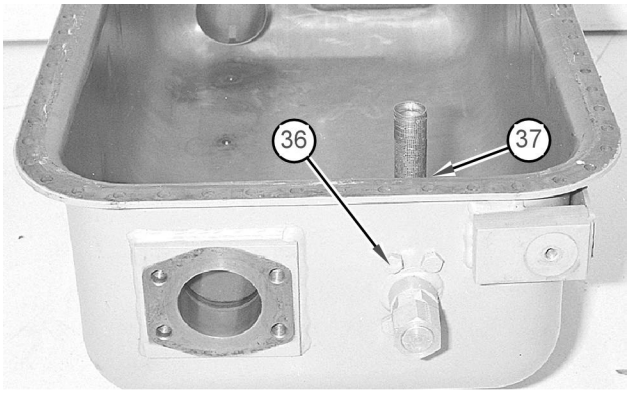


Illustration 87 g01240356

10. Install filter base assembly (37) and four bolts (36).

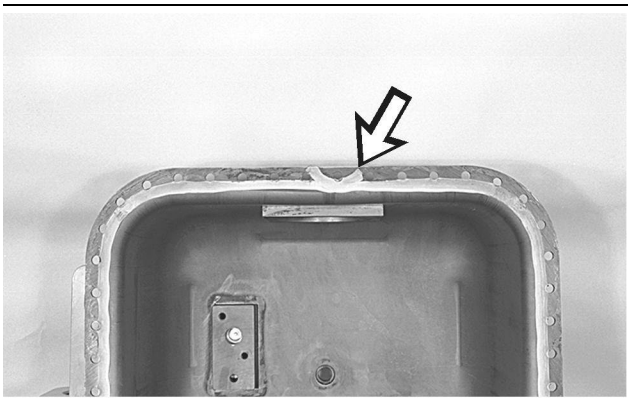


Illustration 88 g00323483
Typical Example

11. Apply Tooling (B) to the mating surfaces of the hydraulic tank. Make sure that the ends of the sealant overlap in a crisscross manner, as shown.

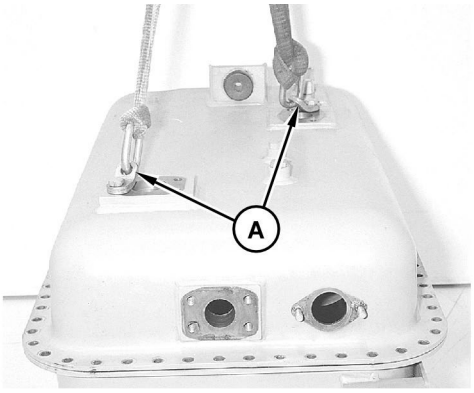


Illustration 89 g01240358

12. Use Tooling (A) and a suitable lifting device in order to Install the top half of the hydraulic tank. The weight of the top half of the hydraulic tank is 68 kg (150 lb).

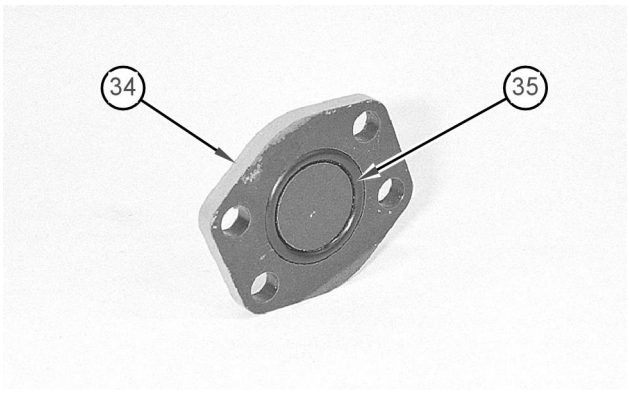


Illustration 90 g01240359

13. Install O-ring seal (35) to cover (34).

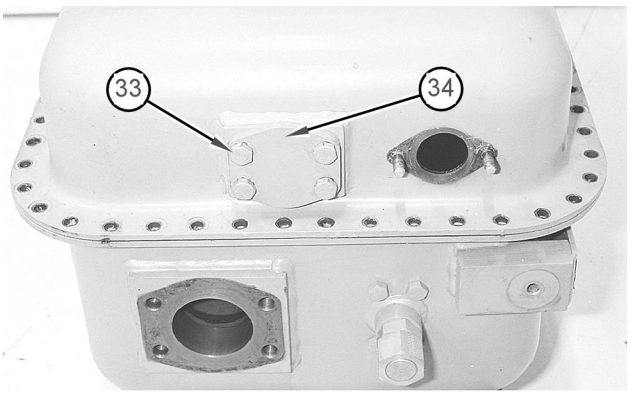


Illustration 91 g01240360

14. Install cover (34) and bolts (33).

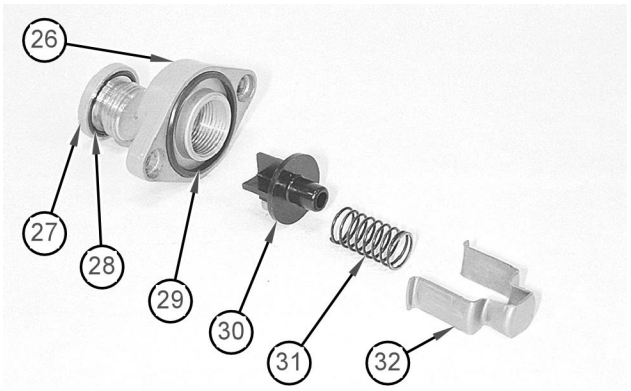


Illustration 92 g01240362

15. Install O-ring seal (28) to plug (27).

16. Install plug (27) into drain valve body (26).

17. Install seal (29), valve (30), spring (31), and valve guide (32) into drain valve body (26).

18. Tighten plug (27) to a torque of 68 ± 7 N·m (50 ± 5 lb ft).

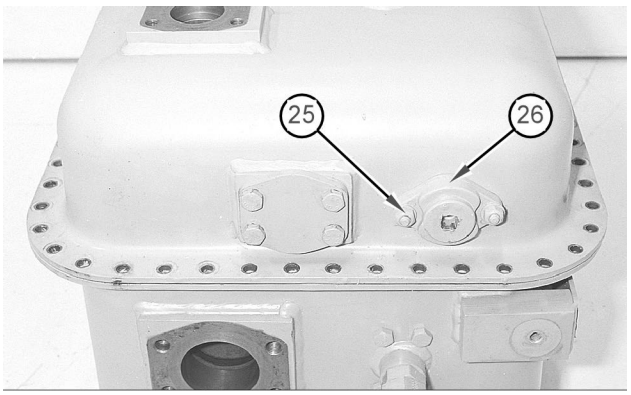


Illustration 93 g01240363

19. Install drain valve body (26), nuts (25) and the washers.

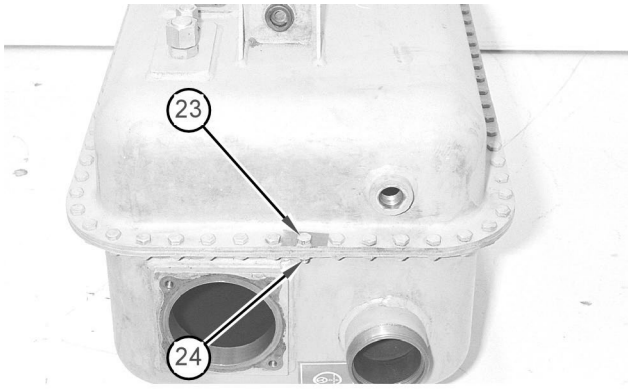


Illustration 94 g01240364

20. Install bolts (23) and nuts (24) into the hydraulic tank.

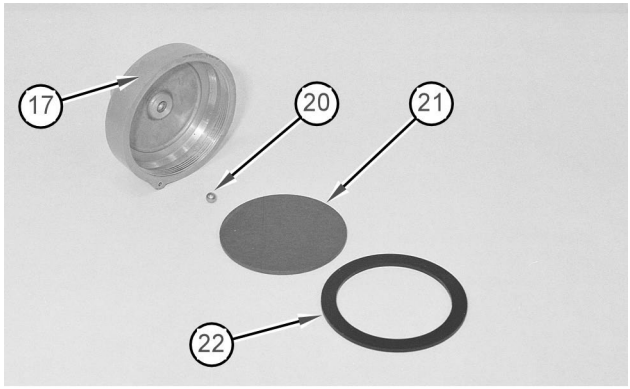


Illustration 95 g01240366

21. Install ball (20), plate (21), and gasket (22) into filler cap (17).

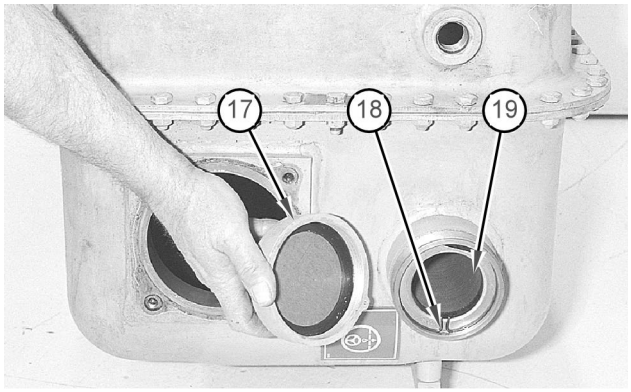


Illustration 96 g01240335

22. Install strainer assembly (19), lock ring (18), and filler cap (17).

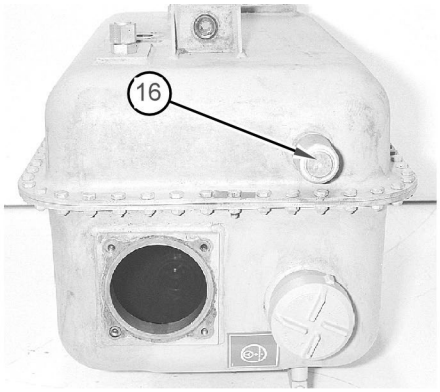


Illustration 97 g01240334

23. Install breaker relief valve (16).

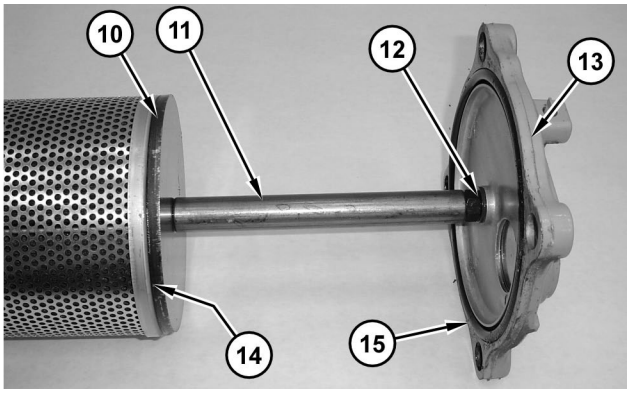


Illustration 98 g01240368

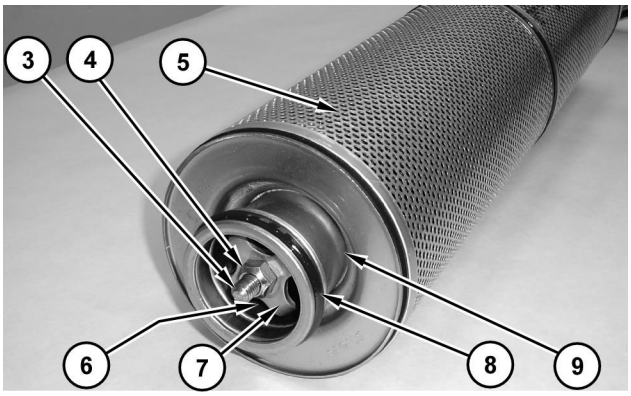


Illustration 99 g01240367

24. Install O-ring seals (15) to cover assembly (13). Install nut (12) onto rod (3). Install rod (3) onto cover assembly (13) and tighten nut (12). Install spacer (11), plate (10), spacer (14), filters(5), retainer (9), and nut (6). Install O-ring seals (8), spring (7), and nut (4). Tighten nut (4) to a torque of 10 ± 1.5 N·m (88 ± 13 lb in).

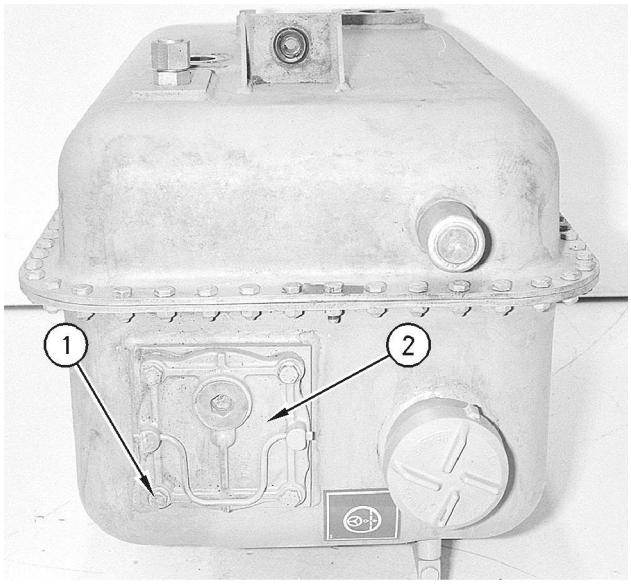


Illustration 100 g00867865

25. Install the filter assembly (2) and bolts (1).

End By:

a. Install the left side hydraulic tank for the steering system and the hydraulic fan. Refer to Disassembly and Assembly, "Hydraulic Tank (Steering and Hydraulic Fan) - Install".

i02484912

Hydraulic Tank (Steering, Hydraulic Fan) - Install

SMCS Code: 5056-012-ZH; 5056-012-HFN

Installation Procedure

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	3

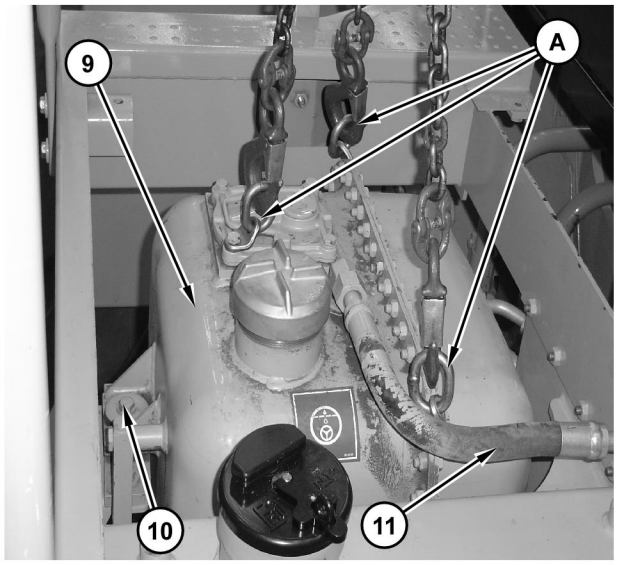


Illustration 101 g01240336

1. Attach Tooling (A) and a suitable lifting device to hydraulic tank assembly (9). Install hydraulic tank assembly (9). The weight of hydraulic tank assembly (9) is approximately 283 kg (625 lb). Install bolt (10) and the washer. Connect hose assembly (11).

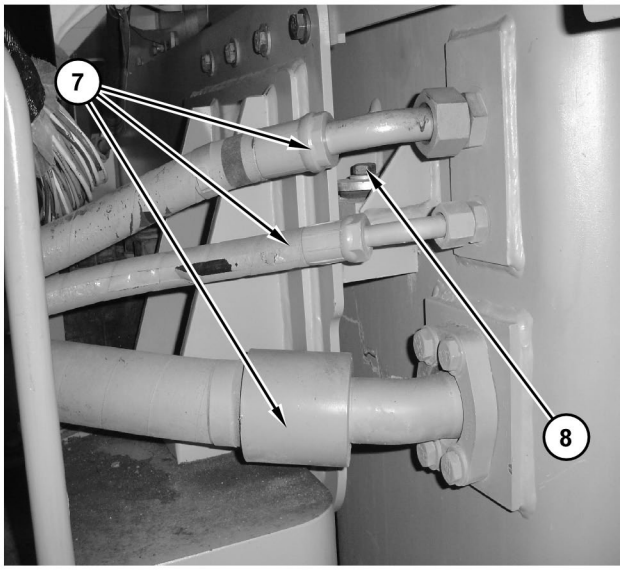


Illustration 102 g01240211

2. Install bolt (8). Connect hose assemblies (7).

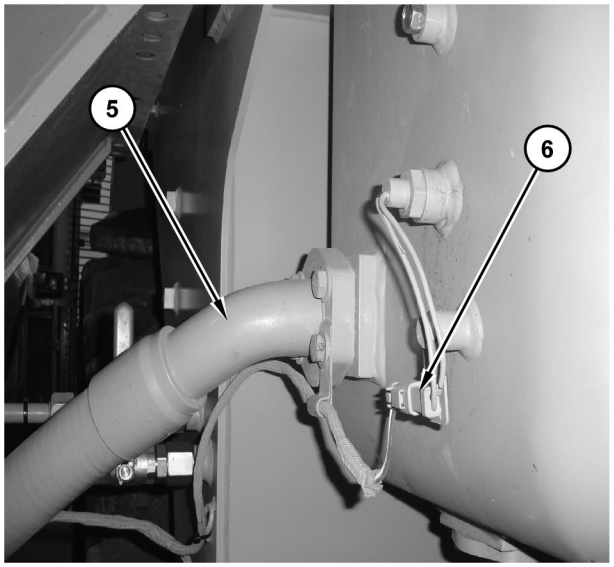


Illustration 103 g01240209

3. Connect harness assembly (6). Connect hose assembly (5).

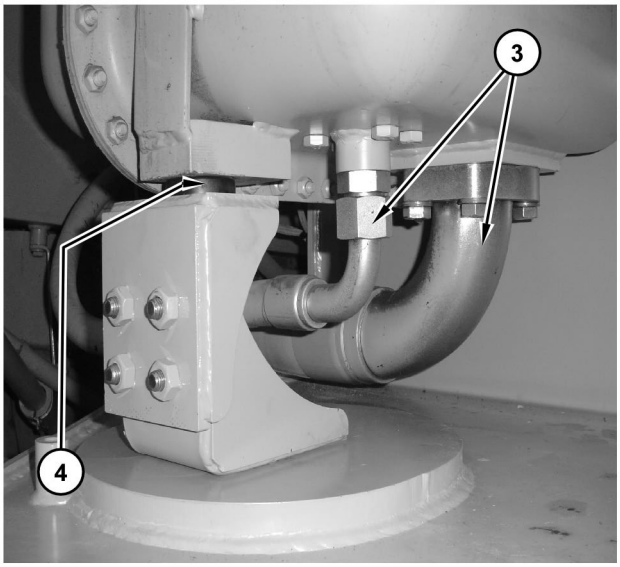


Illustration 104 g01240206

4. Install bolt (4). Connect hose assemblies (3).



Illustration 105 g01240215

5. Remove panel assembly (2).

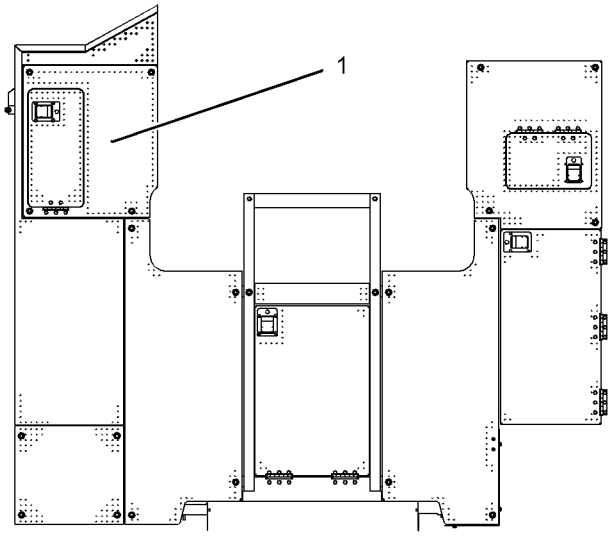


Illustration 106 g01240726

6. Use two people in order to install panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).

7. Fill the hydraulic oil tank . Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Steering and Hydraulic Fan) - Change”.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02473428

Piston Pump (Steering) - Remove

SMCS Code: 4306-011-QP; 5070-011-ZH

Removal Procedure

Start By:

a. Remove the piston pump (hydraulic fan). Refer to Disassembly and Assembly Manual, “Piston Pump (Hydraulic Fan) - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Cleanliness is an important factor. Before the removal procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

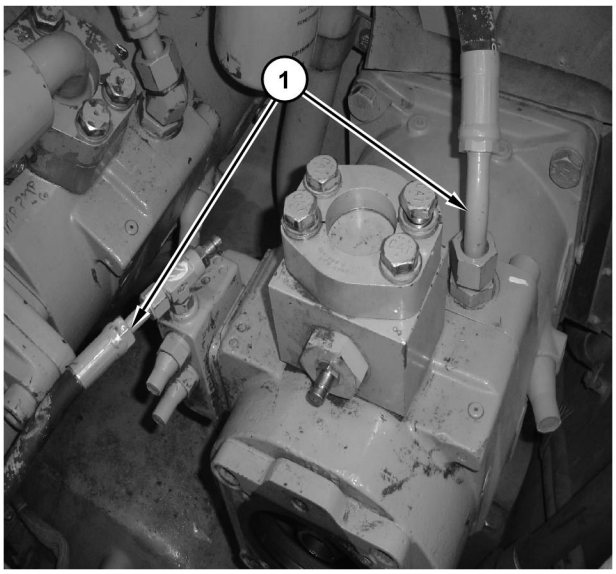


Illustration 107 g01233786

1. Disconnect hose assemblies (1).



Illustration 108 g01233787

2. Disconnect hose assembly (2).

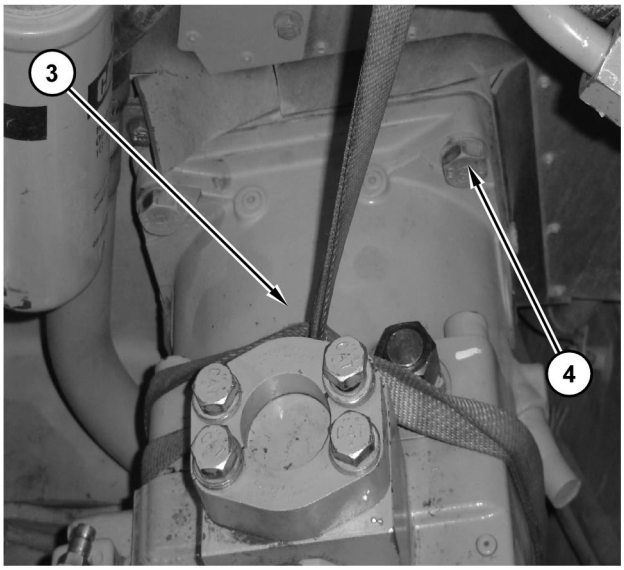


Illustration 109 g01233788

3. Attach a suitable lifting device to piston pump assembly (3). The weight of piston pump assembly (3) is approximately 131 kg (290 lb). Remove bolts (4). Remove piston pump assembly (3).

i02472315

Piston Pump (Steering) - Disassemble

SMCS Code: 4306-015-QP; 5070-015-ZH

Disassembly Procedure

Table 7

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1863	Retaining Ring Pliers	1
B	138-7574	Link Bracket	2
C	1P-1859	Retaining Ring Pliers	1

Start By:

a. Remove the piston pump. Refer to Disassembly and Assembly, "Piston Pump (Hydraulic Fan) - Remove".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the oil into a suitable container.

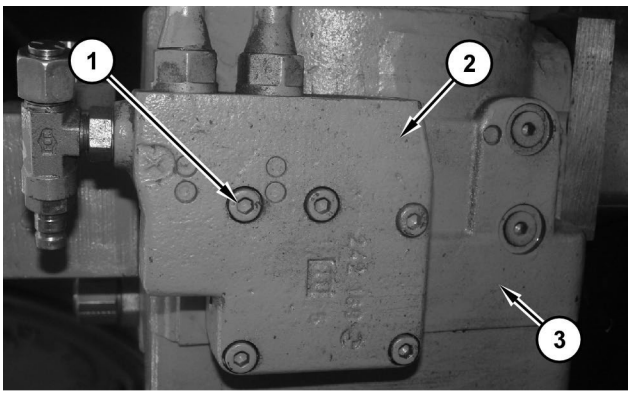


Illustration 110 g01232982

2. Remove bolts (1) and pressure and flow compensator valve (2) from head assembly (3).

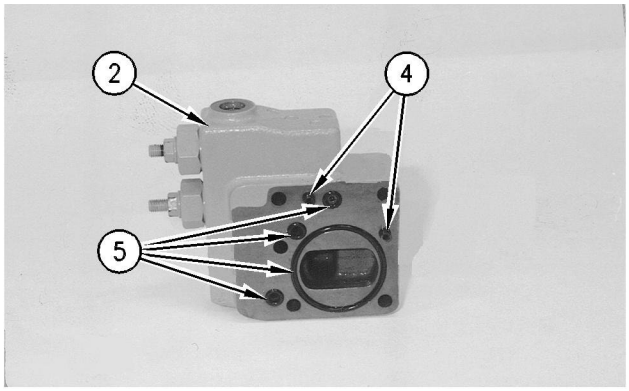


Illustration 111 g00344085

3. Remove O-ring seals (5) and pins (4) from pressure and flow compensator valve (2).

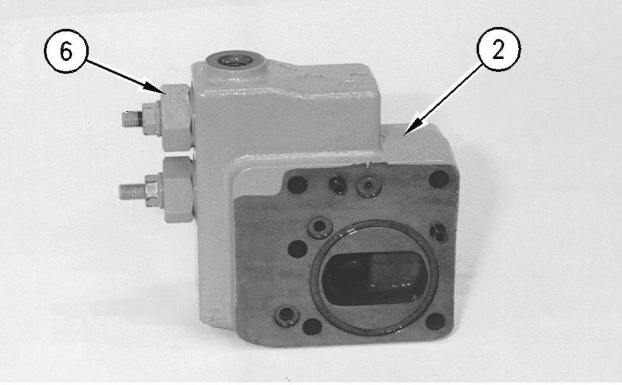


Illustration 112 g00344086

4. Use a depth micrometer to measure the distance from the end of the setscrew to the outside surface of pressure and flow compensator valve (2). Record this dimension for assembly purposes. Remove flow compensator valve (6) from pressure and flow compensator valve (2).

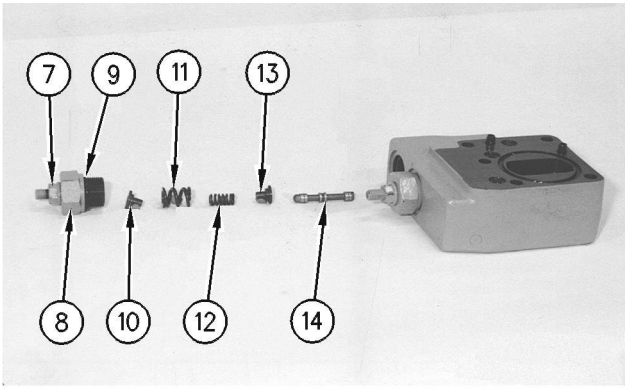


Illustration 113 g00344087

5. Remove the setscrew and locknut (7) from pressure and flow compensator valve (2). Remove plug (8), seal (9), retainer (10), spring (11), spring (12), retainer (13) and piston (14) from pressure and flow compensator valve (2).

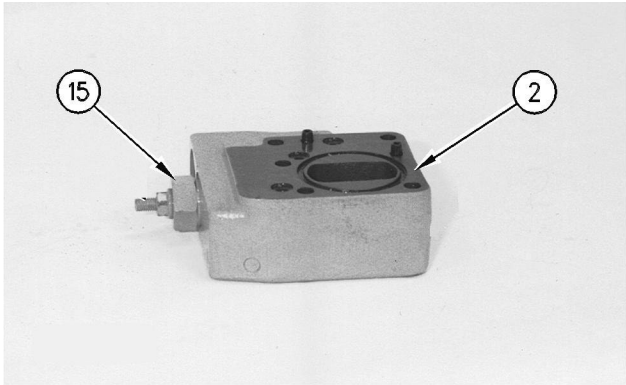


Illustration 114 g00344088

6. Use a depth micrometer to measure the distance from the end of the setscrew to the outside surface of pressure and flow compensator valve (2). Record this dimension for assembly purposes. Remove pressure compensator valve (15) from pressure and flow compensator valve (2).

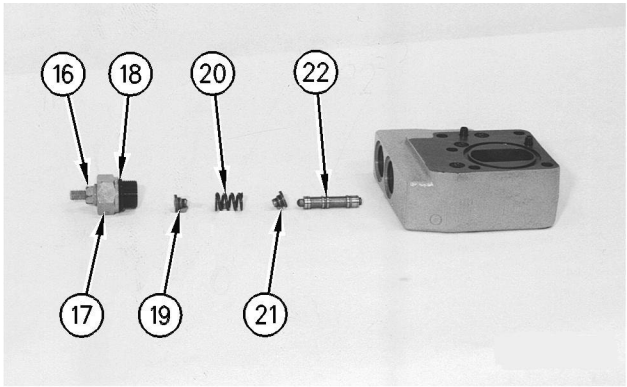


Illustration 115 g00344089

7. Remove the setscrew and locknut (16) from pressure and flow compensator valve (2). Remove plugs (17), seal (18), retainer (19), spring (20), retainer (21) and piston (22) from pressure and flow compensator valve (2).

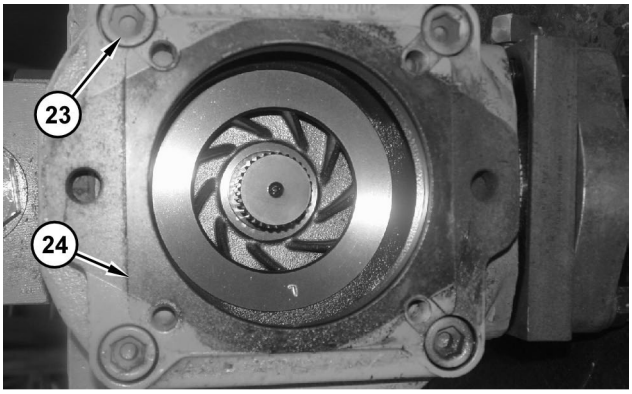


Illustration 116 g01232984

8. Remove bolts (23) and flange (24).

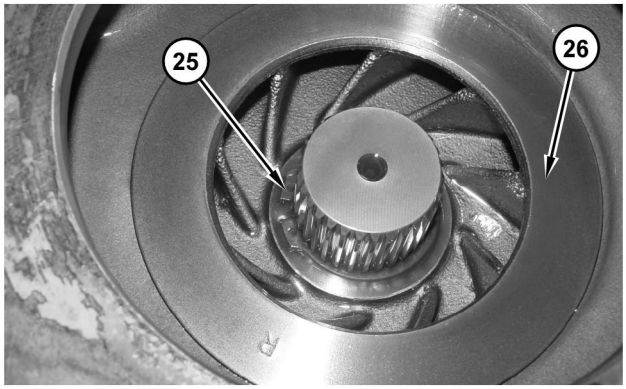


Illustration 117 g01237012

9. Use Tooling (A) in order to remove retaining ring (25). Remove impeller (26).

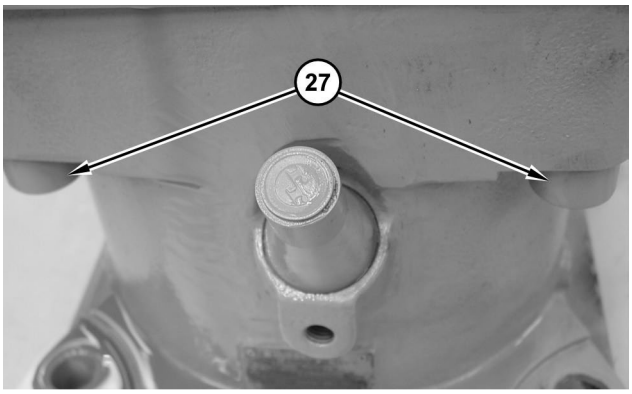


Illustration 118 g01237013

10. Remove bolts (27).

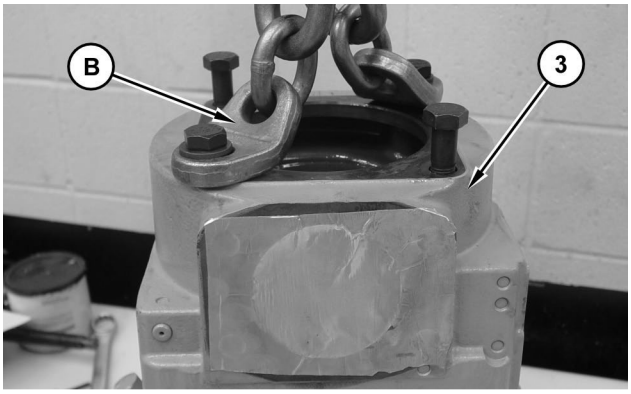


Illustration 119 g01237014

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

11. Attach Tooling (B) and a suitable lifting device to head (3).

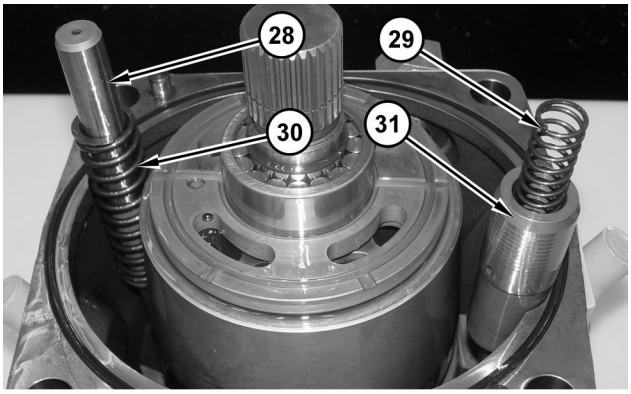


Illustration 120 g01237015

12. Remove piston (28), spring (30), spring (29), and piston (31).

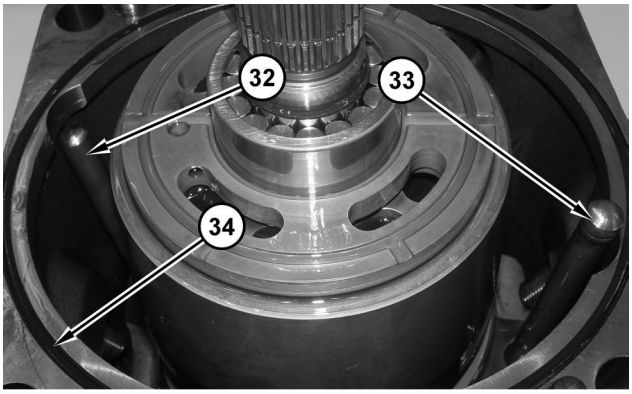


Illustration 121 g01237016

13. Remove rod (32), rod (33), and O-ring seal (34).

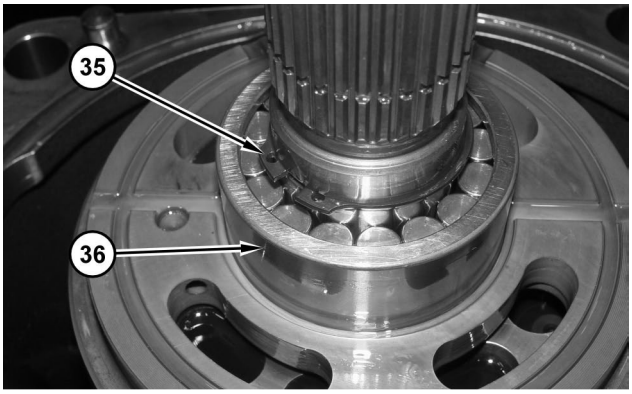


Illustration 122 g01237017

14. Use Tooling (A) in order to remove retaining ring (35).

15. Remove bearing (36).

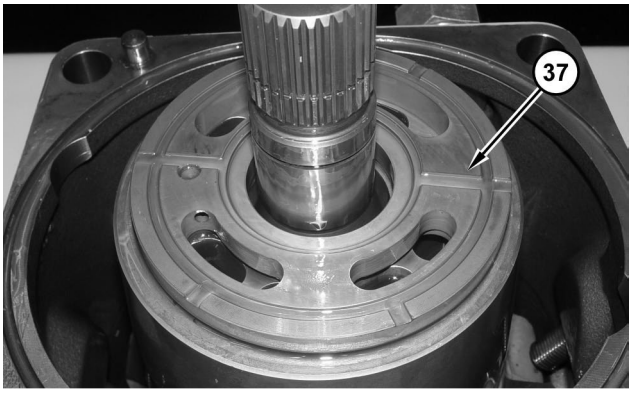


Illustration 123 g01237018

16. Remove port plate (37).

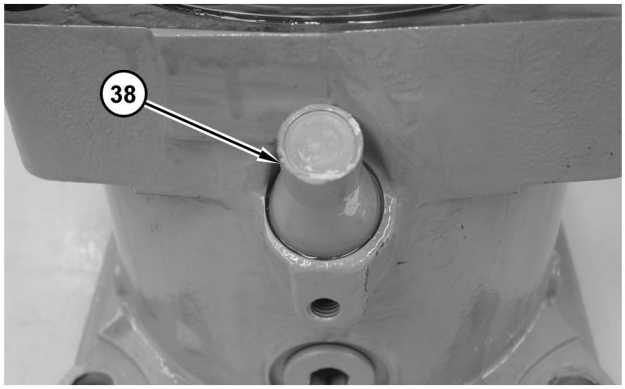


Illustration 124 g01237019

17. Remove cap (38) and the screw.

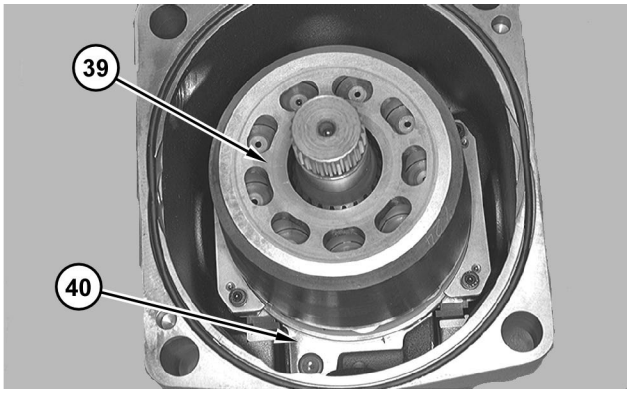


Illustration 125 g01237020

18. Remove swashplate (40) and barrel assembly (39) as one piece.

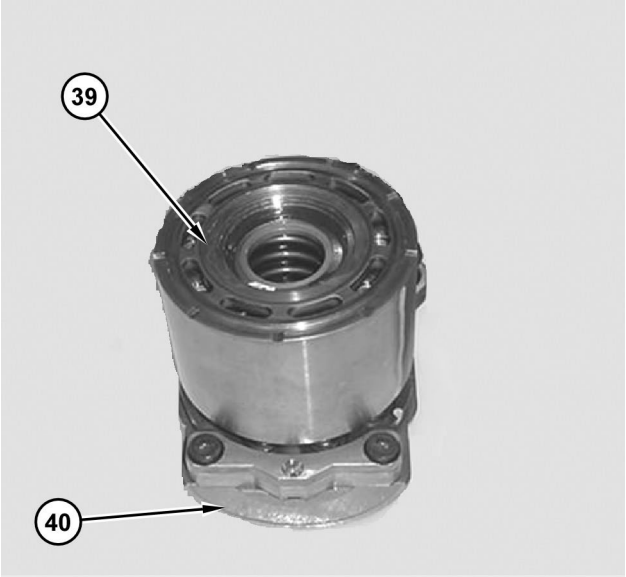


Illustration 126 g01237021

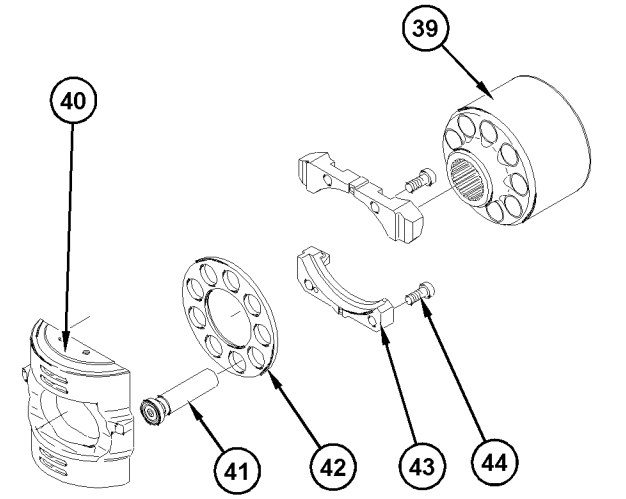


Illustration 127 g01237022

19. Remove bolts (44) from swashplate (40).

Note: Bolts (44) should be replaced with new bolts.

20. Remove retainers (43) from swashplate (40).

21. Remove barrel assembly (39) from swashplate (40).

22. Remove pistons (41) and retaining plate (42) from barrel assembly (39).

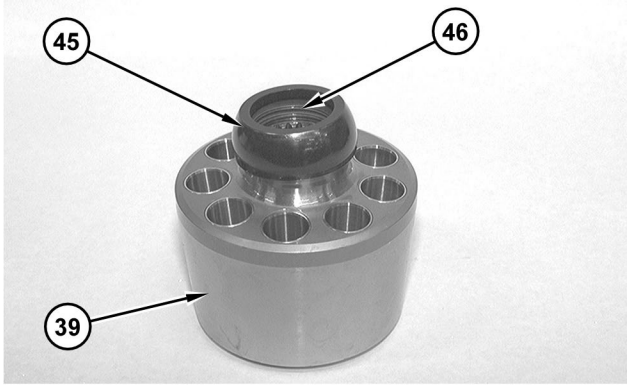


Illustration 128 g01237023

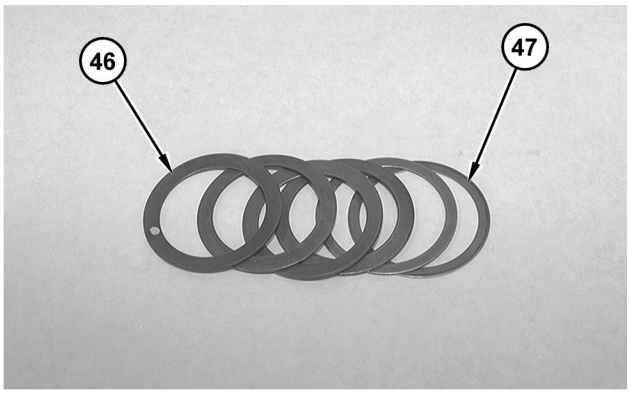


Illustration 129 g01237024

23. Remove bearing (45) from barrel assembly (39).

24. Remove cup springs (46) and shims (47) from barrel assembly (39).

Note: Mark orientation of cup springs (46) and shims (47) for installation.

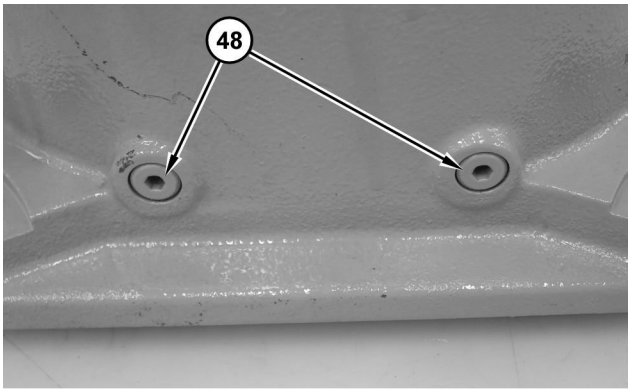


Illustration 130 g01237025

25. Remove retainers (48).

26. Repeat Step 25 for the opposite side.

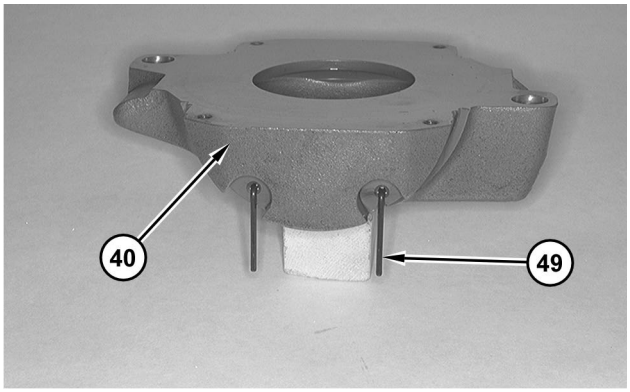


Illustration 131 g01237026

27. Remove rods (49) from swashplate (40).

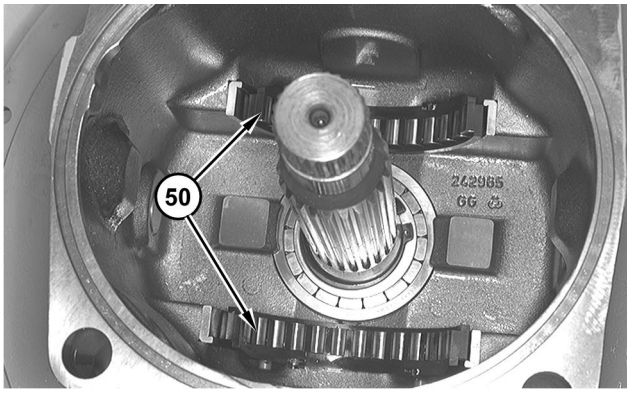


Illustration 132 g01237027

28. Remove bearings (50).

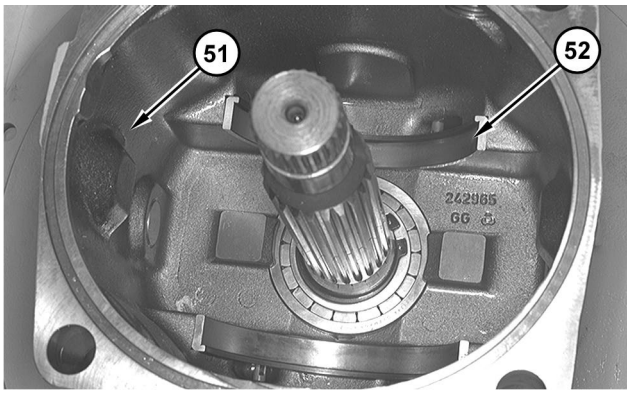


Illustration 133 g01237028

29. Remove outer races (52) from housing (51).

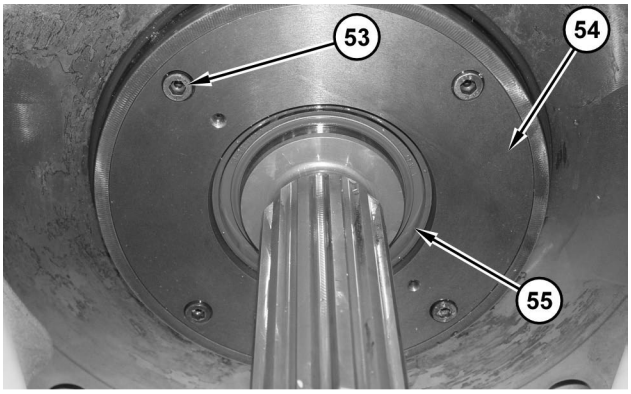


Illustration 134 g01237031

30. Remove bolts (53), cover (54), lip seal (55), and the O-ring seals.

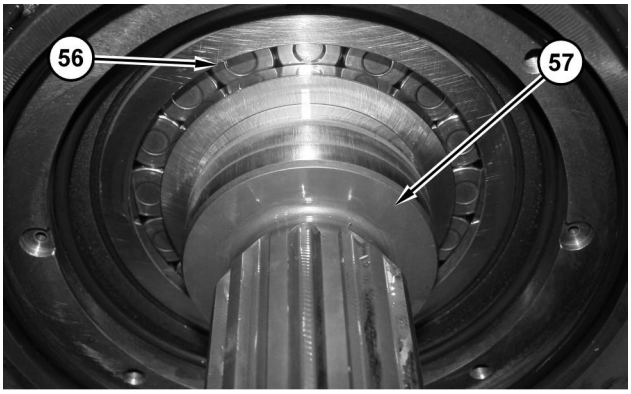


Illustration 135 g01237032

31. Remove bearing (56) and shaft (57).

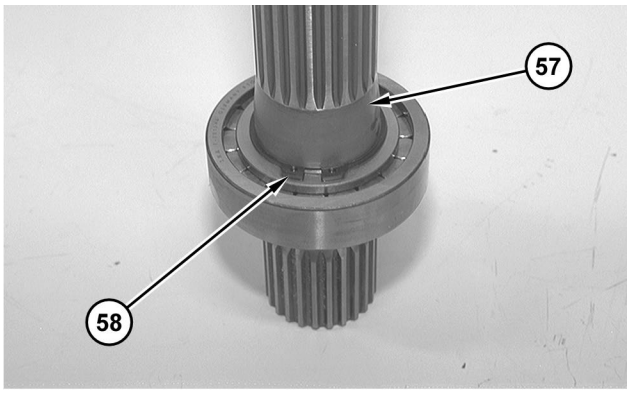


Illustration 136 g01237033

32. Use Tooling (C) in order to remove retaining ring (58) from shaft (57).

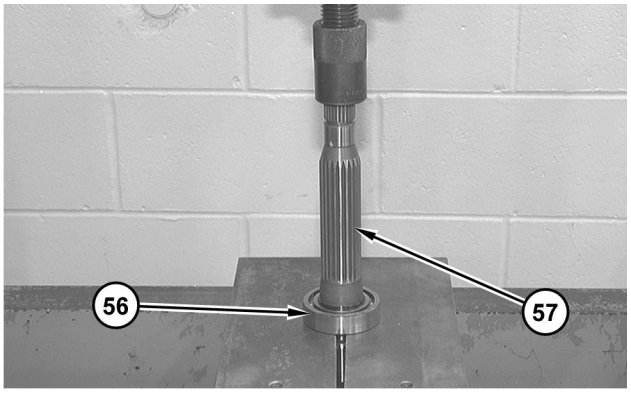


Illustration 137 g01237034

33. Use a suitable press in order to remove bearing (56) from shaft (57).

i06636627

Piston Pump (Steering) - Assemble

SMCS Code: 4306-016-QP; 5070-016-ZH

Assembly Procedure

Table 8

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1863	Retaining Ring Pliers	1
B	138-7574	Link Bracket	2
C	1P-1859	Retaining Ring Pliers	1
D	137-1326	Measuring Hub	1
E	129-3876	Measuring Bell	1
F		Height Gauge	1
G	137-1329	Test Pins	3
H	137-1311	Alignment Plug	1

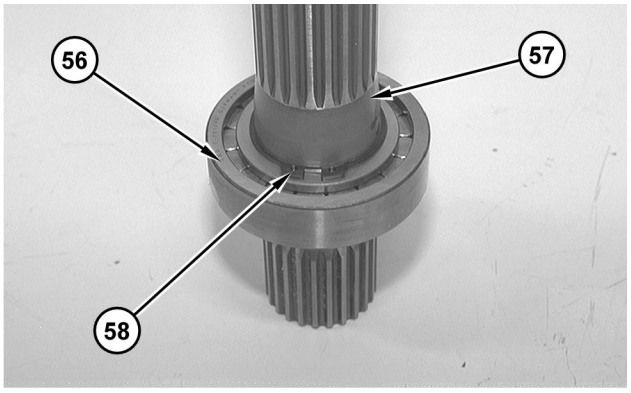


Illustration 138 g01246245

1. Raise the temperature of bearing (56).

2. Install bearing (56) onto shaft (57).

3. Use Tooling (C) in order to install retaining ring (58) to shaft (57).

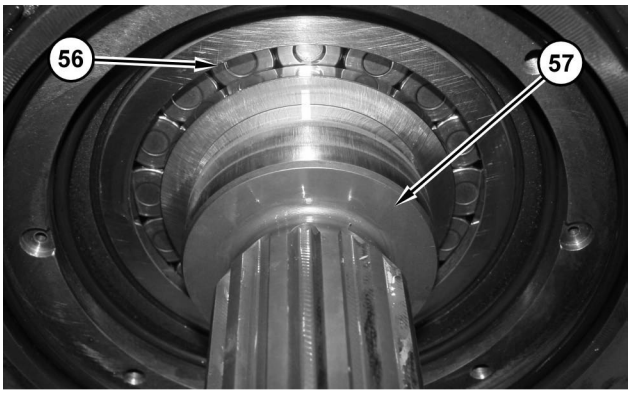


Illustration 139 g01237032

4. Install bearing (56) and shaft (57).

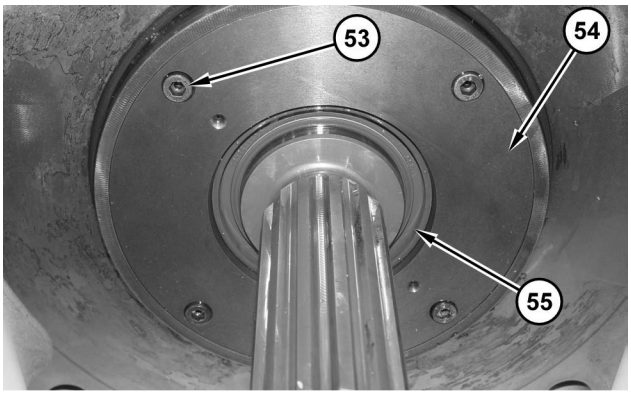


Illustration 140 g01237031

5. Install the O-ring seals, lip seal (55), cover (54), and bolts (53).

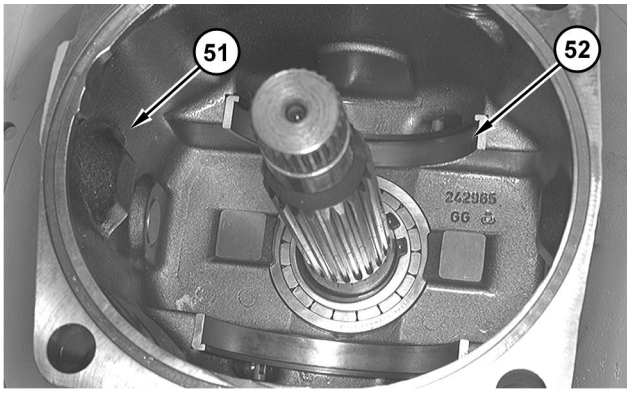


Illustration 141 g01237028

6. Install outer races (52) into housing (51).

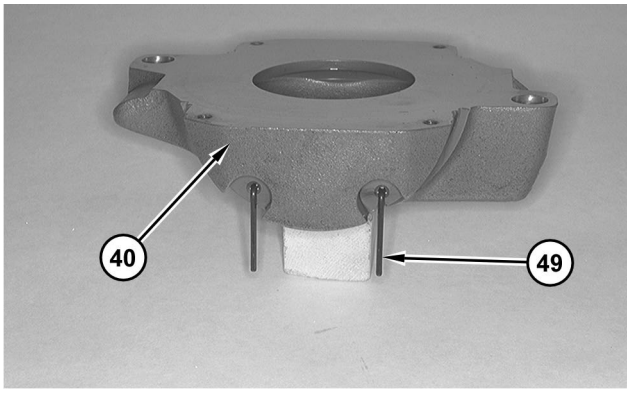


Illustration 142 g01237026

7. Install rods (49) to swashplate (40).

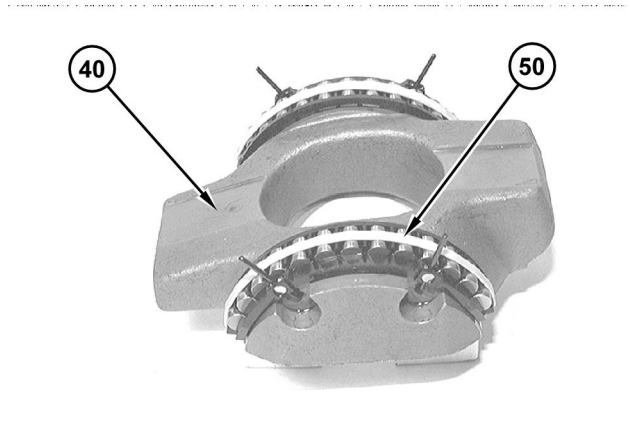


Illustration 143 g01237585

8. Install bearings (50) to swashplate (40). Install a rubber band to each bearing (50). The rubber band will hold bearing (50) to swashplate (40).

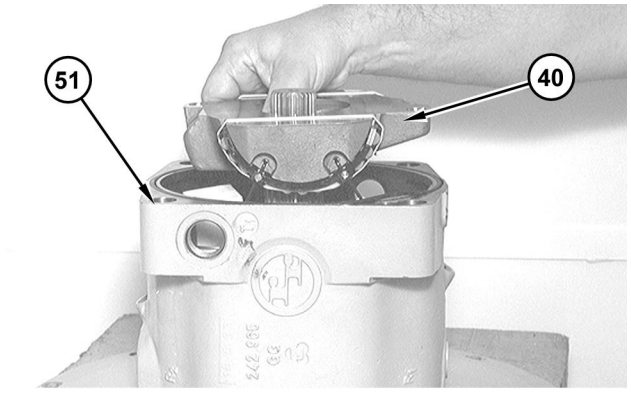


Illustration 144 g01237587

9. Carefully install swashplate (40) into housing (51).

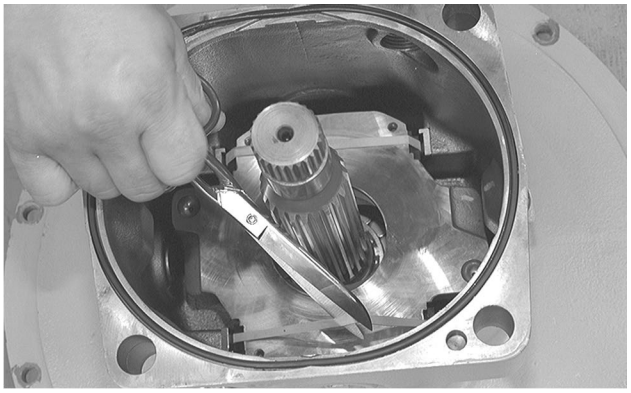


Illustration 145 g01171288

10. Remove the rubber band on each of the bearings.

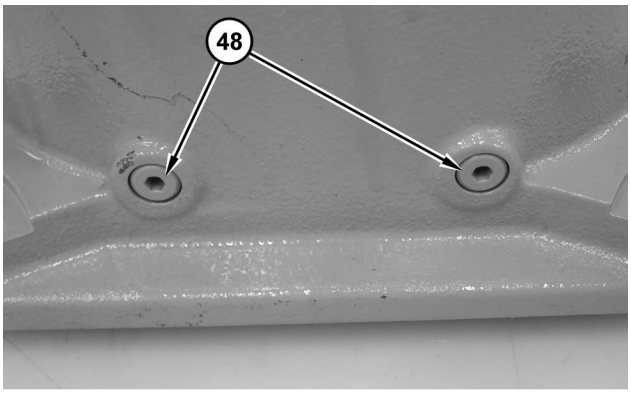


Illustration 146 g01237025

11. Install retainers (48).

12. Repeat Step 4 for the opposite side.

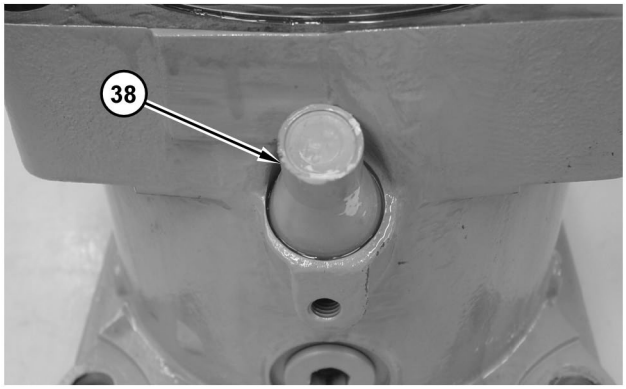


Illustration 147 g01237019

13. Install the screw and cap (38).

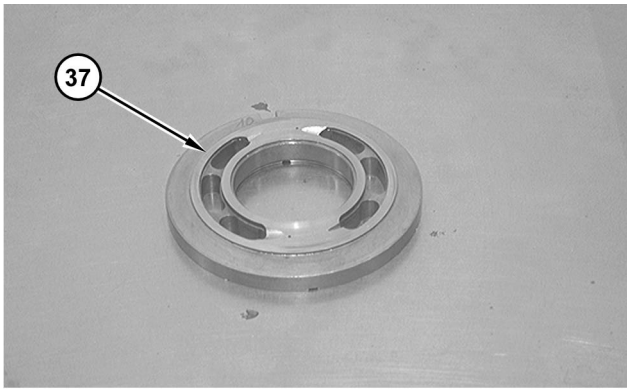


Illustration 148 g01237588

14. Place port plate (37) on a surface plate.

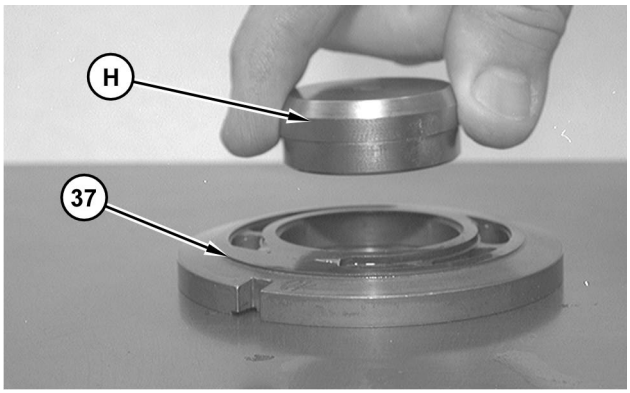


Illustration 149 g01237590

15. Install Tooling (H) to port plate (37).

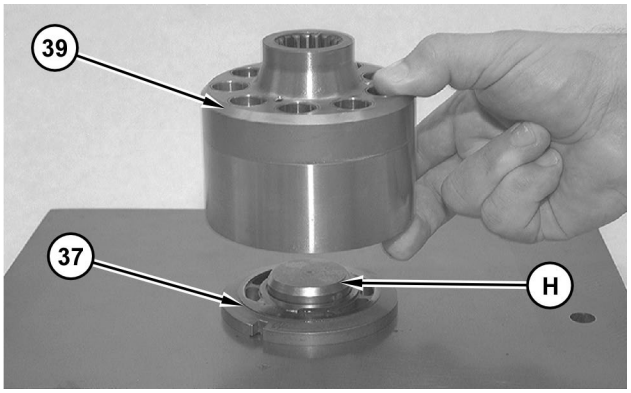


Illustration 150 g01237591

16. Install barrel assembly (39) onto Tooling (B) and port plate (37).

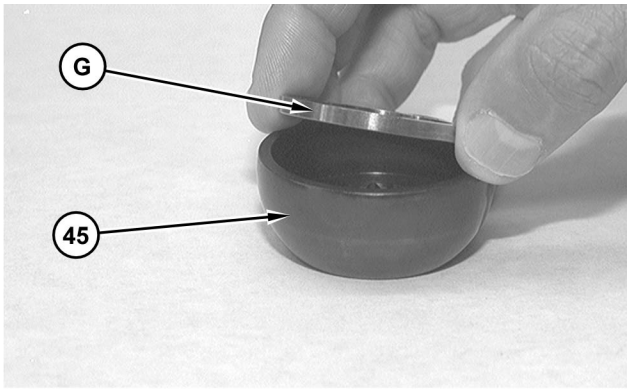


Illustration 151 g01237594

17. Install Tooling (G) onto bearing (45). Shims and springs must be removed from bearing (45).

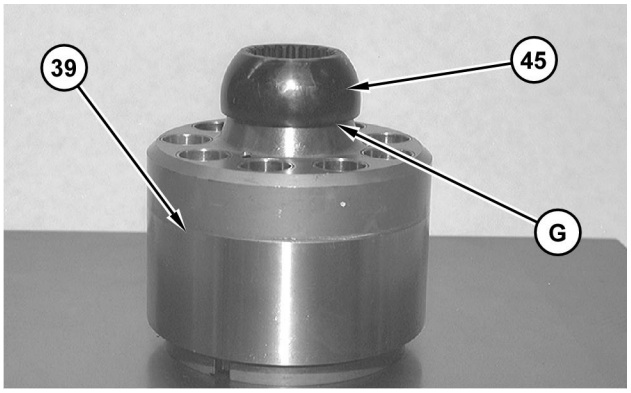


Illustration 152 g01237595

18. Install bearing (45) and Tooling (G) onto barrel assembly (39).

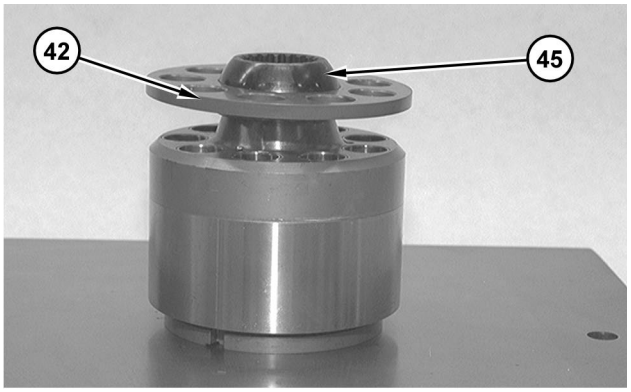


Illustration 153 g01237597

19. Install retainer plate (42) onto bearing (45).

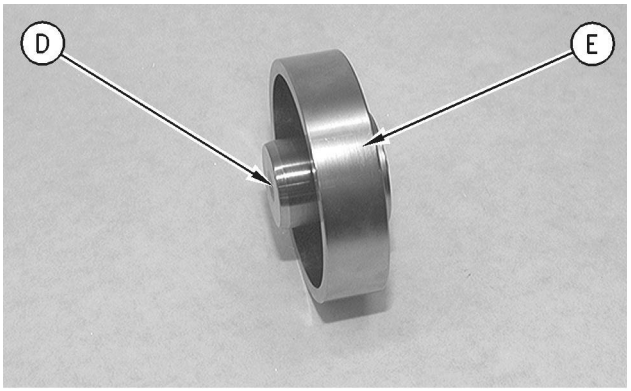


Illustration 154 g00903603

20. Bolt Tooling (D) to Tooling (E).

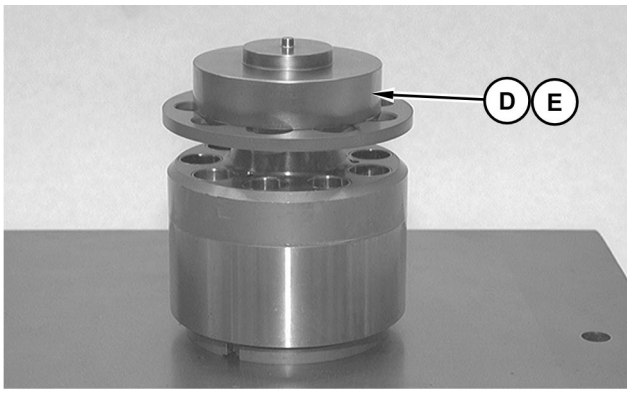


Illustration 155 g01171297

21. Install assembled Tooling (D) and Tooling (E) onto the bearing. Make sure that Tooling is properly seated.

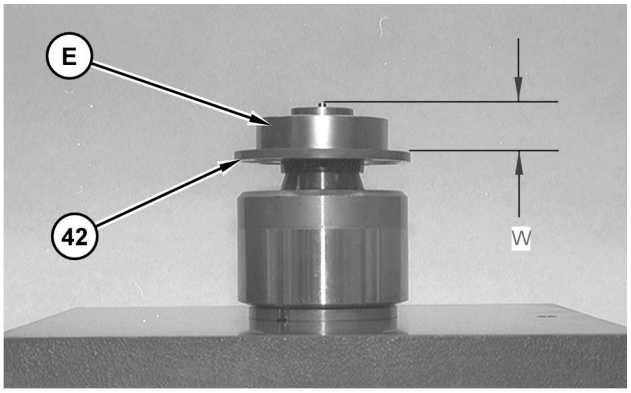


Illustration 156 g01237598

22. Record the dimension that is stamped on the side of Tooling (E). This dimension is the distance from the top of retainer plate (42) to the top of Tooling (E). This dimension is called Dimension (W).

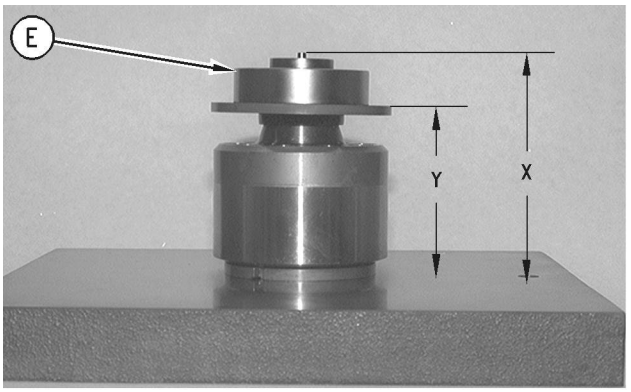


Illustration 157 g00903619

23. Use Tooling (F) to measure the distance from the top of the surface plate to the top of Tooling (E). Record this dimension. Call this Dimension (X).

24. Use the following calculation: Dimension (X) - Dimension(W) = Dimension(Y).

25. Dimension (Y) is the correct lift-off limitation without shim (46).

Note: This is the correct lift-off limitation for the main hydraulic pump. **146.10 + 0.0 − 0.25 mm (5.752 + 0.00 − 0.0098 inch)** Call this Dimension (Z).

26. Use the following calculation: Dimension (Z) - Dimension (Y) = Thickness of shim (42).

Note: Shim (46) is available in several thicknesses. Select the correct thickness of shim (46) in order to obtain the correct lift-off limitation. Only one shim (46) should be used.

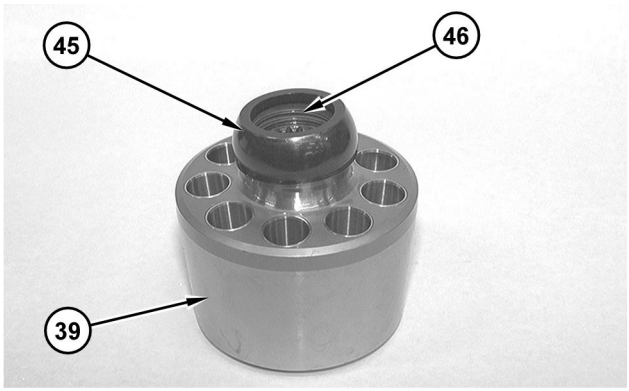


Illustration 158 g01237023

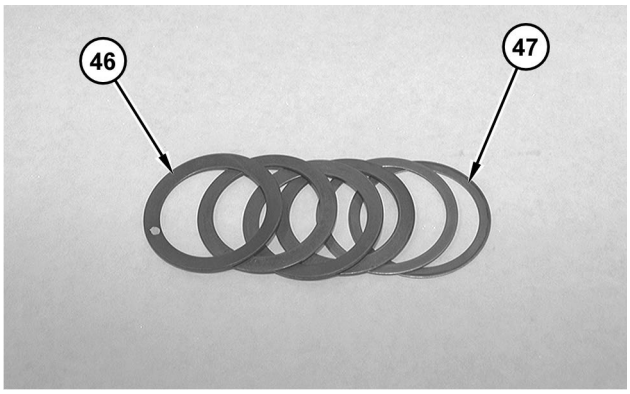


Illustration 159 g01237024

27. Install cup springs (46) and shim (47) to barrel assembly (39).

28. Install bearing (45) to barrel assembly (39).

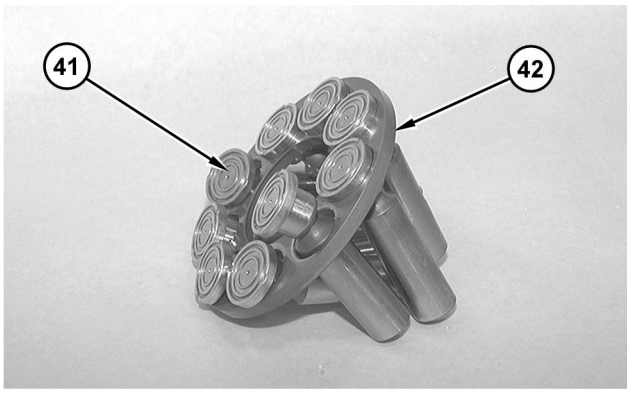


Illustration 160 g01237599

29. Install pistons (41) to retainer plate (42).

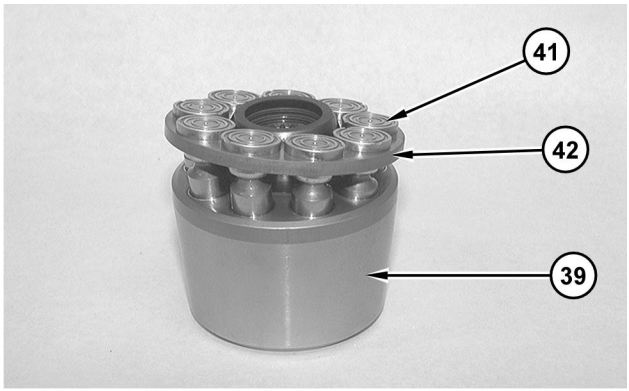


Illustration 161 g01237601

30. Install retainer plate (42) with pistons (41) into barrel assembly (39).

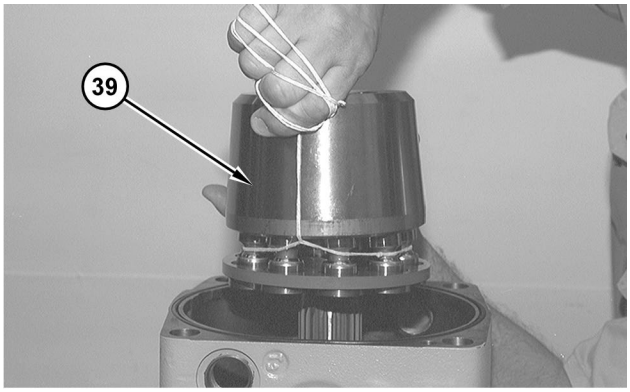


Illustration 162 g01237602

31. Install barrel assembly (39).

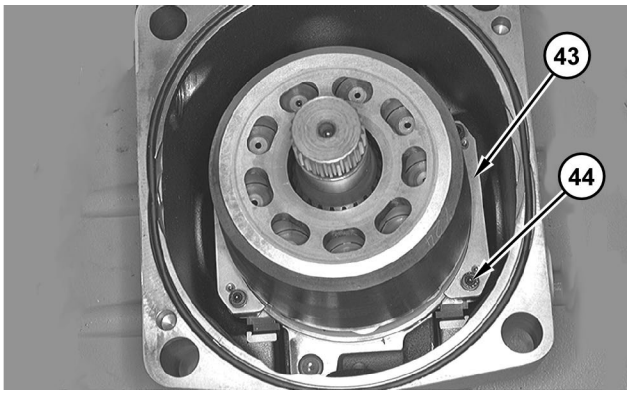


Illustration 163 g01237604

32. Install retainers (43) and bolts (44). Apply thread lock to the threads of bolts (44).

Note: Bolts (44) should be replaced with new bolts.

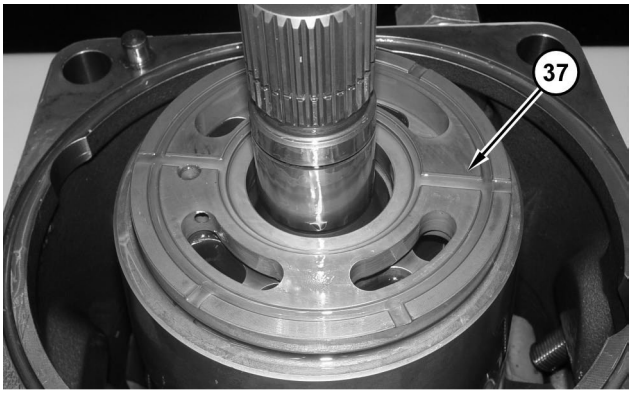


Illustration 164 g01237018

33. Install port plate (37).

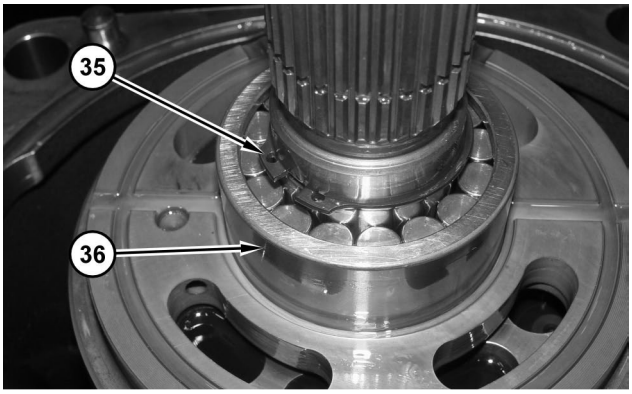


Illustration 165 g01237017

34. Install bearing (36).

35. Use Tooling (A) in order to install retainer ring (35).

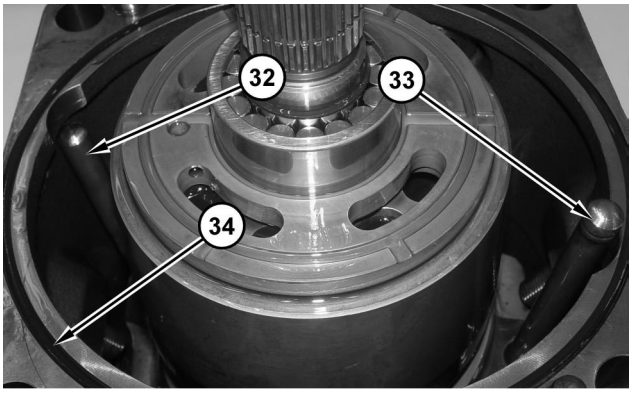


Illustration 166 g01237016

36. Install rod (32), rod (33), and O-ring seal (34).

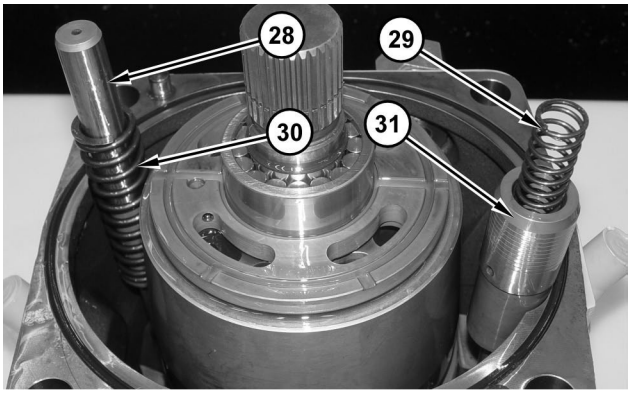


Illustration 167 g01237015

37. Install piston (28), spring (30), piston (31), and spring (29).

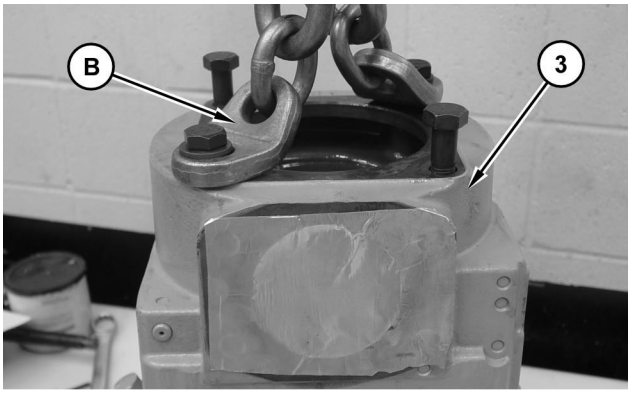


Illustration 168 g01237014

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

38. Attach Tooling (B) and a suitable lifting device to head (3).

39. Install head (3).

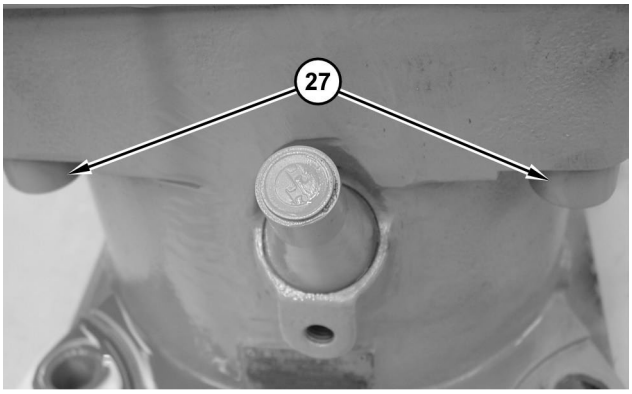


Illustration 169 g01237013

40. Install bolts (27).

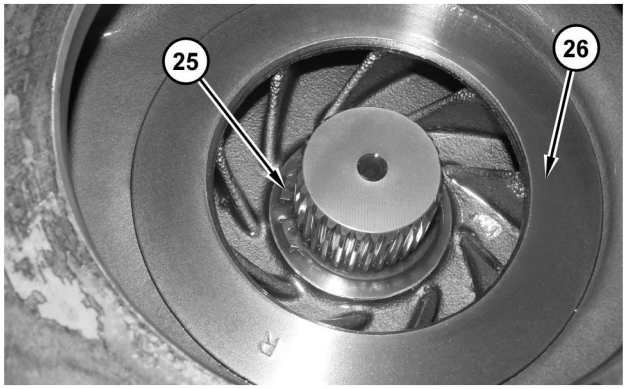


Illustration 170 g01237012

41. Install impeller (26). Use Tooling (A) in order to install retaining ring (25).

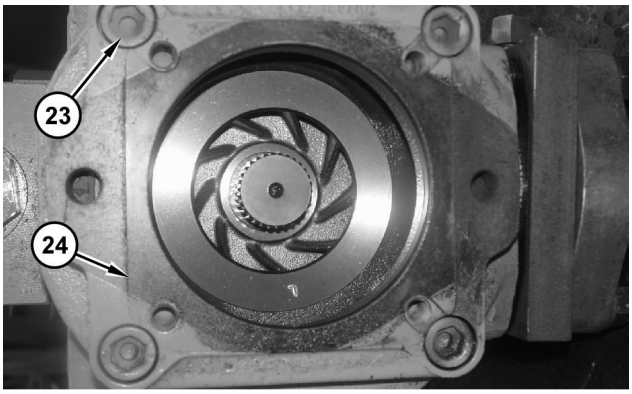


Illustration 171 g01232984

42. Install flange (24) and bolts (23).

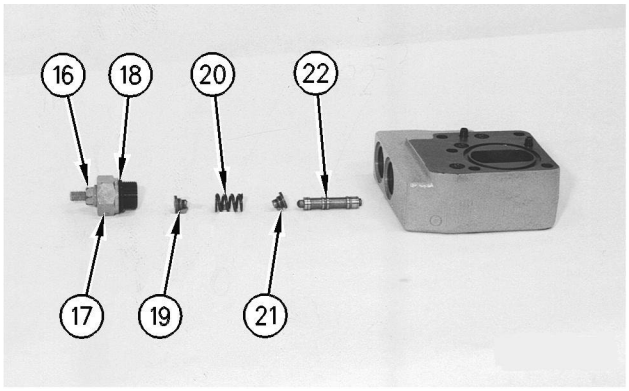


Illustration 172 g00344089

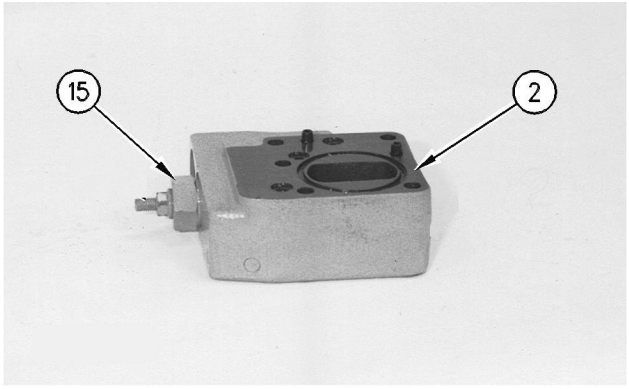


Illustration 173 g00344088

43. Install piston (22), retainer (21), spring (20) and retainer (19) in the pressure and flow compensator valve.

44. Install the setscrew and nut (16) in plug (17). Install plug (17) in pressure and flow compensator valve (2).

45. Adjust pressure compensating valve (15) as close as possible to the original position.

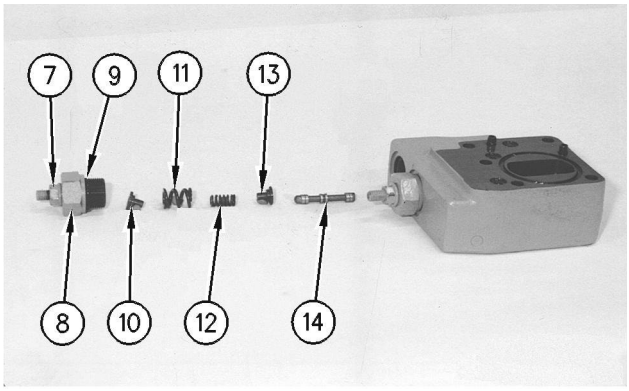


Illustration 174 g00344087

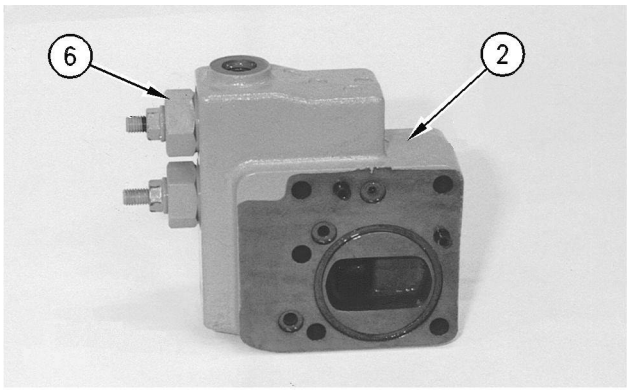


Illustration 175 g00344086

46. Install piston (14), retainer (13), spring (12), spring (11) and retainer (10) in pressure and flow compensator valve (2).

47. Install the setscrew and nut (7) in plug (8). Install O-ring seal (9) on plug (8). Install plug (8) in pressure and flow compensator valve (2).

48. Adjust flow compensator valve (6) as close as possible to the original position.

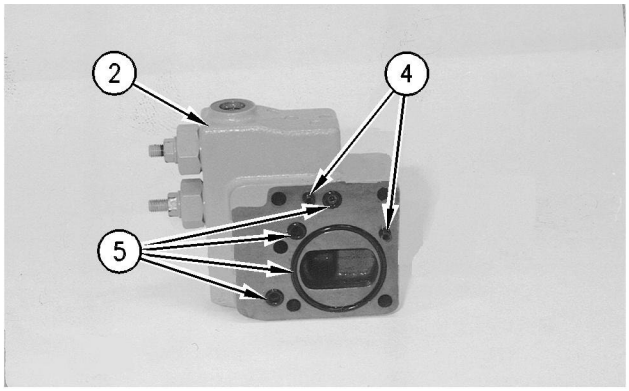


Illustration 176 g00344085

49. Install two pins (4) and four O-ring seals (5) in pressure and flow compensator valve (2).

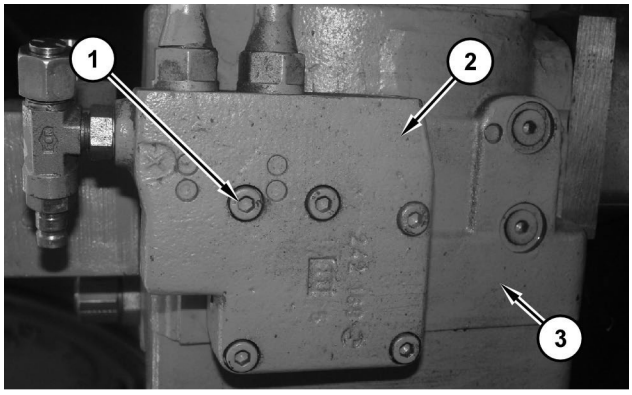


Illustration 177 g01232982

50. Install pressure and flow compensator valve (2) and bolts (1) onto head assembly (3).

End By:

a. Install the piston pump. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic Fan) - Install”.

i02473537

Piston Pump (Steering) - Install

SMCS Code: 4306-012-QP; 5070-012-ZH

Installation Procedure

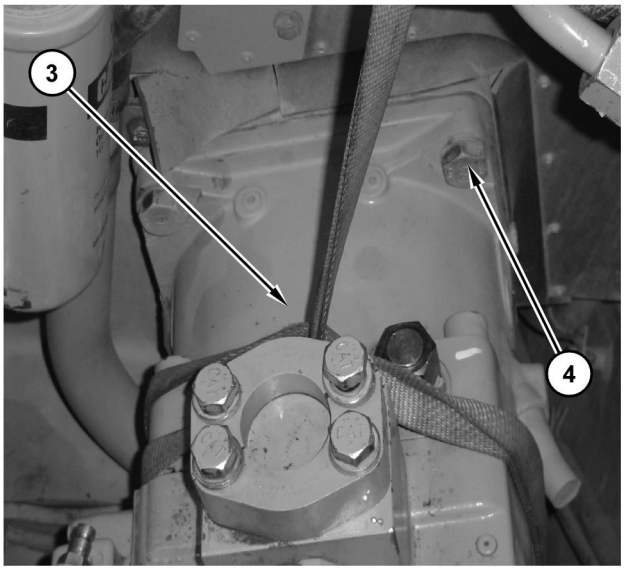


Illustration 178 g01233788

1. Attach a suitable lifting device to piston pump assembly (3). The weight of piston pump assembly (3) is approximately 131 kg (290 lb). Install piston pump assembly (3) into position. Install bolts (4).



Illustration 179 g01233787

2. Connect hose assembly (2).

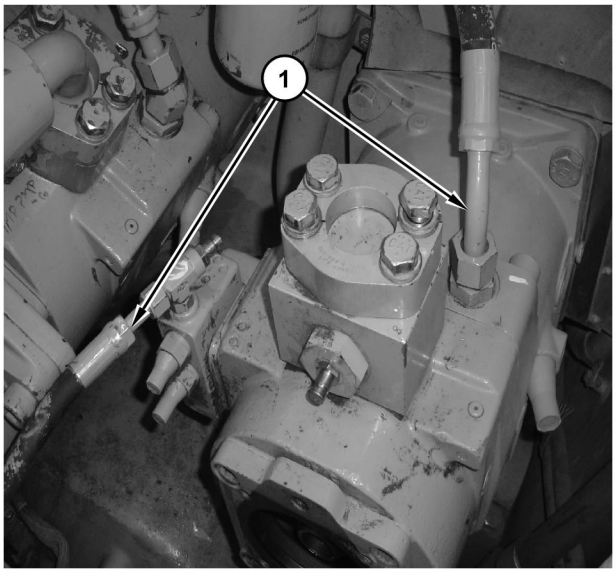


Illustration 180 g01233786

3. Connect hose assemblies (1).

End By:

a. Install the piston pump (hydraulic fan). Refer to Disassembly and Assembly Manual, “Piston Pump (Hydraulic Fan) - Install ”.

i01689512

Gear Pump (Secondary Steering) - Remove

SMCS Code: 4324-011-GT; 5073-011-SST

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the pressure in the steering system and in the braking system. Refer to Disassembly and Assembly, “System Pressure - Release”.

c. Drain the hydraulic oil from the tank for the steering system. Refer to Operation and Maintenance Manual, “Steering and Hydraulic Fan System Oil - Change” for the machine that is being serviced.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

Note: Put identification marks on all hoses for installation purposes. Plug all hoses. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

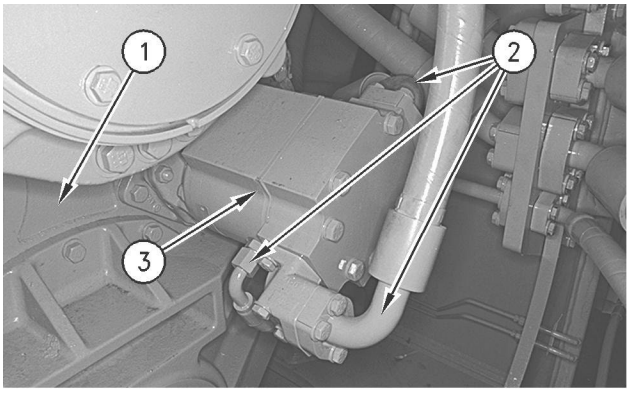


Illustration 181 g00870304

1. Disconnect three hydraulic hose assemblies (2) from secondary steering pump (3).

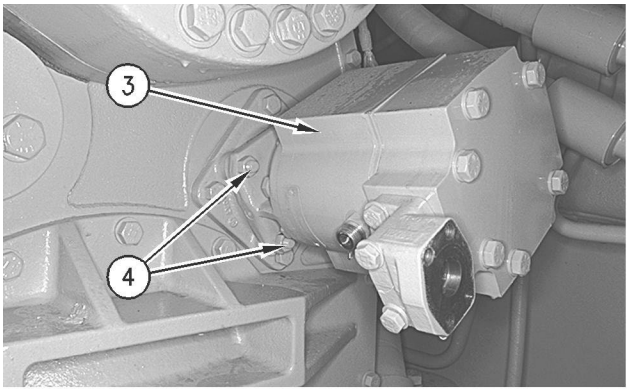


Illustration 182 g00870305

2. Remove nuts (4) and secondary steering pump (3) from output transfer gear case (1). The weight of the secondary steering pump is 18 kg (40 lb).

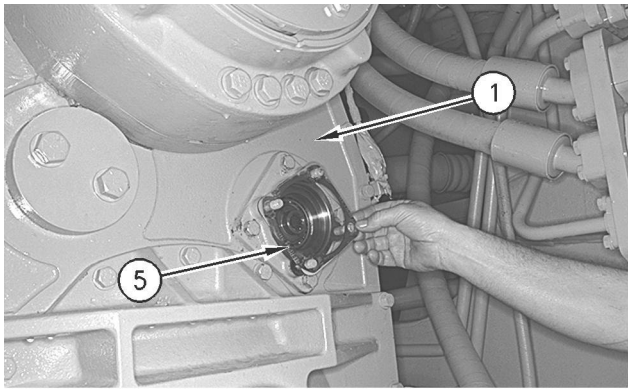


Illustration 183 g00870306

3. Remove gasket (5) from output transfer gear case (1).

i01689703

Gear Pump (Secondary Steering) - Disassemble

SMCS Code: 4324-015-GT; 5073-015-SST

Disassembly Procedure

Start By:

a. Remove the secondary steering pump. Refer to Disassembly and Assembly, "Gear Pump (Secondary Steering) - Remove".

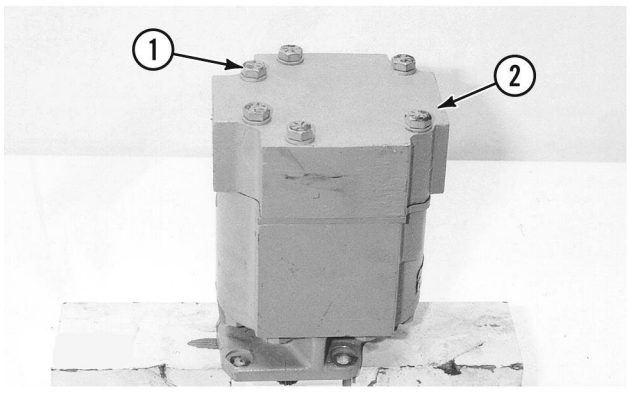


Illustration 184 g00346187

1. Remove bolts (1) and the washers. Remove body (2) from the secondary steering pump.

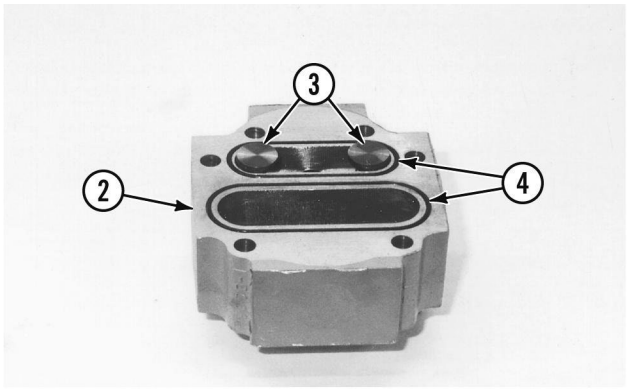


Illustration 185 g00346188

2. Remove two pistons (3) and two springs from body (2).

3. Remove two seals (4) from body (2).

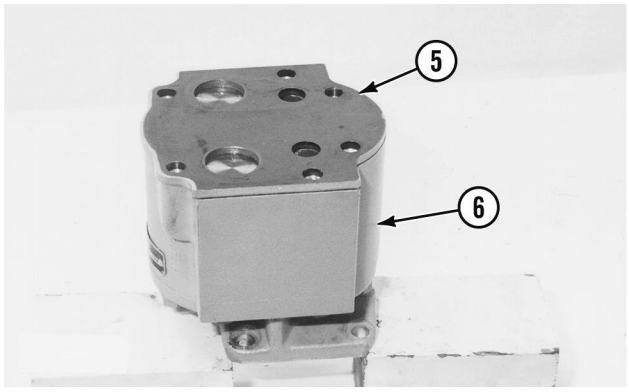


Illustration 186 g00346189

4. Remove spacer (5) from body assembly (6).

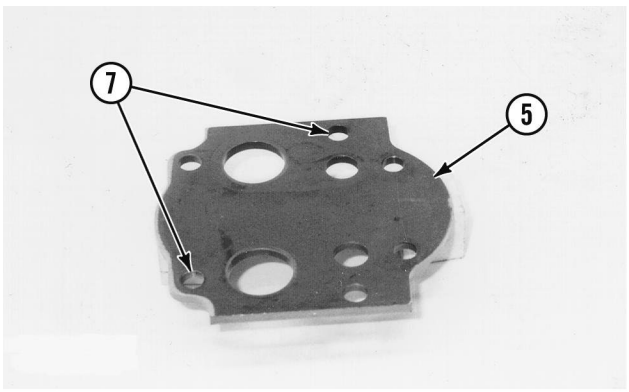


Illustration 187 g00346190

5. Remove two spacers (7) from spacer (5).

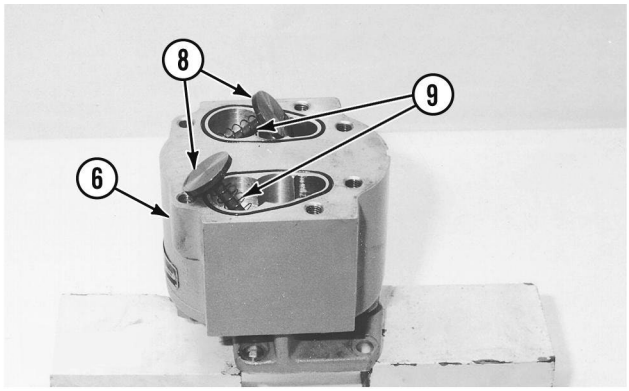


Illustration 188 g00346191

6. Remove two pistons (8) and two springs (9) from body assembly (6).

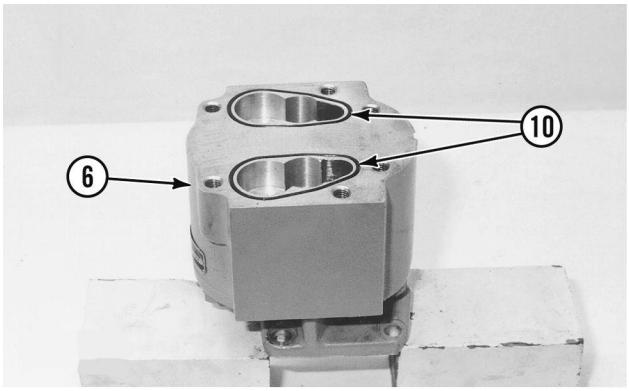


Illustration 189 g00346232

7. Remove two seals (10) from body assembly (6).

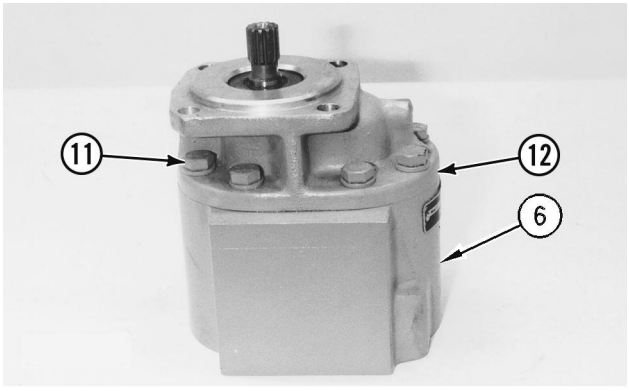


Illustration 190 g00346233

8. Remove bolts (11) and the washers from flange assembly (12). Remove flange assembly (12) from body assembly (6).

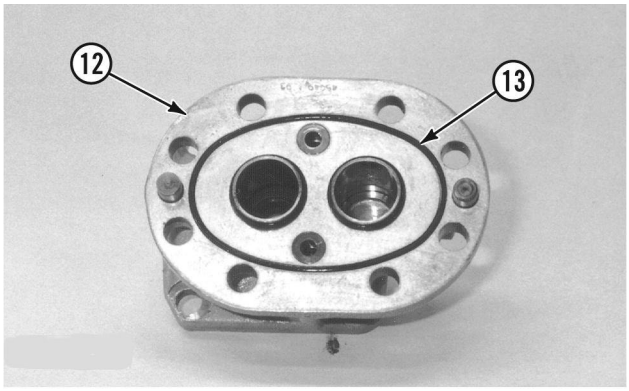


Illustration 191 g00346234

9. Remove seal (13) from flange assembly (12).

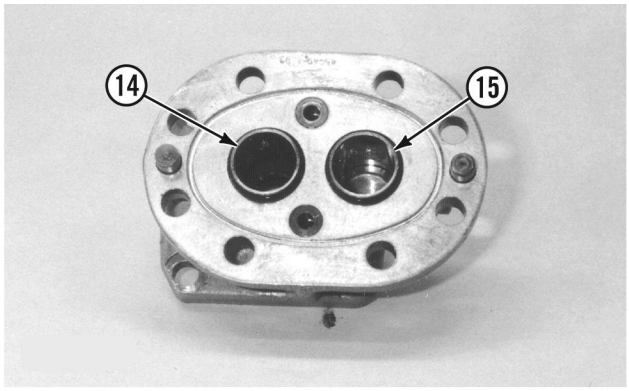


Illustration 192 g00346235

10. Remove seals (14) from bushings (15).

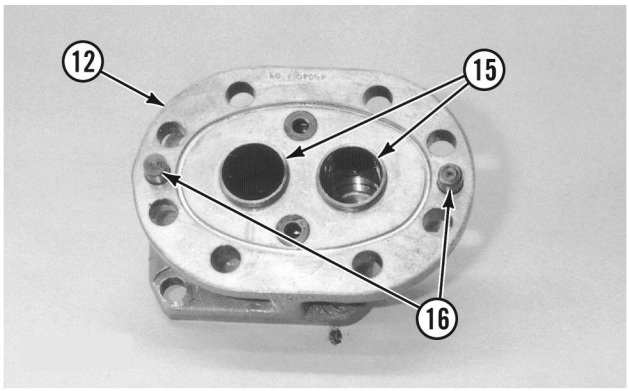


Illustration 193 g00346236

11. Remove two dowels (16) and two bushings (15) from flange assembly (12).

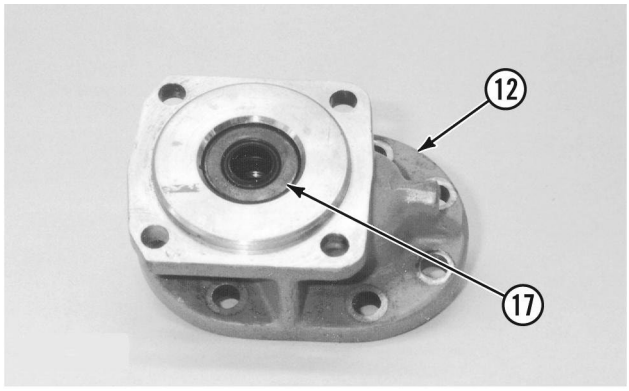


Illustration 194 g00346237

12. Remove two lip seals (17) and the ring from flange assembly (12).

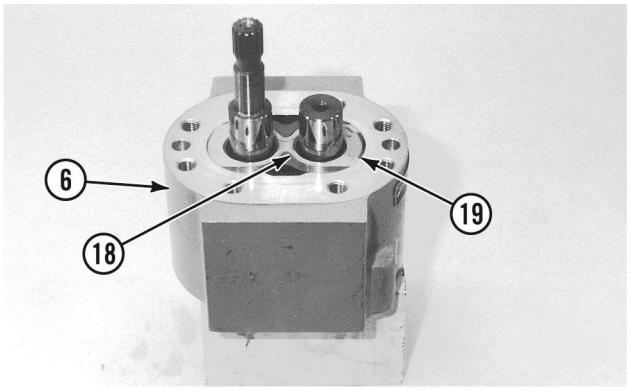


Illustration 195 g00346239

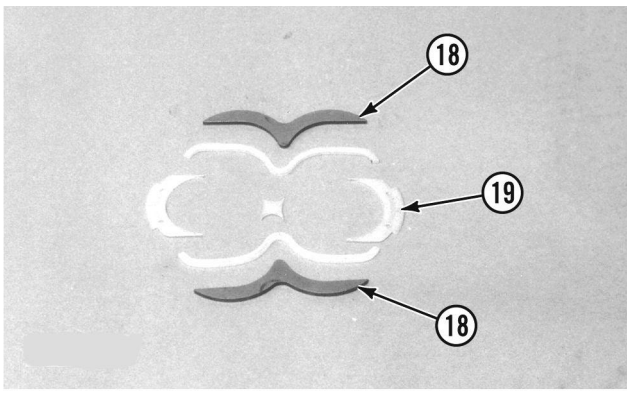


Illustration 196 g00346240

13. Remove two metal seals (18) and five plastic seals (19) from body assembly (6).

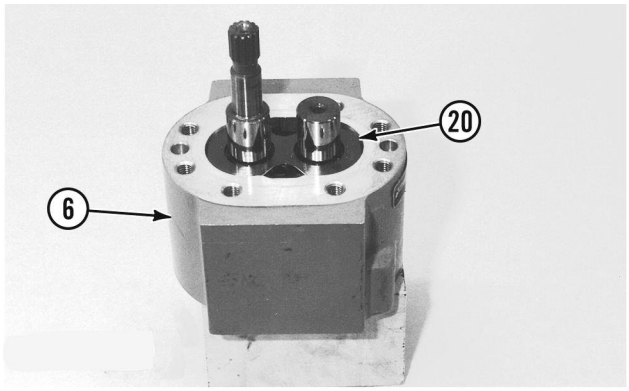


Illustration 197 g00346241

14. Remove plate (20) from body assembly (6).

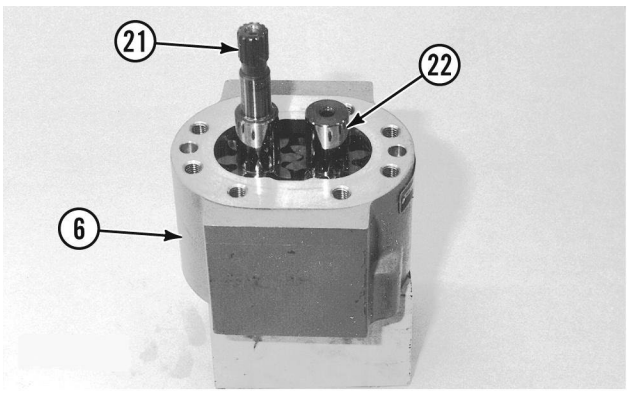


Illustration 198 g00346242

15. Remove shaft (21) and gear (22) from body assembly (6).

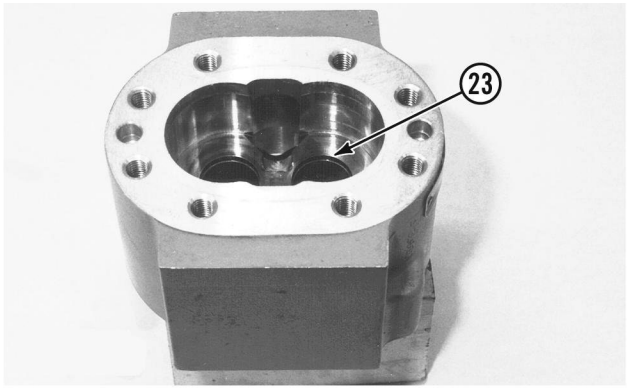


Illustration 199 g00346243

16. Remove plate (23) from body assembly (6).

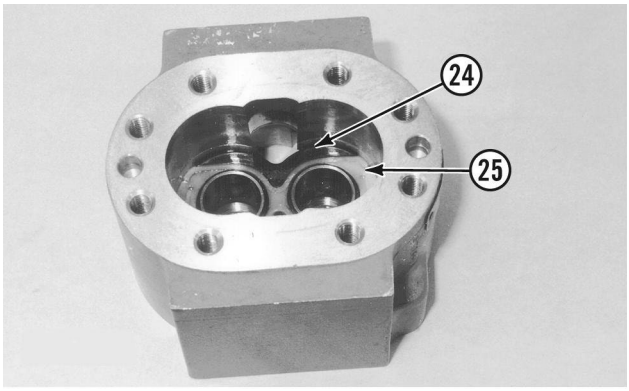


Illustration 200 g00346244

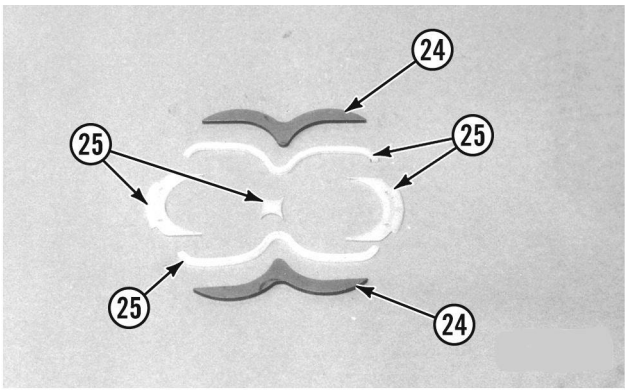


Illustration 201 g00346245

17. Remove two metal seals (24) and five plastic seals (25) from body assembly (6).

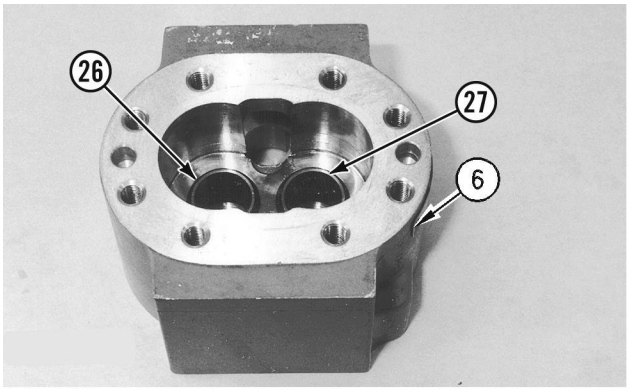


Illustration 202 g00346246

18. Remove seals (26) from bushings (27). Remove bushings (27).

i01689963

Gear Pump (Secondary Steering) - Assemble

SMCS Code: 4324-016-GT; 5073-016-SST

Assembly Procedure

Table 9

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Gp	1

Note: Thoroughly clean all parts of the secondary steering pump prior to assembly.

1. Check the condition of all seals. If any seals are worn or damaged, use new parts for replacement . Lubricate the seals with clean hydraulic oil.

2. Apply clean hydraulic oil on all internal parts of the secondary steering pump.

NOTICE
Failure to follow the recommended procedure or the specified tooling that is required for the procedure could result in damage to components.

To avoid component damage, follow the recommended procedure using the recommended tools.

Note: Two isolation plates are required for the bottom of the pump housing. Two isolation plates are required for the top of the pump housing. The isolation plates hold the seal components together. The isolation plates that have round edges on one outer radius will be at the bottom of the pump housing. The round edges should face downward. The isolation plates that have square edges on the radius will be next to the top flange.

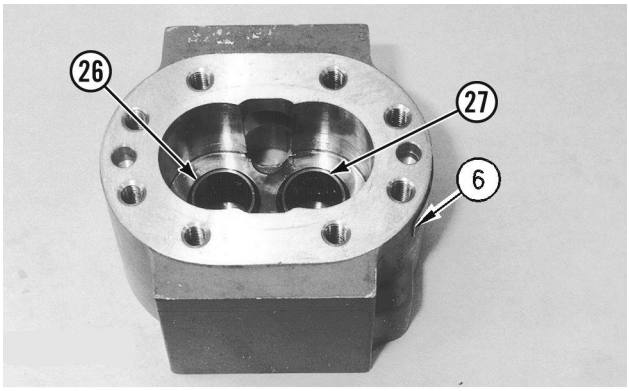


Illustration 203 g00346246

3. Install bushings (27) so that the bushings protrude from the face of body assembly (6) by 5.6 to 5.8 mm (.22 to .23 inch).

4. Install O-ring seals (26) on bushings (27).

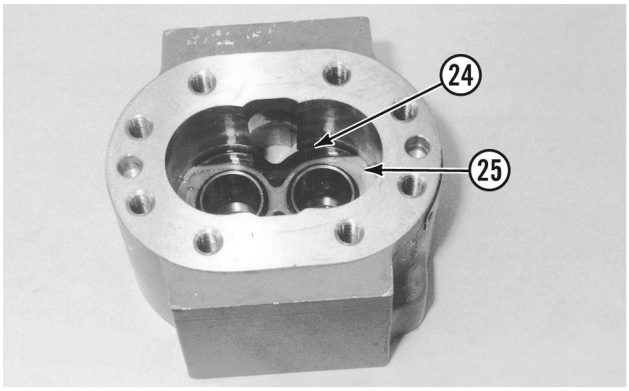


Illustration 204 g00346244

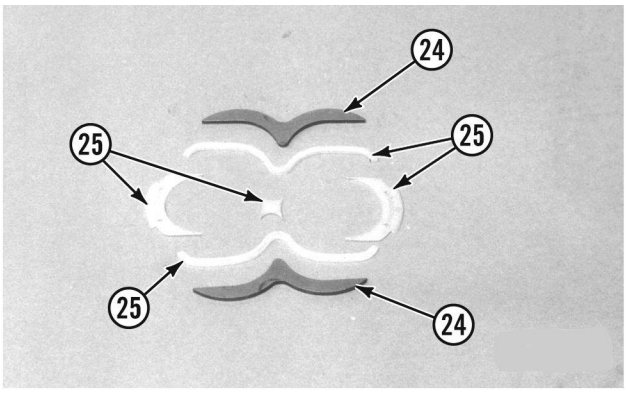


Illustration 205 g00346245

5. Install two metal seals (24) and five plastic seals (25) in body assembly (6).

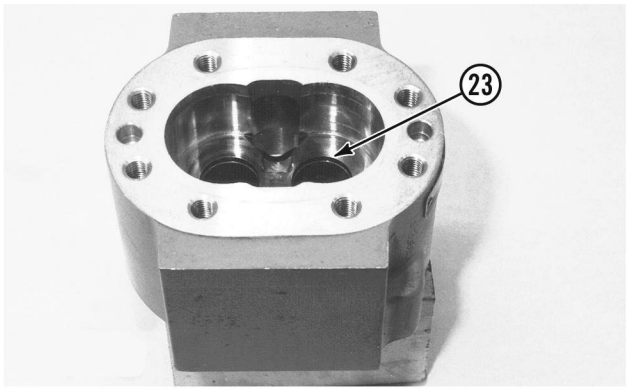


Illustration 206 g00346243

6. Install plate (23) in body assembly (6).

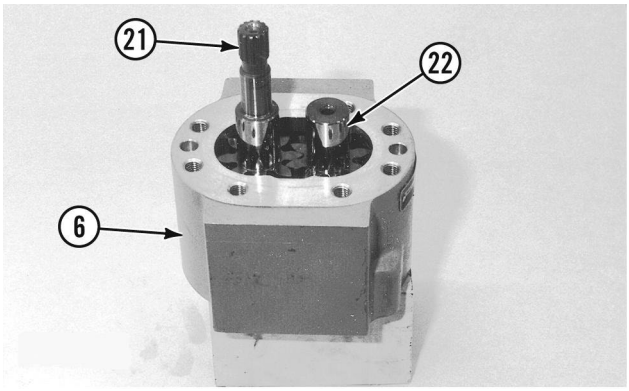


Illustration 207 g00346242

7. Install gear (22) and shaft (21) in body assembly (6).

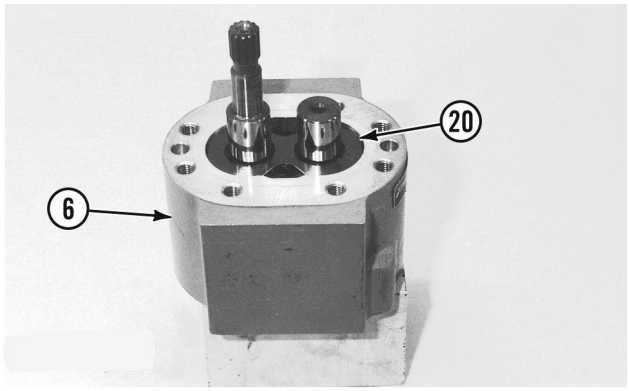


Illustration 208 g00346241

8. Install plate (20) in body assembly (6).

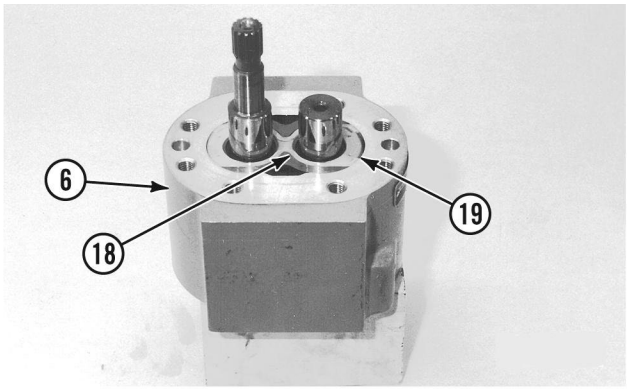


Illustration 209 g00346239

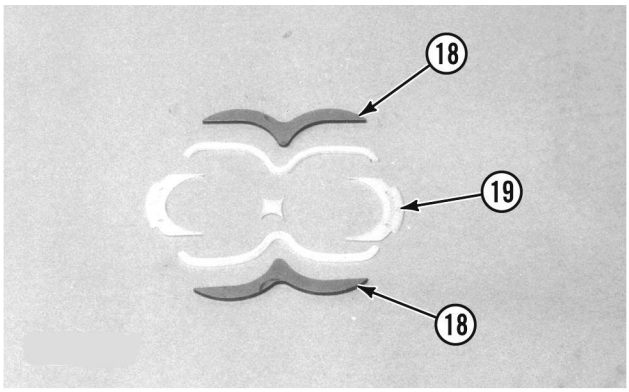


Illustration 210 g00346240

9. Install two metal seals (18) and five plastic seals (19) in body assembly (6).

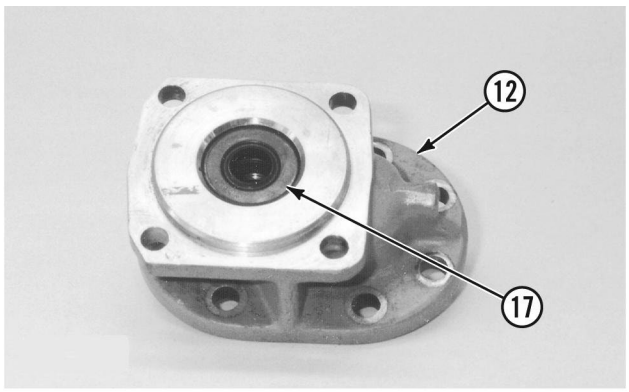


Illustration 211 g00346237

10. Install the ring in flange assembly (12). The ring opening should be placed over the drain hole. Use Tooling (A) to install two lip seals (17). Assemble the seals so that the spring-loaded members are facing away from each other.

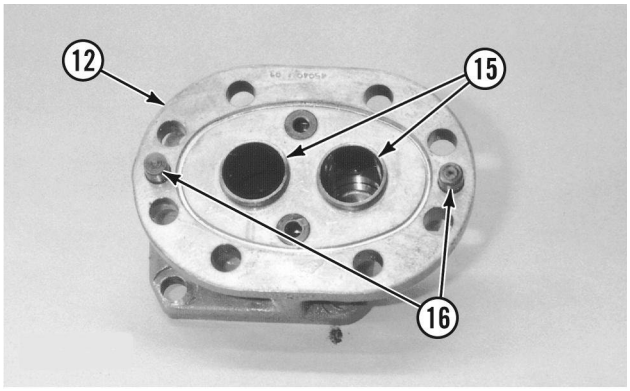


Illustration 212 g00346236

11. Install two bushings (15) and two dowels (16) in flange assembly (12). Bushings (15) should protrude from the face of flange assembly (12) by 5.6 to 5.8 mm (.22 to .23 inch).

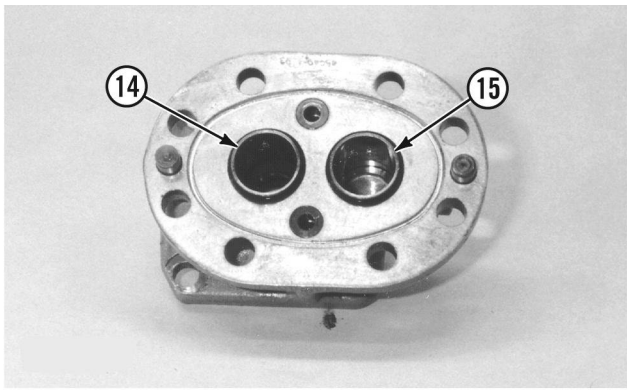


Illustration 213 g00346235

12. Install O-ring seals (14) on bushings (15).

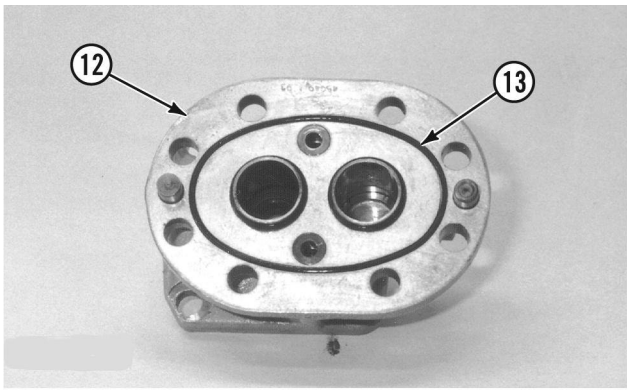


Illustration 214 g00346234

13. Install seal (13) on flange assembly (12).

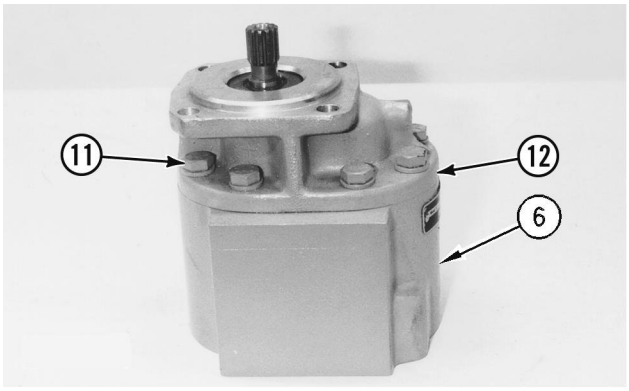


Illustration 215 g00346233

14. Install flange assembly (12) on body assembly (6) in the original position. Install the washers and bolts (11) that secure flange assembly (12) to body assembly (6). The torque for the bolts is 115 ± 5 N·m (85 ± 4 lb ft).

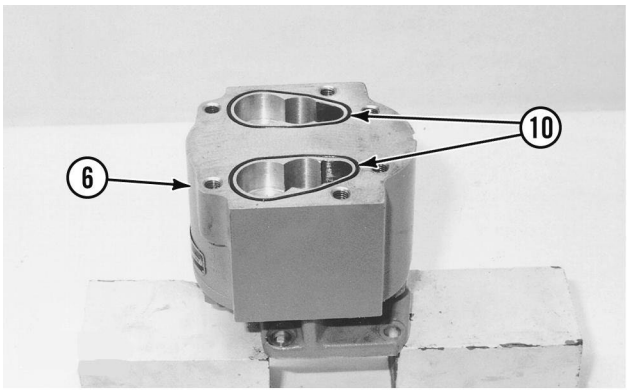


Illustration 216 g00346232

15. Install two seals (10) on body assembly (6).

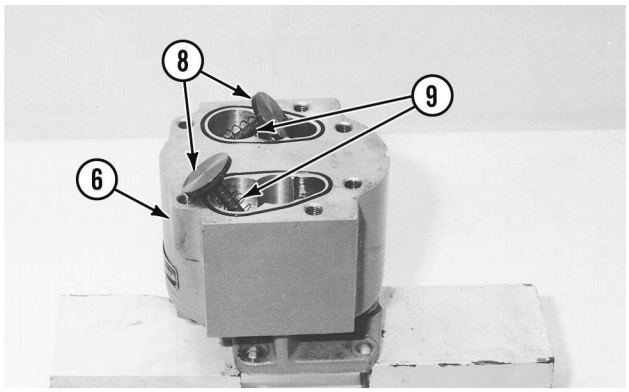


Illustration 217 g00346191

16. Install two pistons (8) and two springs (9) in body assembly (6).

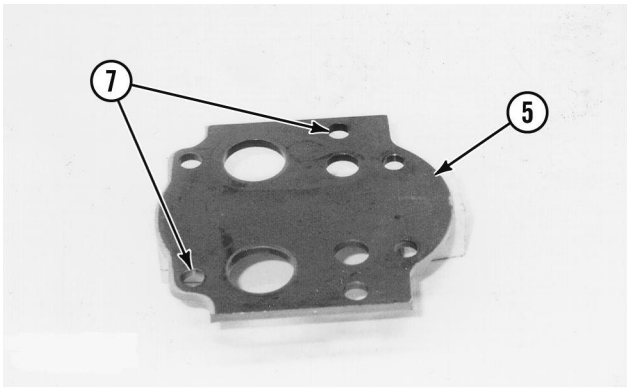


Illustration 218 g00346190

17. Install two spacers (7) in spacer (5).

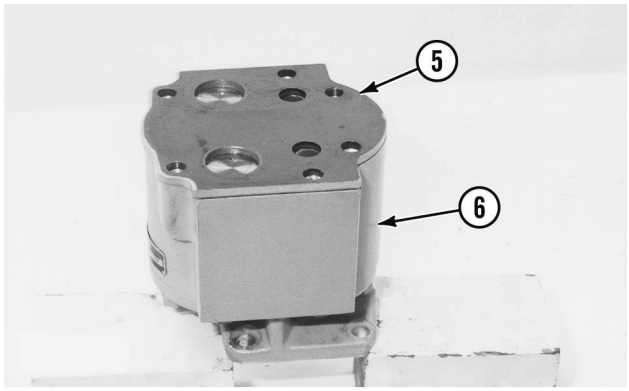


Illustration 219 g00346189

18. Install spacer (5) in body assembly (6).

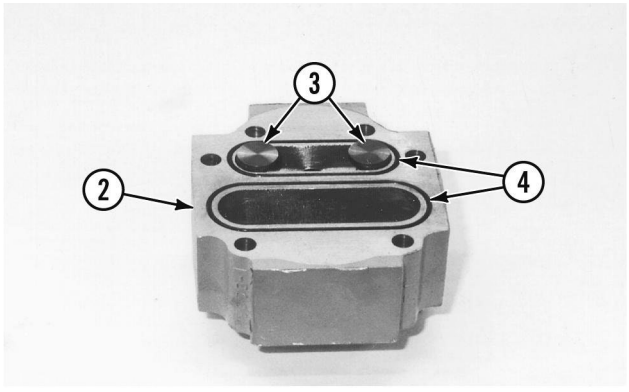


Illustration 220 g00346188

19. Install two seals (4) in body (2).

20. Install two pistons (3) and two springs in body (2).

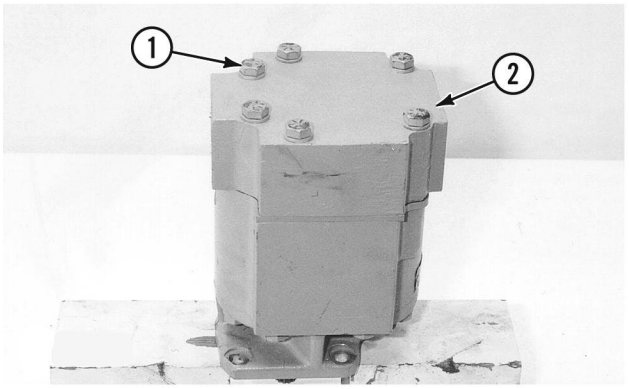


Illustration 221 g00346187

21. Place body (2) on the body assembly of the secondary steering pump. Install the washers and bolts (1) that secure body (2) to the body assembly. The torque for the bolts is 115 ± 5 N·m (85 ± 4 lb ft).

End By:

a. Install the secondary steering pump. Refer to Disassembly and Assembly, “Gear Pump (Secondary Steering) - Install”.

i01689565

Gear Pump (Secondary Steering) - Install

SMCS Code: 4324-012-GT; 5073-012-SST

Installation Procedure

1. Check the condition of the gasket for the pump drive. If the gasket is worn or damaged, use a new gasket.

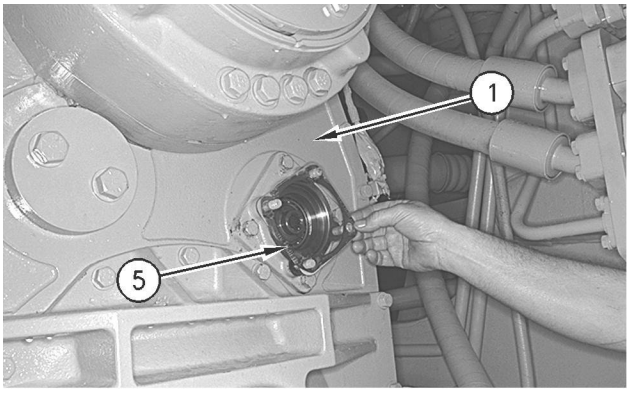


Illustration 222 g00870306

2. Install gasket (5) to output transfer gear case (1).

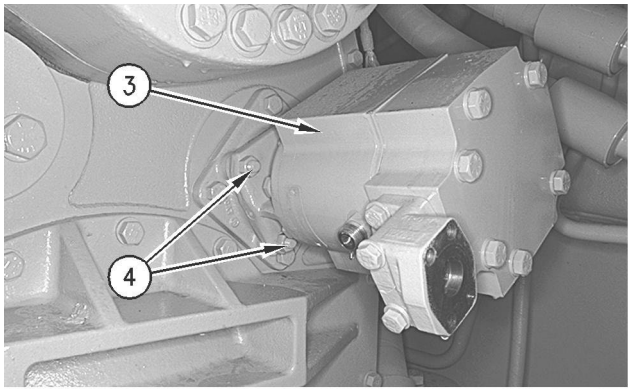


Illustration 223 g00870305

3. Install secondary steering pump (3) and nuts (4) to output transfer gear case (1). The weight of the secondary steering pump is 18 kg (40 lb).

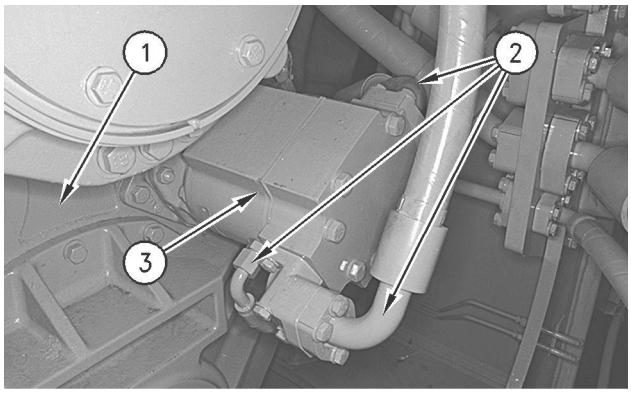


Illustration 224 g00870304

4. Connect three hydraulic hose assemblies (2) to secondary steering pump (3).

End By:

a. Fill the hydraulic oil tank for the steering system. Refer to Operation and Maintenance Manual, “Steering and Hydraulic Fan System Oil - Change” for the machine that is being serviced.

b. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02476932

STIC Control and Pilot Valve (Steering) - Remove

SMCS Code: 3033-011; 4342-011

Removal Procedure

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “Hydraulic System Pressure - Release”.

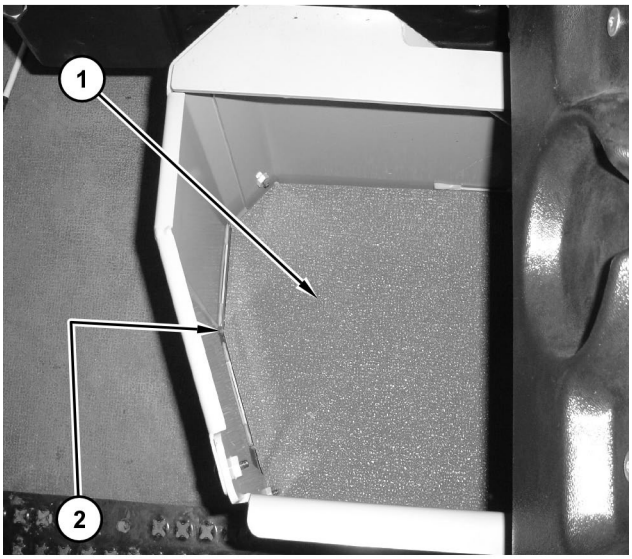


Illustration 225 g01236797

1. Remove mat (1). Remove plate (2).

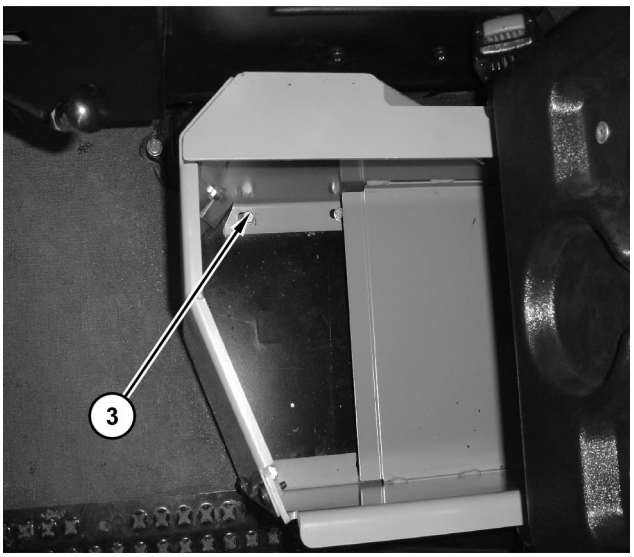


Illustration 226 g01236798

2. Remove bolts (3).

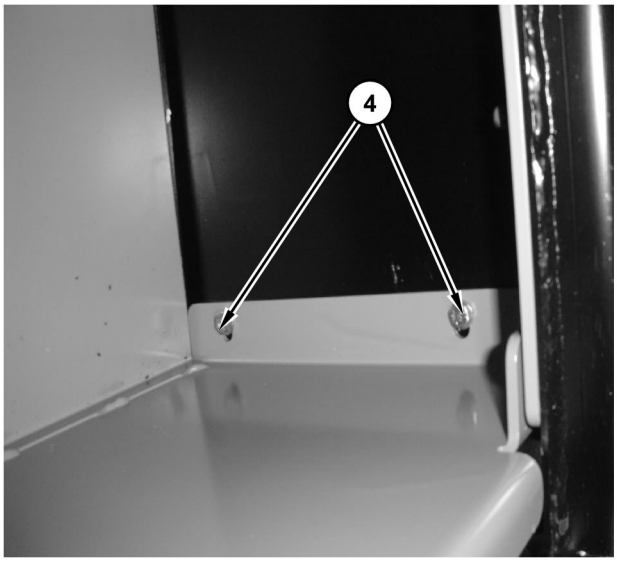


Illustration 227 g01236833

3. Remove bolts (4).

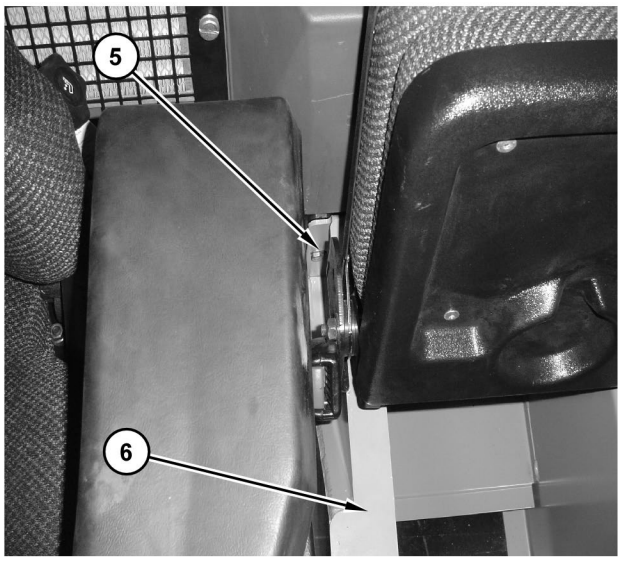


Illustration 228 g01236837

4. Remove bolts (5). Remove storage box assembly (6).

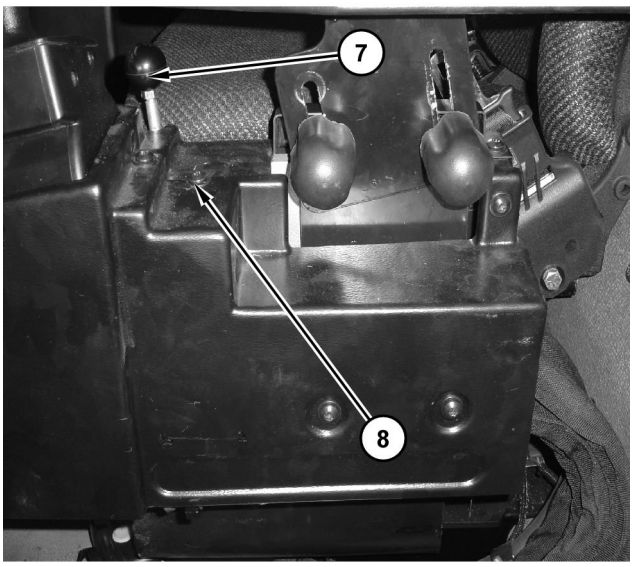


Illustration 229 g01236838

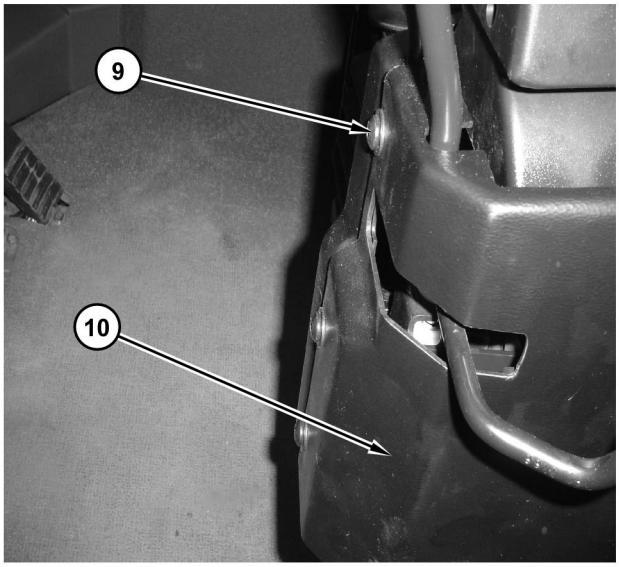


Illustration 230 g01236840

5. Remove knob (7). Remove bolts (8) and (9). Remove covers (10).

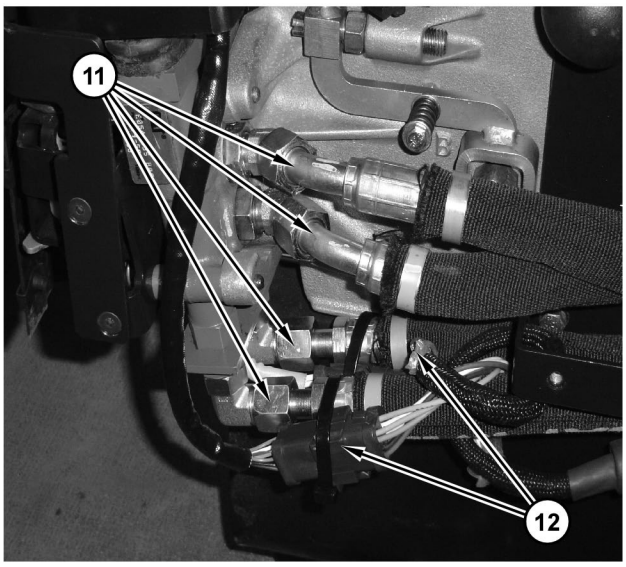


Illustration 231 g01236883

6. Disconnect hose assemblies (11). Disconnect harness assemblies (12).

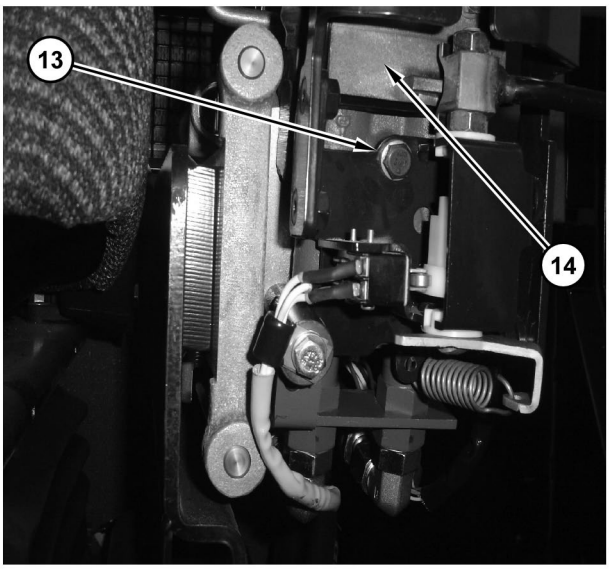


Illustration 232 g01237035

7. Remove bolts (13). Remove the STIC steering control lever and the steering pilot valve (14) as a unit.

i02477309

Pilot Valve (STIC Steering) - Disassemble

SMCS Code: 4342-015

Disassembly Procedure

Start By:

a. Remove the STIC control. Refer to Disassembly and Assembly, "STIC Control and Pilot Valve (Steering) - Remove".

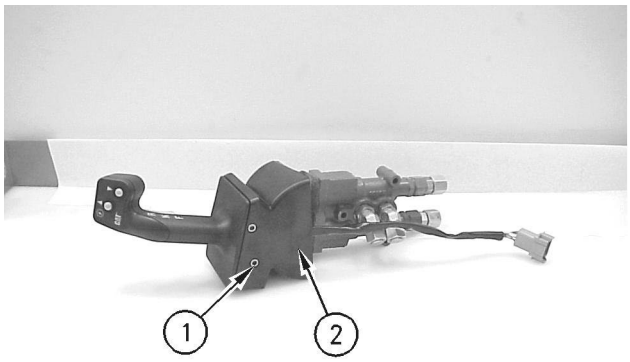


Illustration 233 g00690330

1. Remove screws (1) and cover (2).

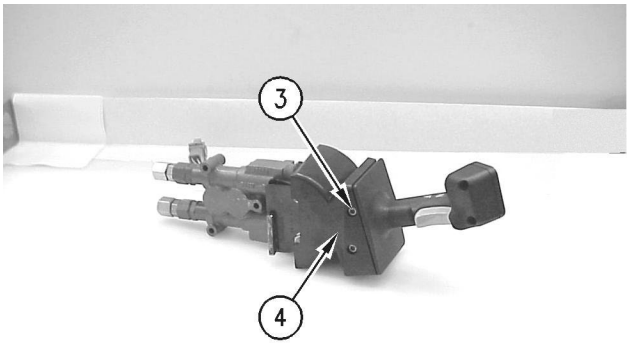


Illustration 234 g00690331

2. Remove bolts (3) and housing (4).

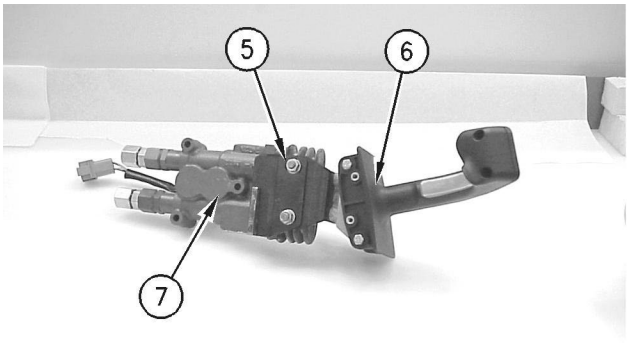


Illustration 235 g00690332

3. Remove screws (5). Repeat this procedure for the opposite side.

4. Remove STIC steering control lever (6) from the steering pilot valve (7).

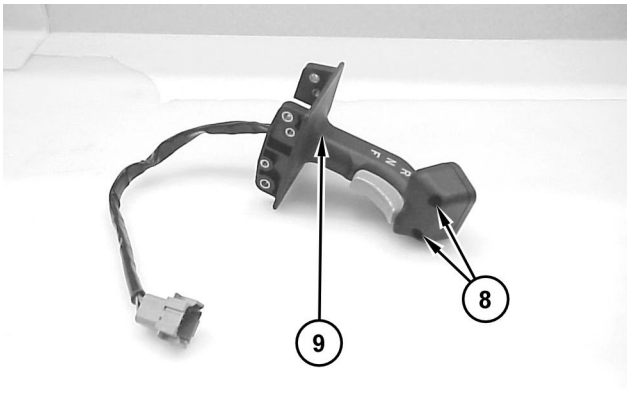


Illustration 236 g01237270

5. Remove screws (8) from the rocker switch assembly. Remove cover (9) for the rocker switch.

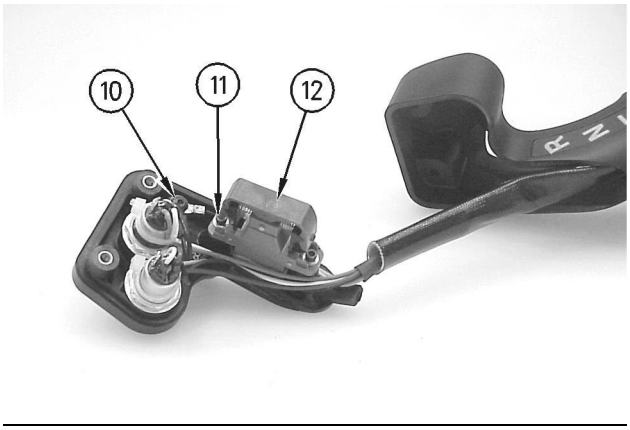


Illustration 237 g00690339

6. Remove ground bolt (10).

7. Remove bolts (11).

8. Place rocker switch (12) aside.

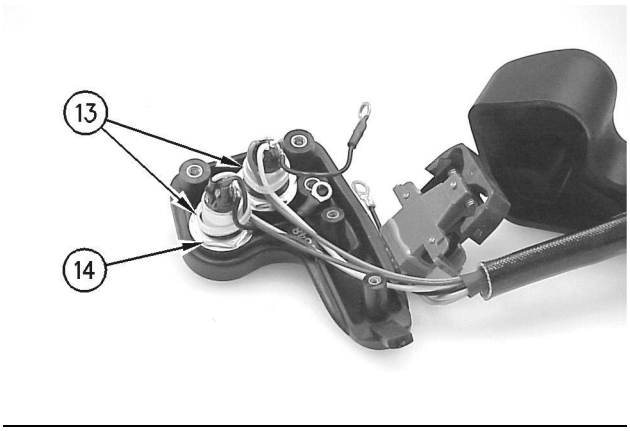


Illustration 238 g00690381

9. Remove cable straps (13), nuts (14) and the washers.

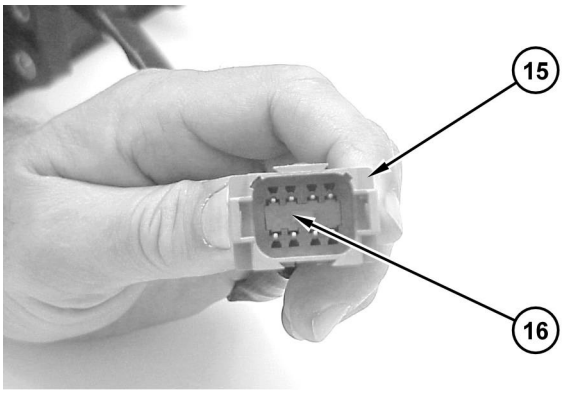


Illustration 239 g01237280

10. Mark the location of the wires in harness assembly (15).

11. Remove wedge (16) from harness assembly (15).

12. Carefully remove wires from the harness assembly .

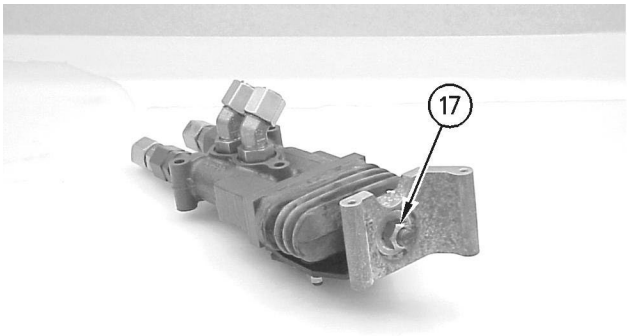


Illustration 240 g00690387

13. Remove locknut (17).

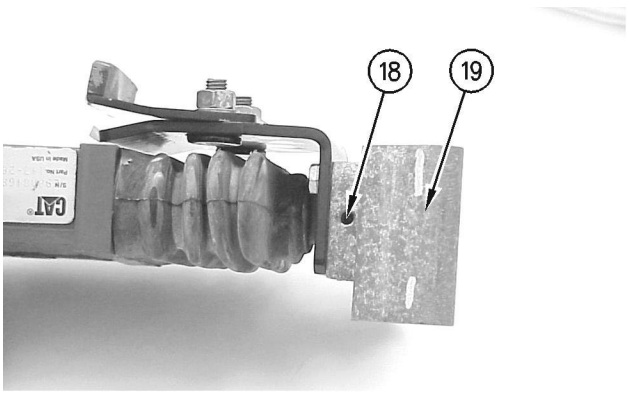


Illustration 241 g00690390

14. Loosen setscrew (18). Repeat this procedure for the opposite side.

15. Remove base (19).

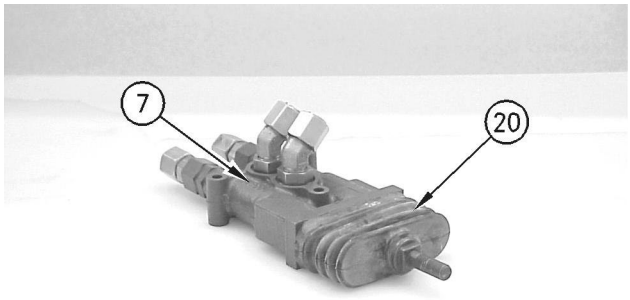


Illustration 242 g00690391

16. Remove boot (20) from the steering pilot valve (7).

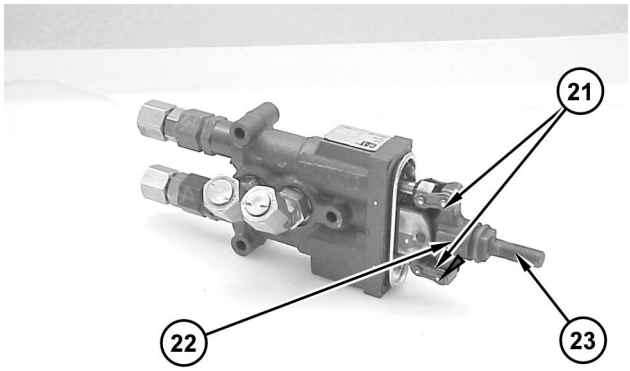


Illustration 243 g01237287

17. Remove connecting links (21).

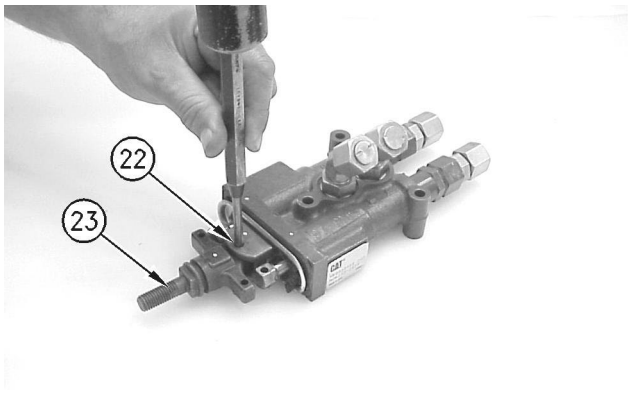


Illustration 244 g00690428

18. Remove dowel (22) and handle (23) from the steering pilot valve.

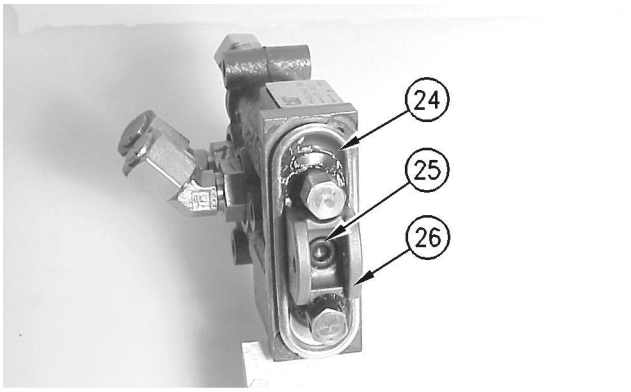


Illustration 245 g00690430

19. Remove bolt (25) and bracket (26).

20. Remove clamp (24) for the boot.

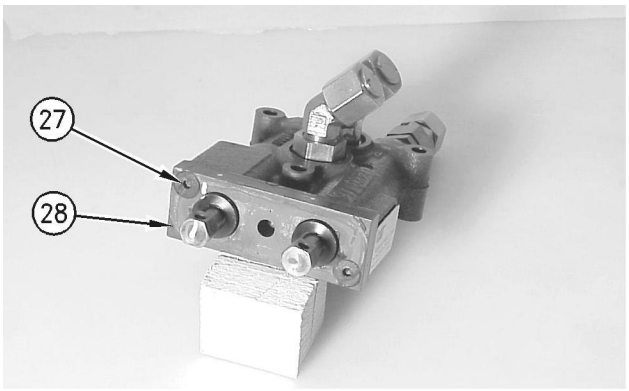


Illustration 246 g00690482

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

21. Remove bolts (27) and spacer (28) from the steering pilot valve.

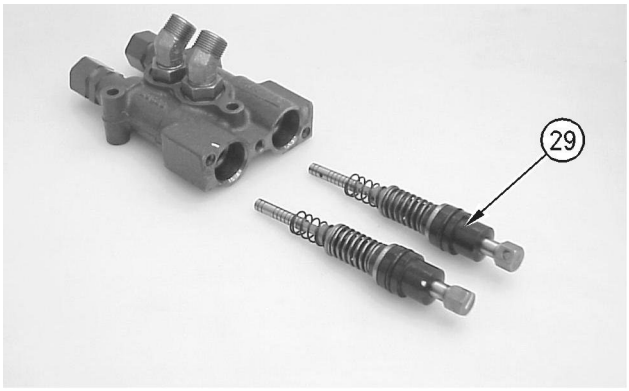


Illustration 247 g00690536

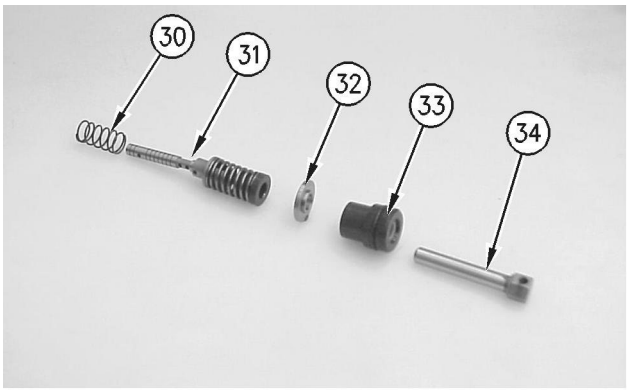


Illustration 248 g00690553

22. Remove capsule assemblies (29) from the valve body.

23. Remove spring (30), spool assembly (31), retainer (32), cap (33), and plunger (34) from each capsule assembly.

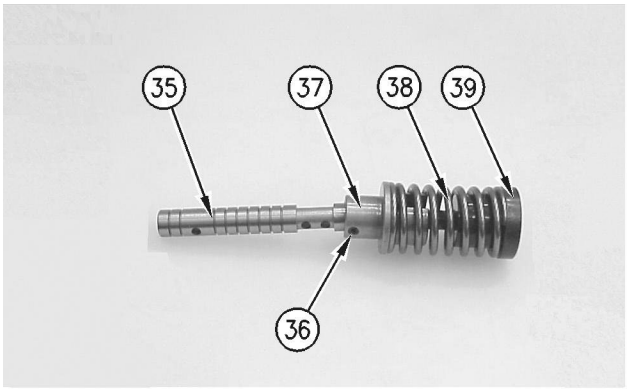


Illustration 249 g00690555

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

24. Remove pin (36) and retainer (37) from spool (35).

25. Remove the screw, spring (38), and retainer (39) from retainer (37).

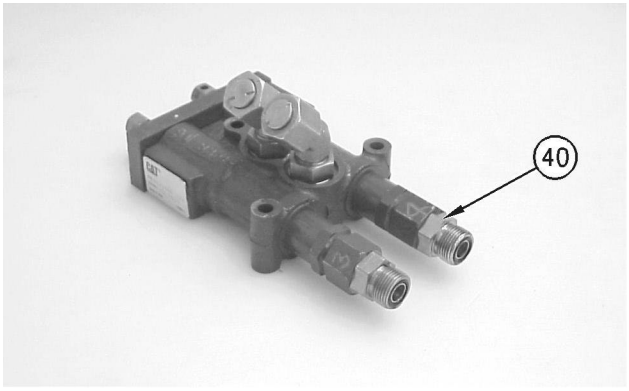


Illustration 250 g00690557

26. Remove fittings (40) from the pilot valve.

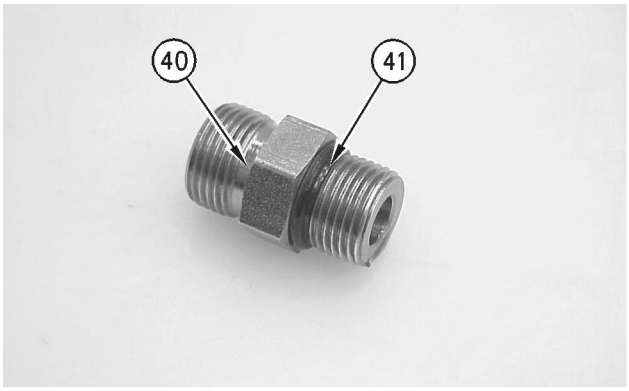


Illustration 251 g00690559

27. Remove O-ring seal (41) from fitting (40).

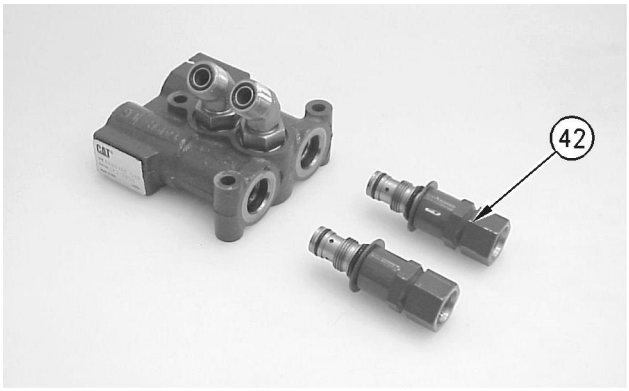


Illustration 252 g00690551

28. Remove capsule assemblies (42) from the valve body.

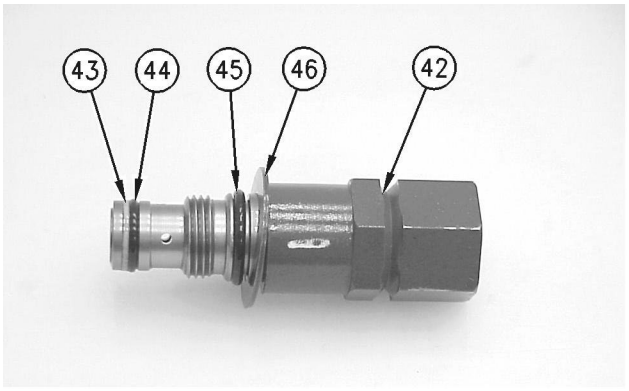


Illustration 253 g00690552

29. Remove backup ring (43), O-ring seals (44) and (45), and shims (46) from capsule assembly (42).

i02477636

Pilot Valve (STIC Steering) - Assemble

SMCS Code: 4342-016

Assembly Procedure

Table 10

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	154-9731	Thread Lock Compound	1

Note: Check the condition of the O-ring seals that are used in the steering pilot control valve. If any of the seals are damaged, use new parts for replacement. Lubricate the seals with fresh hydraulic oil.

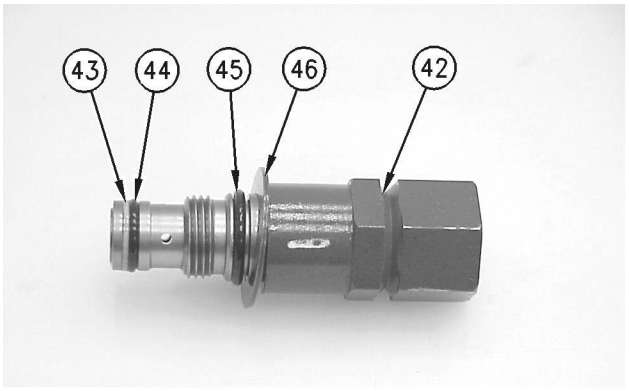


Illustration 254 g00690552

1. Install shims (46), O-ring seals (44) and (45), and backup ring (43) to capsule assembly (42).



Illustration 255 g00690551

2. Install capsule assemblies (42) to the valve body. Tighten capsule assemblies (42) to a torque of 35 ± 3 N·m (26 ± 2 lb ft).

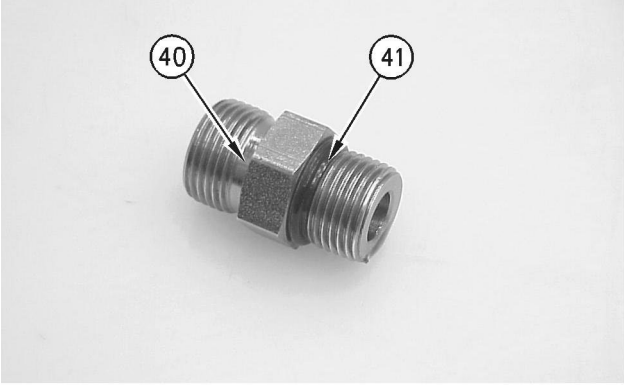


Illustration 256 g00690559

3. Install O-ring seal (41) to each fitting (40).

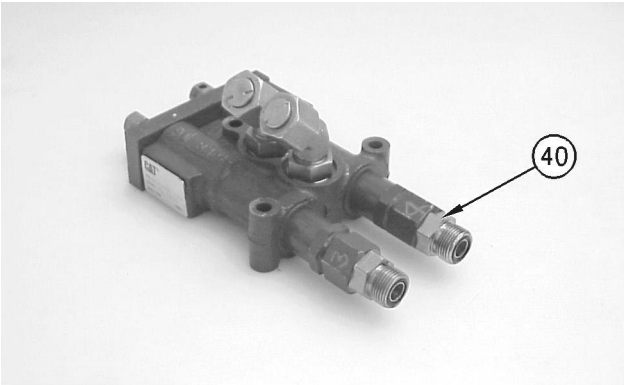


Illustration 257 g00690557

4. Install fittings (40) to the pilot valve.

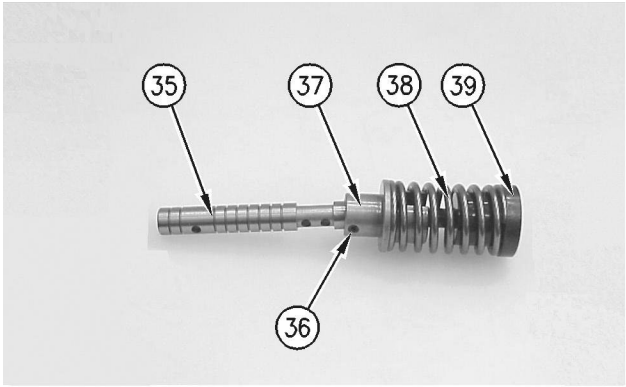


Illustration 258 g00690555

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

5. Install spring (38), retainer (39), and the screw to retainer (37). Tighten the screw to a torque of 1.20 ± 0.25 N·m (10.6 ± 2.2 lb in).

6. Install retainer (37) and pin (36) to spool (35).

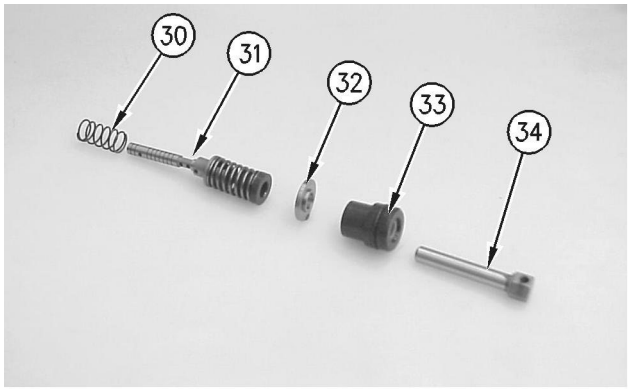


Illustration 259 g00690553

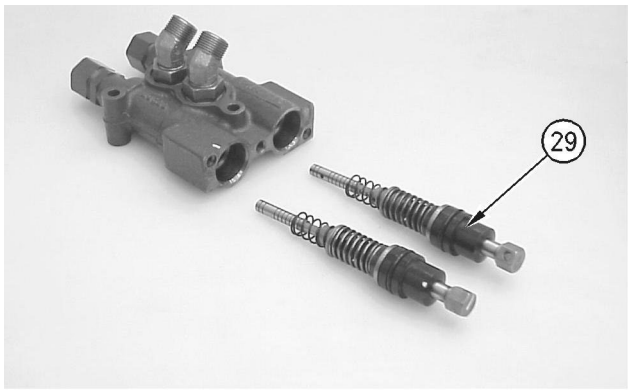


Illustration 260 g00690536

7. Install plunger (34), cap (33), retainer (32), spool assembly (31), and spring (30) to each capsule assembly.

8. Install capsule assemblies (29) to the valve body.

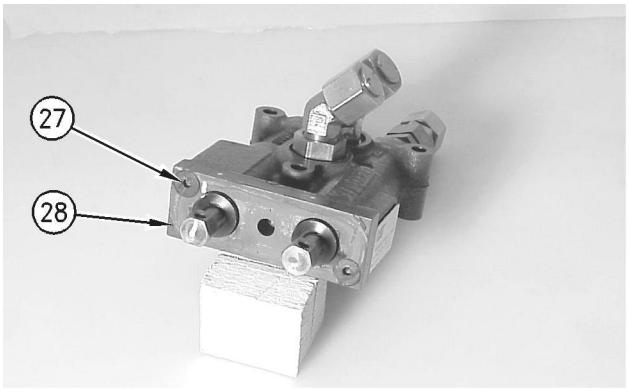


Illustration 261 g00690482

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

9. Install spacer (28) and bolts (27) to the steering pilot valve. Tighten bolts (27) to a torque of 13 ± 1.5 N·m (115 ± 13 lb in).

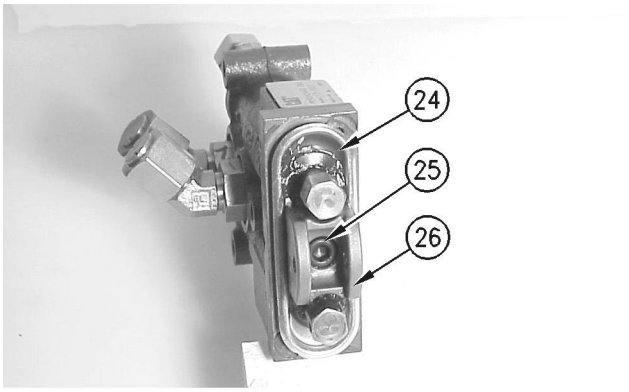


Illustration 262 g00690430

10. Install clamp (24) for the boot.

11. Install bracket (26).

12. Apply Tooling (A) to bolt (25). Install bolt (25). Tighten bolt (25) to a torque of 25 ± 3 N·m (19 ± 2 lb ft).

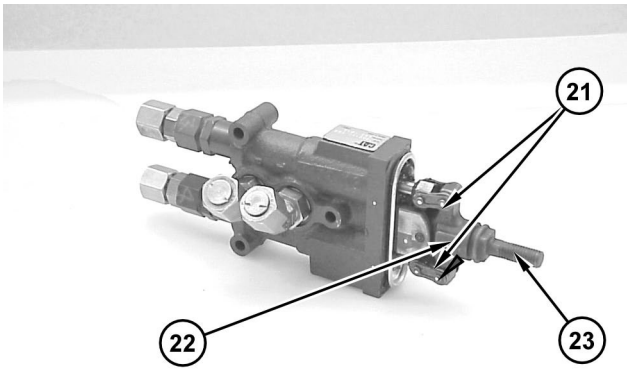


Illustration 263 g01237287

13. Install handle (23) and dowel (22) to the steering pilot valve.

14. Install connecting links (21).

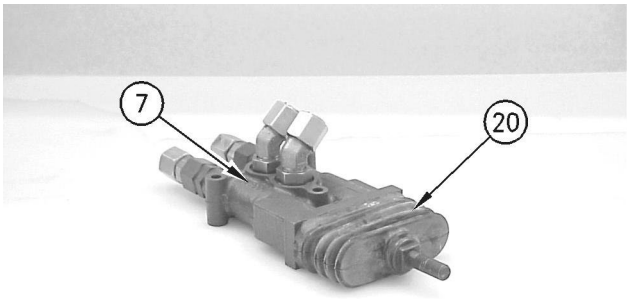


Illustration 264 g00690391

15. Install boot (20) to the steering pilot valve (7).

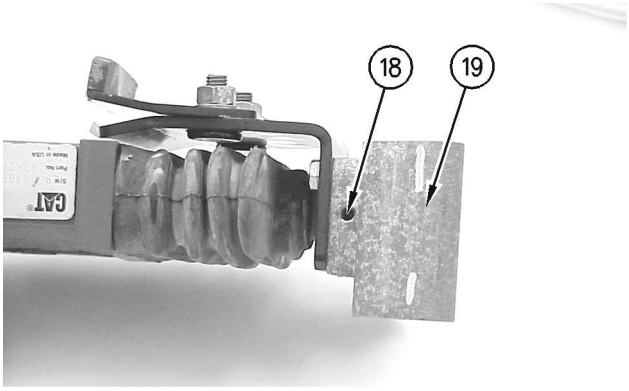


Illustration 265 g00690390

16. Install base (19) to the steering pilot valve. Install set screw (18). Repeat this procedure for the opposite side.

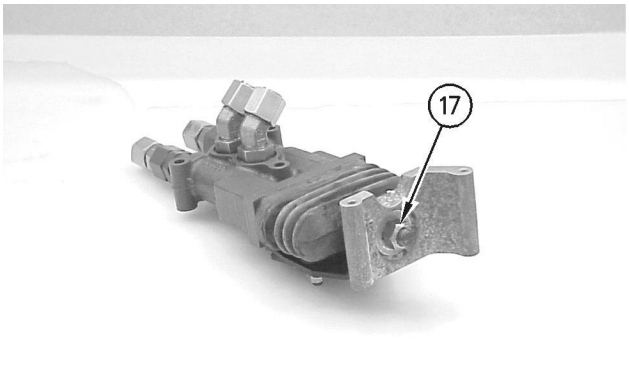


Illustration 266 g00690387

17. Install locknut (17). Tighten locknut (17) to a torque of 100 ± 20 N·m (75 ± 15 lb ft).

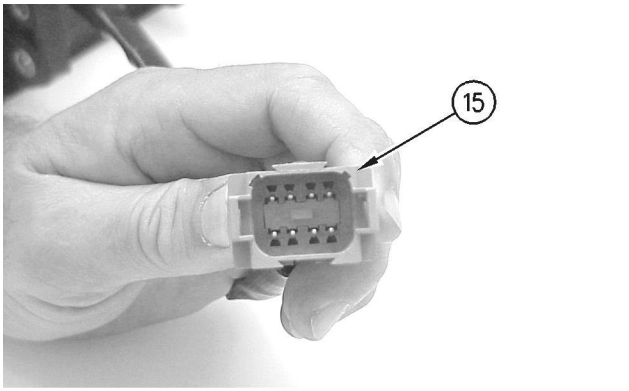


Illustration 267 g00690386

18. Install eight wires to harness assembly (15).

19. Install wedge (16) to the harness assembly (15).

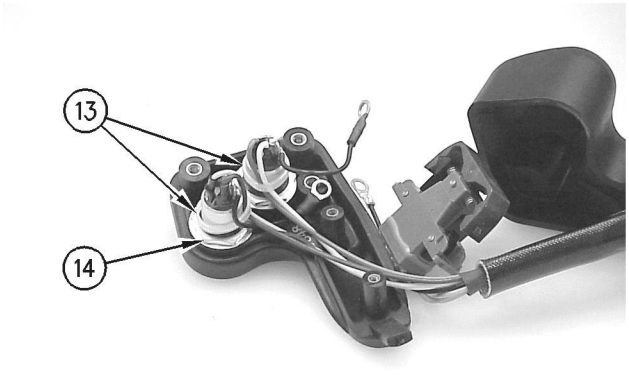


Illustration 268 g00690381

20. Install the harness assemblies.

21. Install nuts (14) and the washers.

22. Install tie straps (13).

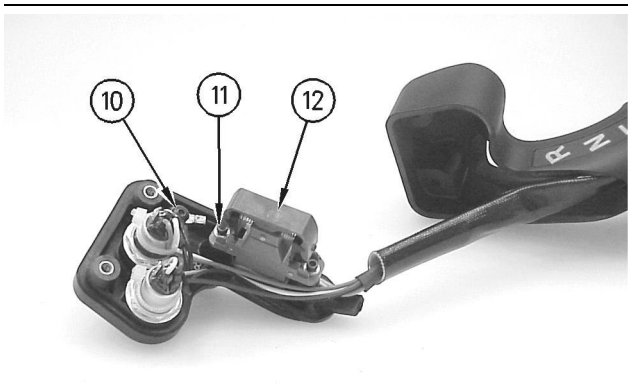


Illustration 269 g00690339

23. Install rocker switch (12).

24. Install bolts (11).

25. Install ground wire and bolt (10).

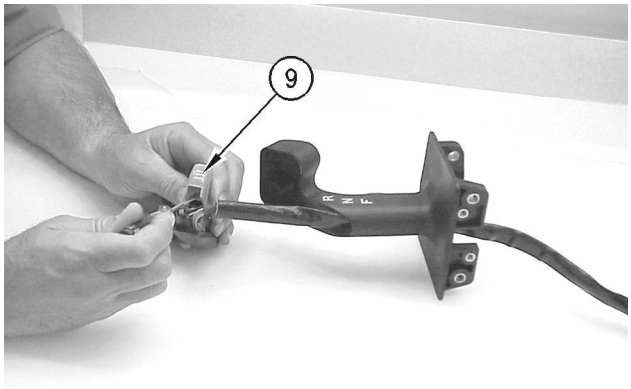


Illustration 270 g00690337

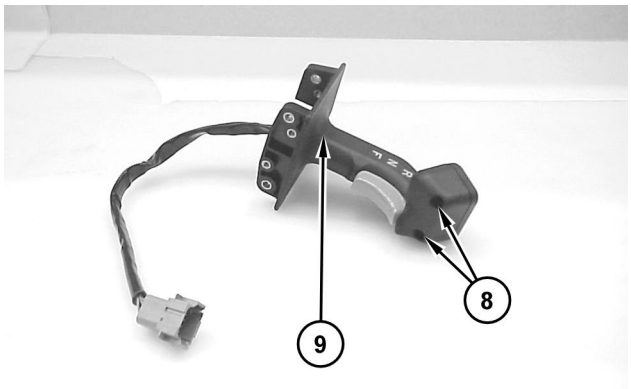


Illustration 271 g01237270

26. Install cover (9) to the rocker switch.

27. Install screws (8) to the rocker switch assembly.

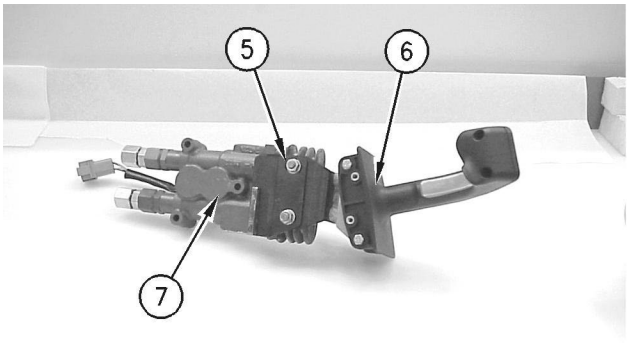


Illustration 272 g00690332

28. Install STIC steering control lever (6) to the steering pilot valve (7). Install screws (5). Repeat this procedure for the opposite side.

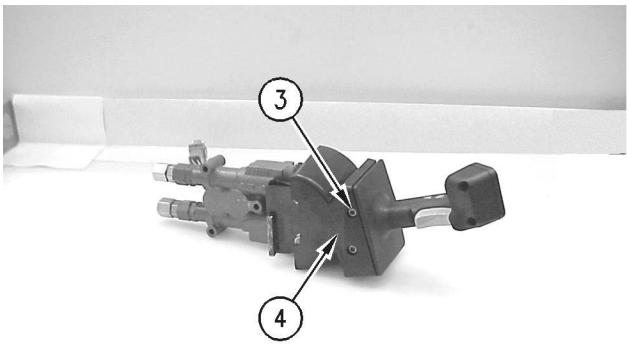


Illustration 273 g00690331

29. Install housing (4) and two screws (3). Tighten screws (3) to a torque of 6 ± 1 N·m (53 ± 9 lb in).

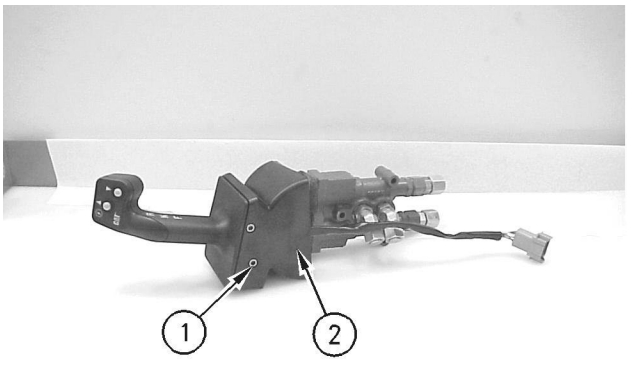


Illustration 274 g00690330

30. Install cover (2) and two screws (1). Tighten screws (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).

End By:

a. Install the STIC control. Refer to Disassembly and Assembly, “STIC Control and Pilot Valve (Steering) - Install”.

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STIC Control and Pilot Valve (Steering) - Install

SMCS Code: 3033-012; 4342-012

Installation Procedure

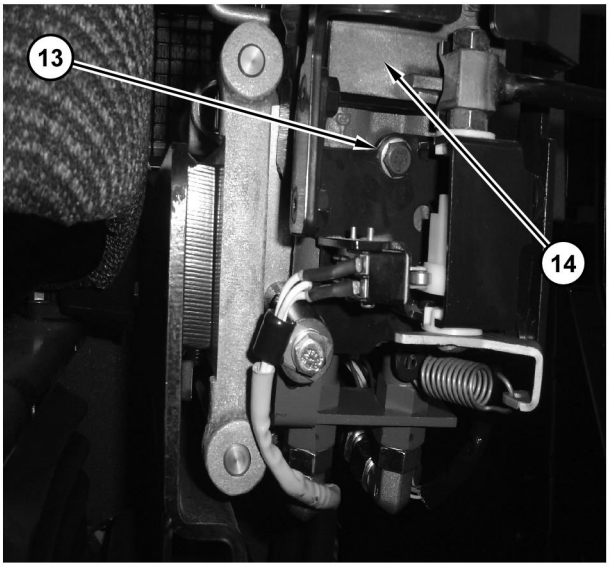


Illustration 275 g01237035

1. Install the STIC steering control lever and the steering pilot valve (14) as a unit. Install bolts (13).

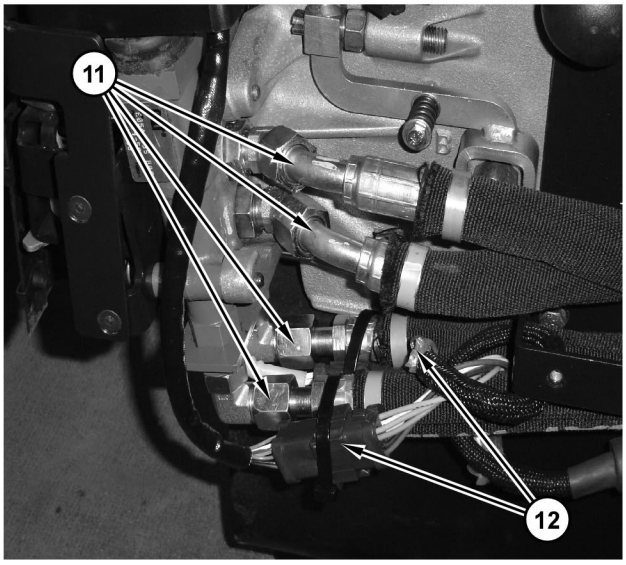


Illustration 276 g01236883

2. Connect hose assemblies (11). Connect harness assemblies (12).

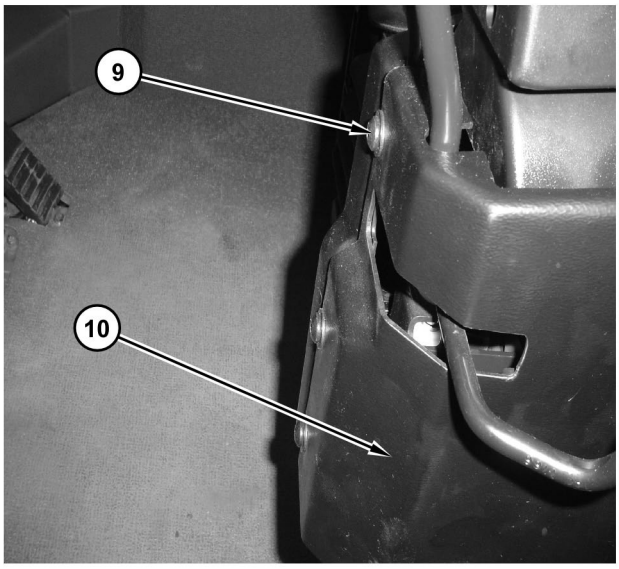


Illustration 277 g01236840

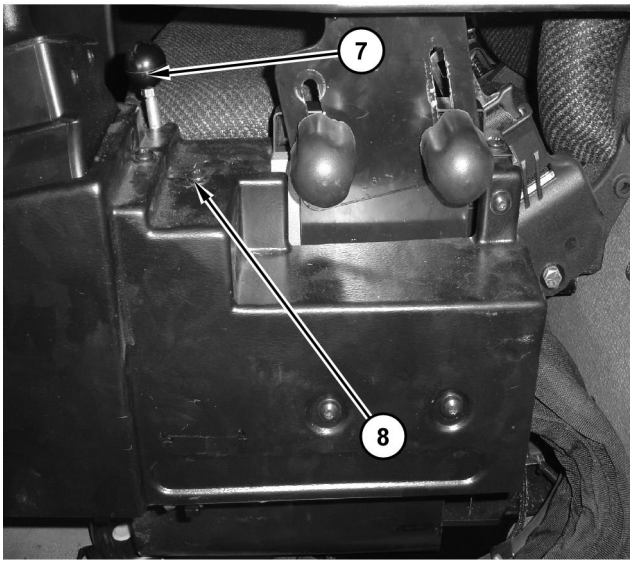


Illustration 278 g01236838

3. Install covers (10). Install bolts (8) and (9). Install knob (7).

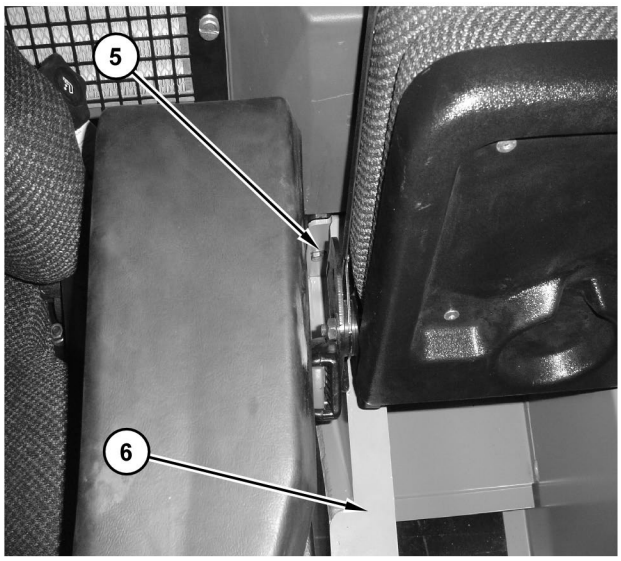


Illustration 279 g01236837

4. Install storage box assembly (6). Install bolts (5).

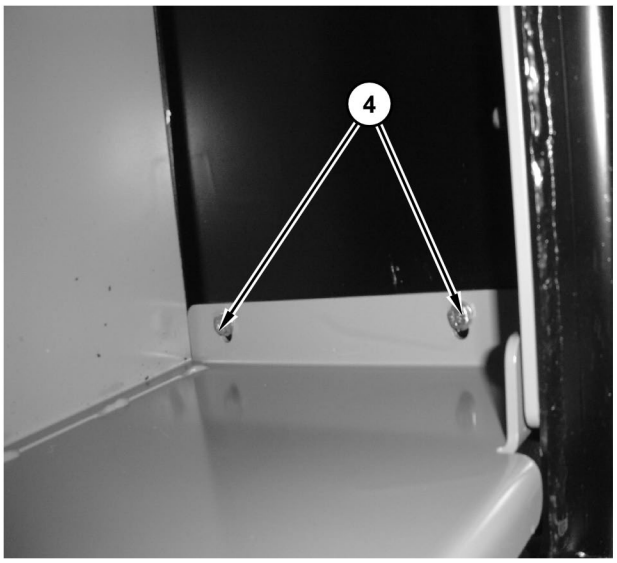


Illustration 280 g01236833

5. Install bolts (4).

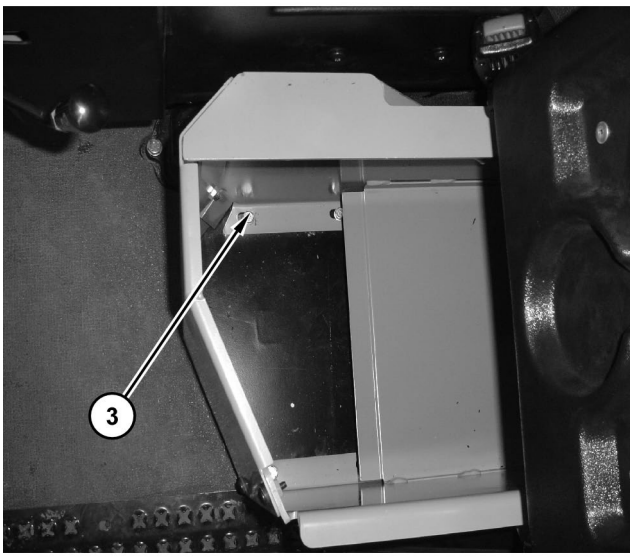


Illustration 281 g01236798

6. Install bolts (3).

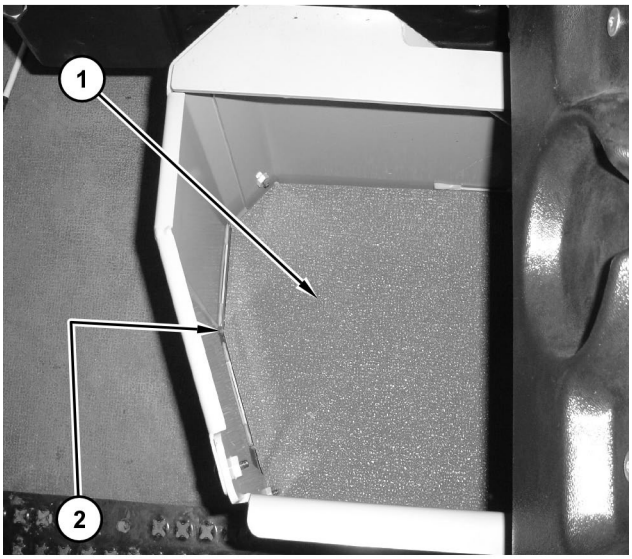


Illustration 282 g01236797

7. Install plate (2). Install mat (1).

i02477792

Selector and Pressure Control Valve (Steering) - Remove and Install

SMCS Code: 4349-010-ZH

Removal Procedure

Table 11

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , “ Hydraulic System Pressure - Release”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

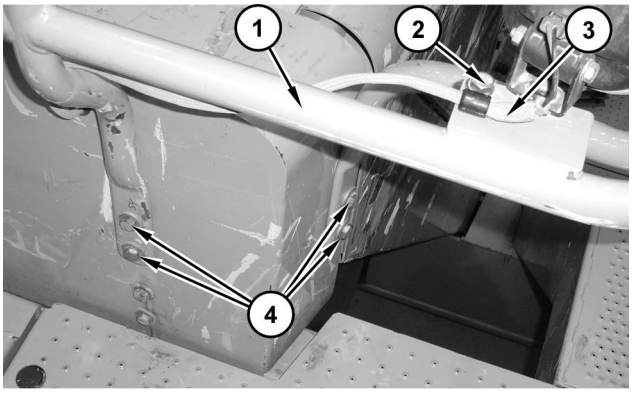


Illustration 283 g01237826

1. Use two people in order to remove hand rail assembly (1). The weight of hand rail assembly (1) is approximately 31 kg (70 lb). Remove bolt (2). Disconnect harness assembly (3). Remove bolts (4). Remove hand rail assembly (1). Repeat for opposite side.

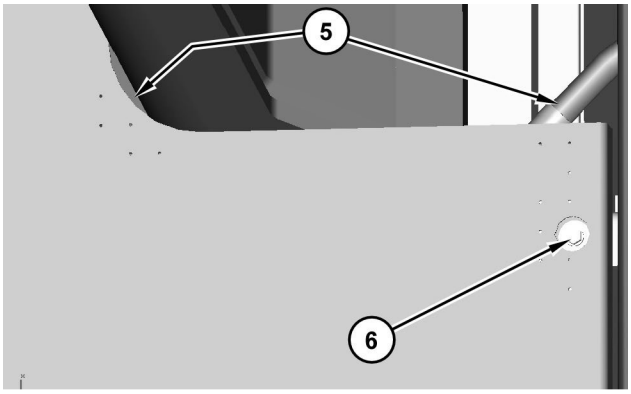


Illustration 284 g01237829

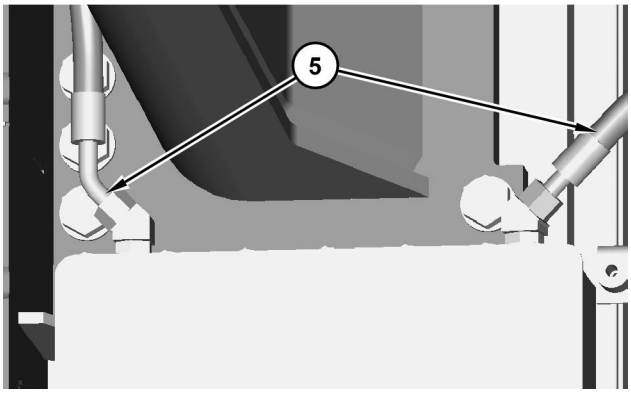


Illustration 285 g01237898

Note: The panel is removed for clarity.

2. Disconnect hose assemblies (5). Remove bolts (6).

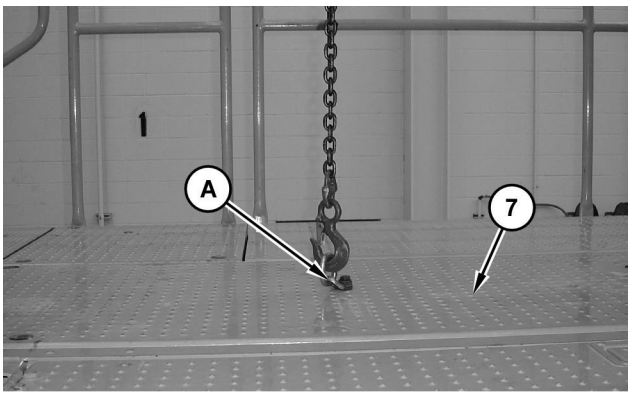


Illustration 286 g01237827

3. Attach Tooling (A) and a suitable lifting device to cover assembly (7). The weight of cover assembly (7) is approximately 117 kg (260 lb). Remove cover assembly (7).

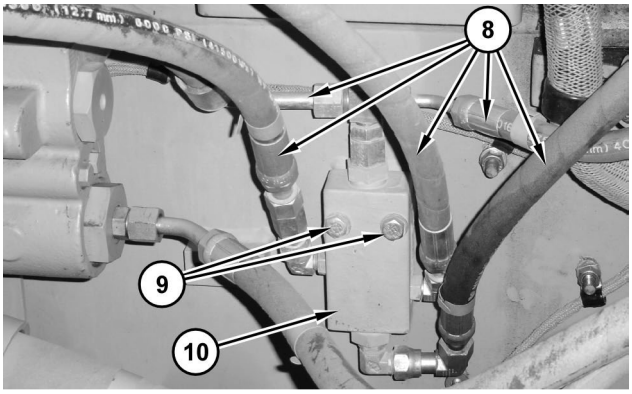


Illustration 287 g01237828

4. Disconnect hose assemblies (8). Remove bolts (9). Remove the selector and press control valve (10).

Installation Procedure

Table 12

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

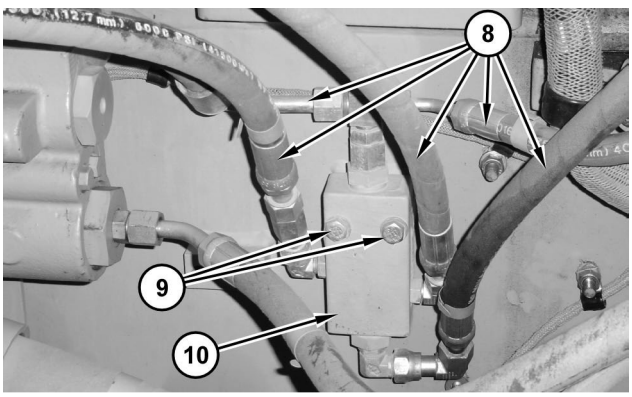


Illustration 288 g01237828

1. Position the selector and press control valve (10). Install bolts (9). Connect hose assemblies (8).

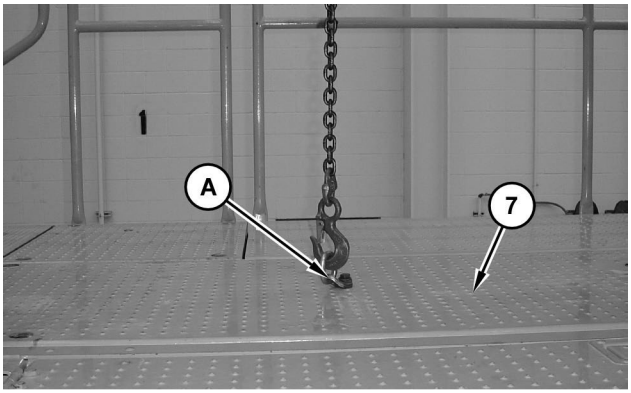


Illustration 289 g01237827

2. Attach Tooling (A) and a suitable lifting device to cover assembly (7). The weight of cover assembly (7) is approximately 117 kg (260 lb). Install cover assembly (7).

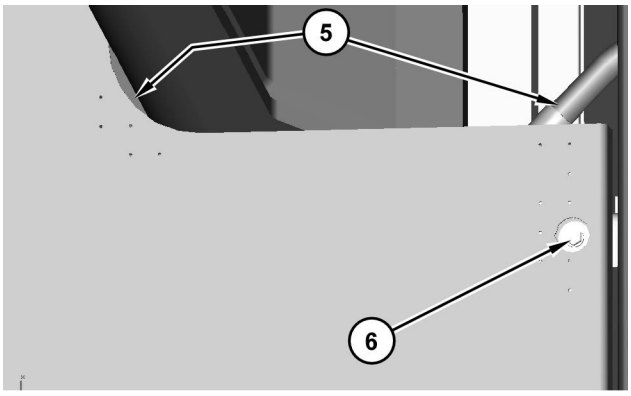


Illustration 290 g01237829

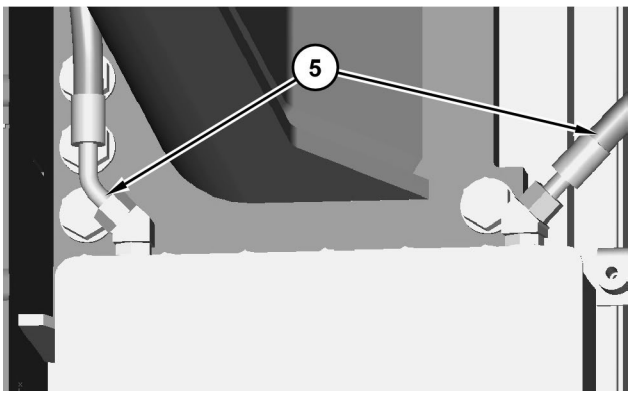


Illustration 291 g01237898

Note: The panel is removed for clarity.

3. Install bolts (6). Connect hose assemblies (5).

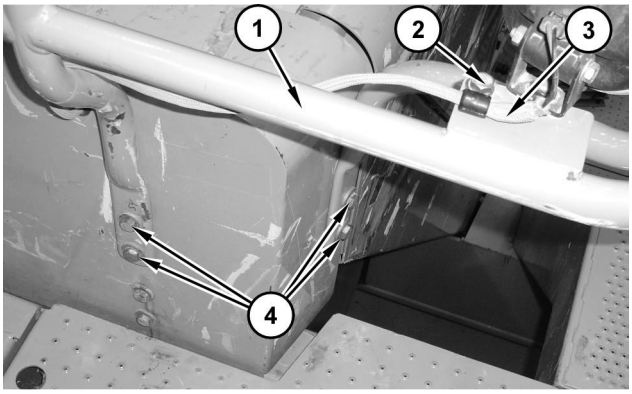


Illustration 292 g01237826

4. Use two people in order to position hand rail assembly (1). The weight of hand rail assembly (1) is approximately 31 kg (70 lb). Install bolts (4). Connect harness assembly (3). Install bolt (2). Repeat for opposite side. Install hand rail assembly (1).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

i02477784

Steering Control Valve - Remove

SMCS Code: 4307-011

Removal Procedure

Table 13

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
B	6V-2082	Lifting Hook	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, "Steering Frame Lock - Seperate and Connect ".

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , " Hydraulic System Pressure - Release".

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

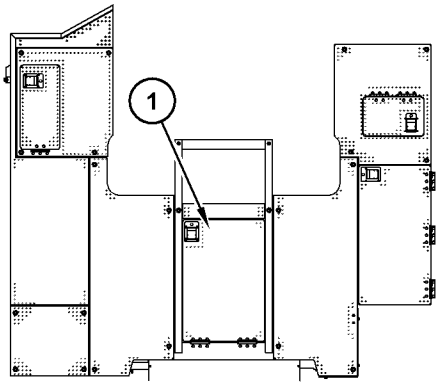


Illustration 293 g01237763

1. Open door assembly (1).

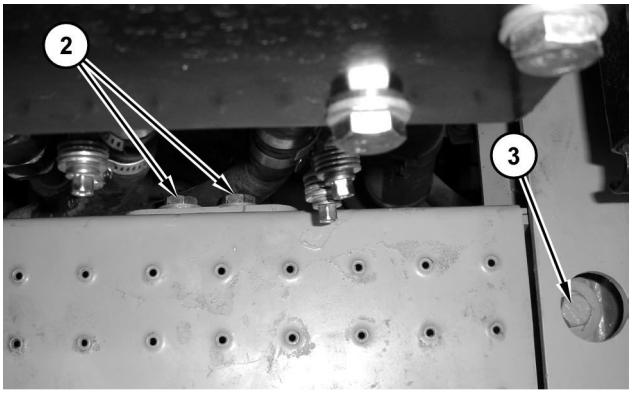


Illustration 294 g01237764

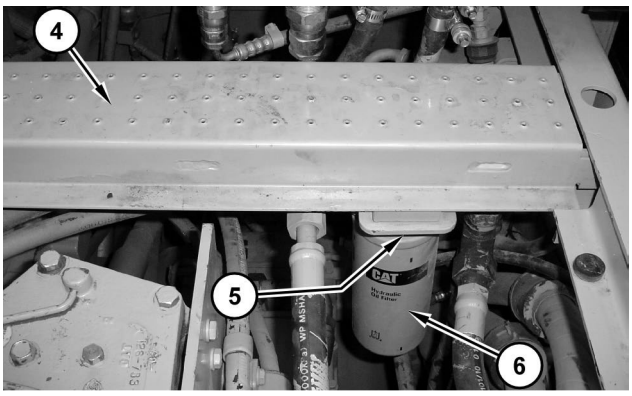


Illustration 295 g01237765

2. Remove bolts (2). Remove bolts (3) from both sides. Remove bolts (5). Position filter base assembly (6) aside. Remove channel assembly (4).

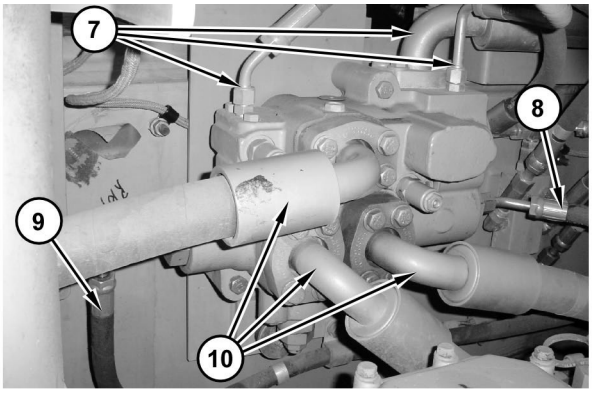


Illustration 296 g01237767

3. Disconnect hose assemblies (7), (8), (9), and (10).

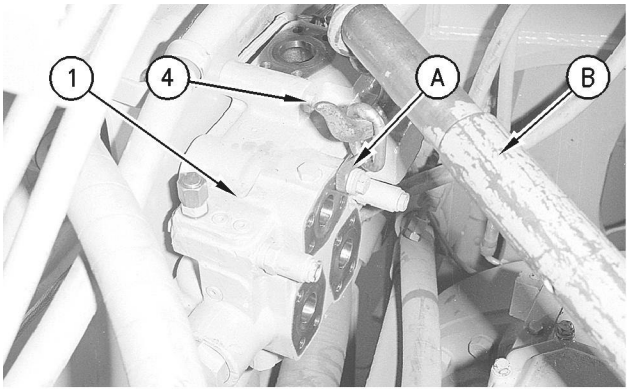


Illustration 297 g00870836

4. Attach Tooling (A) to steering control valve (11). Attach Tooling (B) and a suitable lifting device to Tooling (A). Remove bolts (12) and steering control valve (11). The weight of steering control valve (11) is approximately 50 kg (110 lb).

i02478941

Steering Control Valve - Disassemble

SMCS Code: 4307-015

Disassembly Procedure

Start By:

a. Remove the steering control valve. Refer to Disassembly and Assembly, “Steering Control Valve - Remove”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

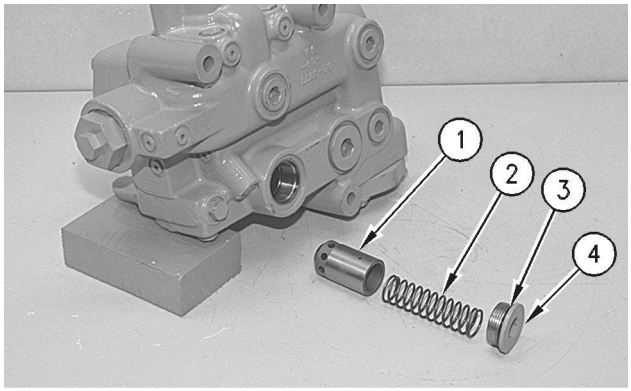


Illustration 298 g00320803

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Remove plug (4), O-ring seal (3), spring (2) and check valve (1).

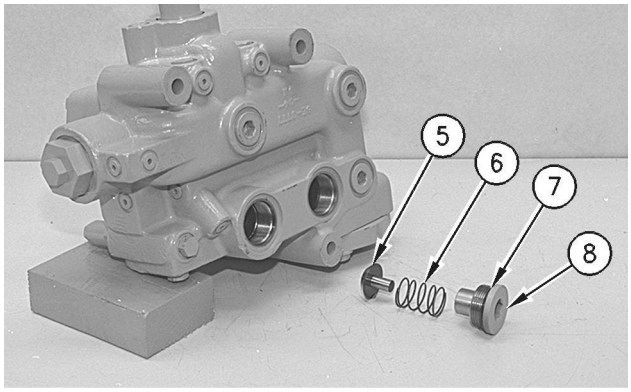


Illustration 299 g00320804

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

2. Remove plug (8), O-ring seal (7), spring (6) and secondary check valve (5).

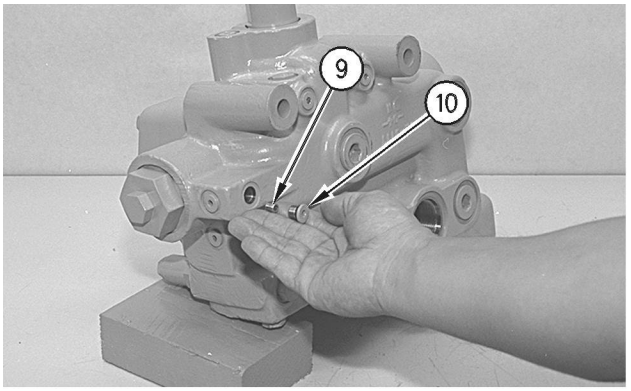


Illustration 300 g00320805

3. Remove plug (10) and orifice (9).

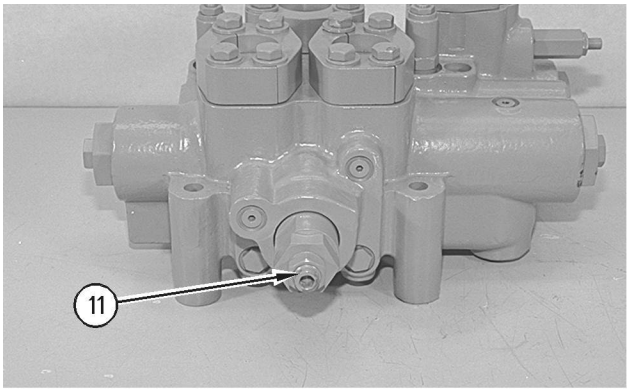


Illustration 301 g00320806

4. Remove relief valve (11).

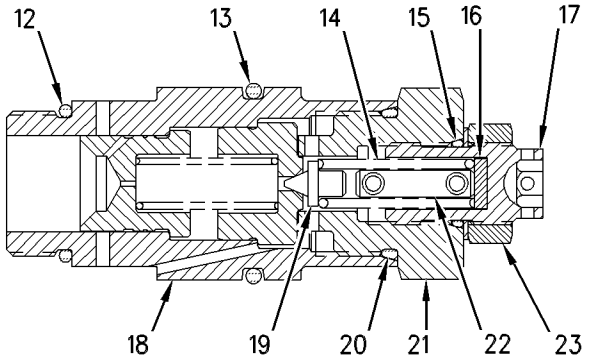


Illustration 302 g00320807

Relief Valve (11)

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

5. Remove cap (21), valve (19), spring (14), pin (22), and plate (16) from the relief valve.

6. Remove O-ring seals (12) and (13) from valve group (18). Remove O-ring seal (20) from cap (21).

7. If it is necessary to remove retainer assembly (17), first record the distance from cap (21) to the top surface of retainer assembly (17). Loosen nut (23) and remove retainer assembly (17) from cap (21).

8. Remove O-ring seal (15) from retainer assembly (17).

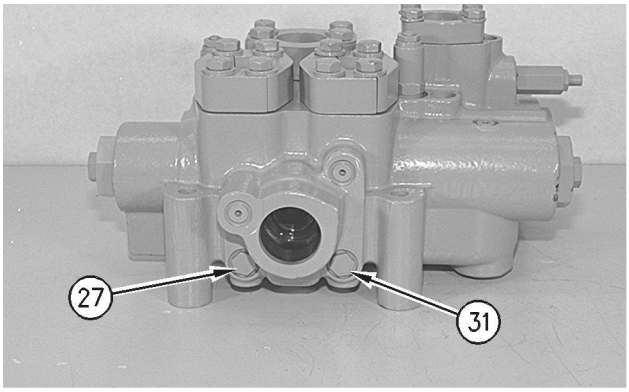


Illustration 303 g00320943

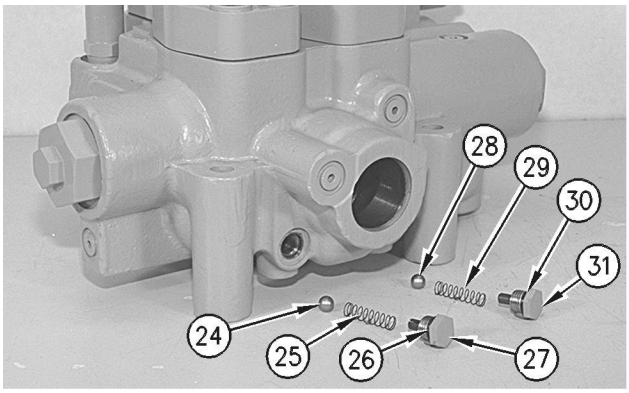


Illustration 304 g00320944

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

9. Remove plug (27), O-ring seal (26), spring (25), and ball (24).

10. Remove plug (31), O-ring seal (30), spring (29), and ball (28).

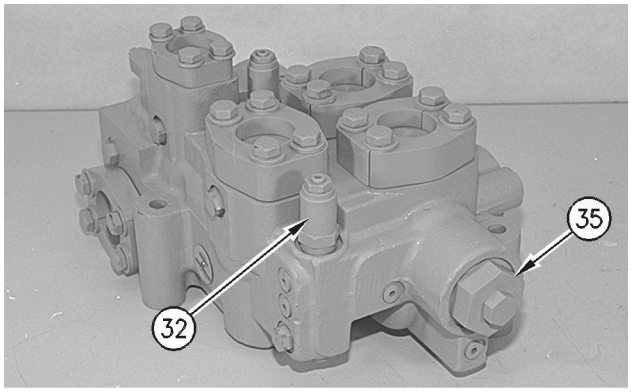


Illustration 305 g00320964

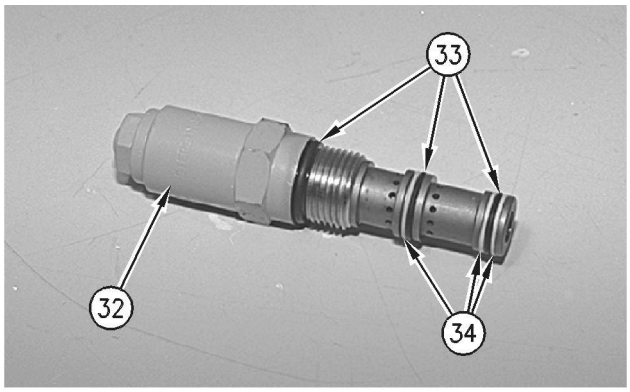


Illustration 306 g00320965

11. Remove pressure reducing valve (32) and adapter (35). Remove O-ring seals (33) and backup rings (34) from pressure reducing valve (32).

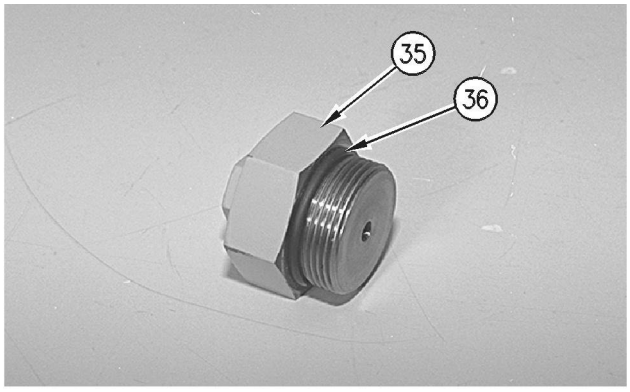


Illustration 307 g00320967

12. Remove O-ring seal (36) from adapter (35).

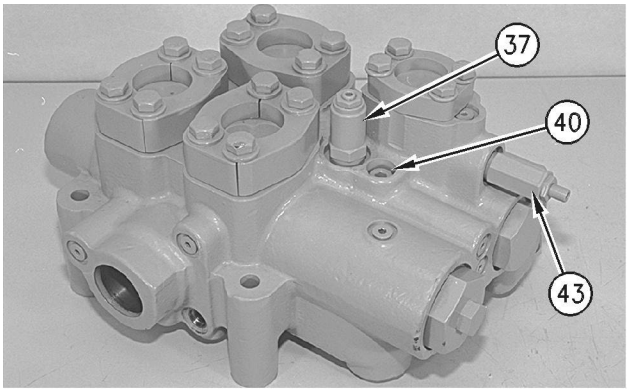


Illustration 308 g00321043

13. Remove cylinder crossover relief valve (37) and cylinder load shuttle valve (40).

14. Remove secondary pump relief valve (43), if the machine is equipped with the secondary steering system.

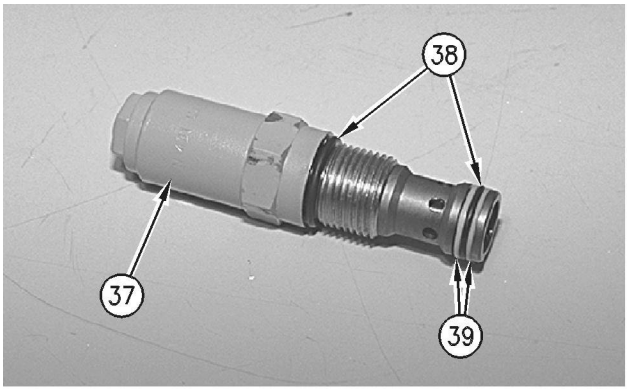


Illustration 309 g00321044

15. Remove O-ring seals (38) and backup rings (39) from cylinder crossover relief valve (37).

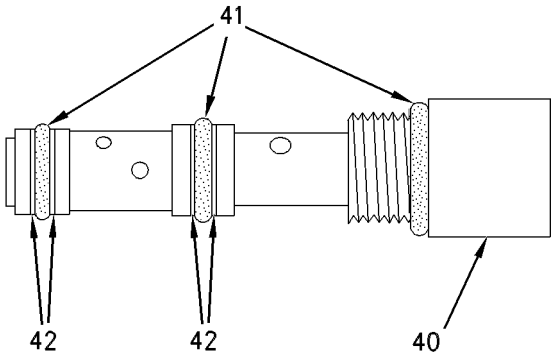


Illustration 310 g00321083

16. Remove O-ring seals (41) and backup rings (42) from cylinder load shuttle valve (40).

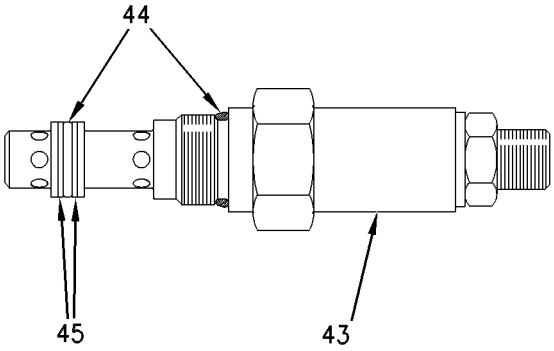


Illustration 311 g00321084

17. Remove O-ring seals (44) and backup rings (45) from secondary pump relief valve (43), if the machine is equipped with the secondary steering system.

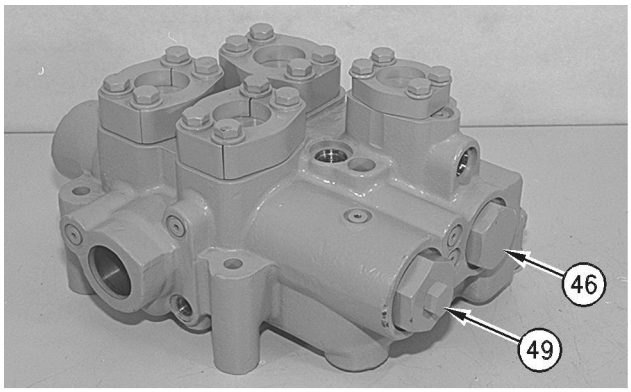


Illustration 312 g00321223

18. Remove diverter valve (46) and adapter (49).

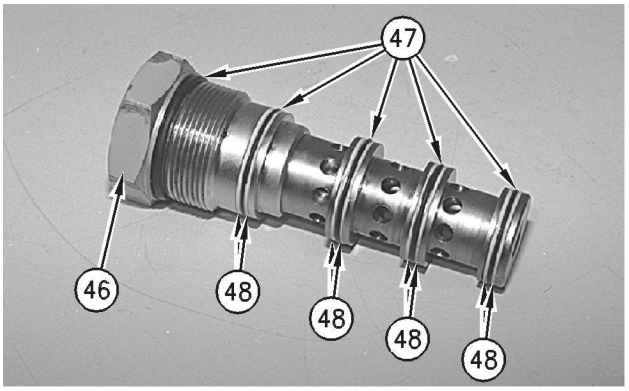


Illustration 313 g00321224

19. Remove O-ring seals (47) and backup rings (48) from diverter valve (46).

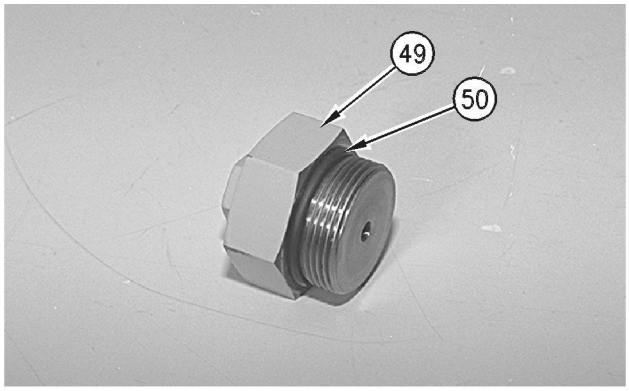


Illustration 314 g00321225

20. Remove O-ring seal (50) from adapter (49).

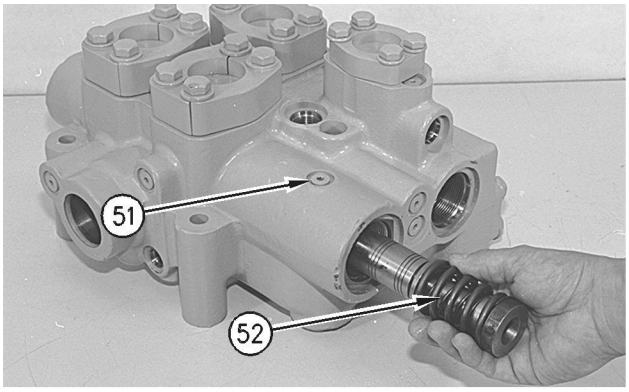


Illustration 315 g00321234

21. Remove valve spool assembly (52) and plug (51).

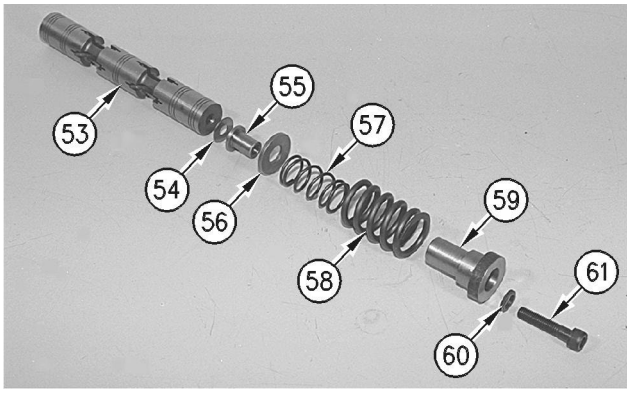


Illustration 316 g00321235

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

22. Disassemble valve spool assembly (52) by removing the following components from stem (53) : bolt (61), washer (60), retainer (59), spring (58), spring (57), washer (56), retainer (55) and shims (54).

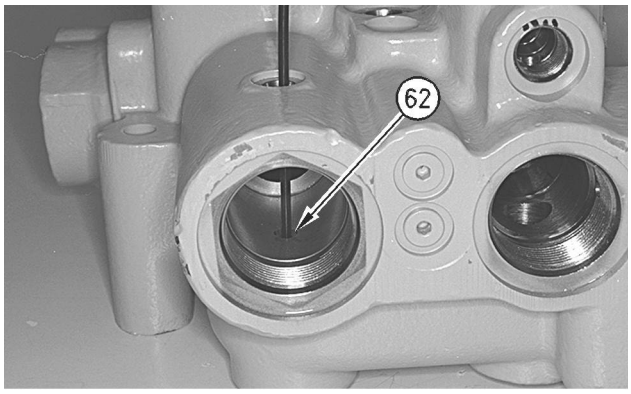


Illustration 317 g00321240

23. Remove orifice (62).

24. Remove the remaining plugs from the steering control valve in order to check the O-ring seals.

i02478943

Steering Control Valve - Assemble

SMCS Code: 4307-016

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

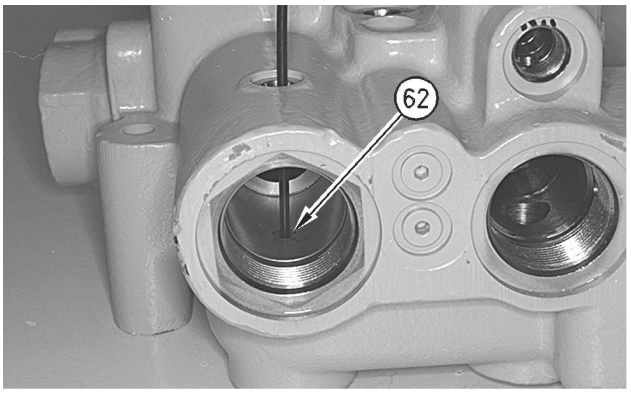


Illustration 318 g00321240

1. Install orifice (62).

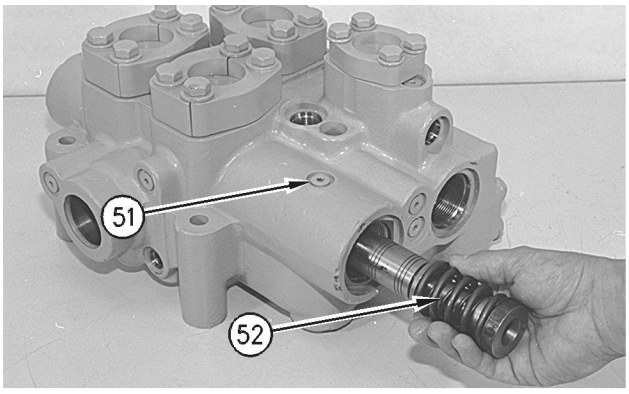


Illustration 319 g00321234

2. Install plug (51).

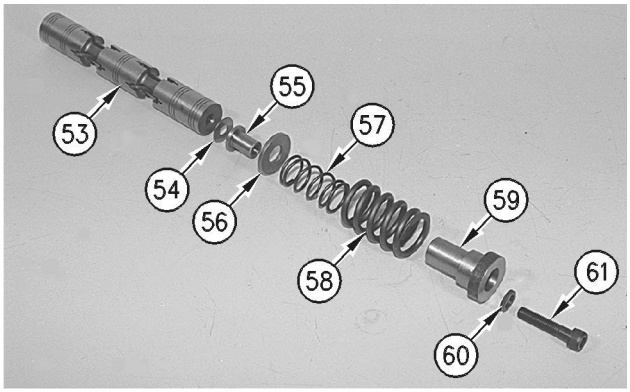


Illustration 320 g00321235

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

3. Assemble valve spool assembly (52) by installing the following components on stem (53) : shims (54), retainer (55), washer (56), spring (57), spring (58), retainer (59), washer (60) and bolt (61). Tighten bolt (61) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

4. Apply clean hydraulic oil to valve spool assembly (52). Carefully insert the valve spool assembly into the steering control valve.

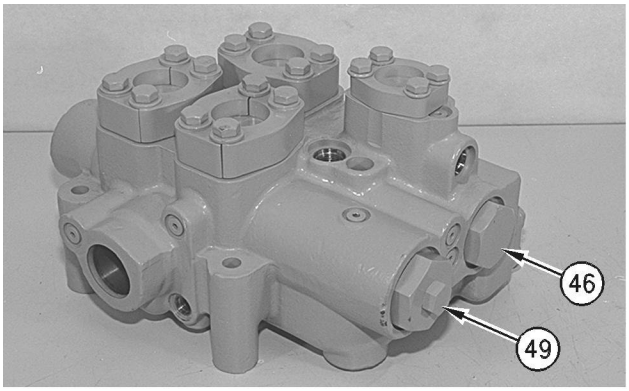


Illustration 321 g00321223

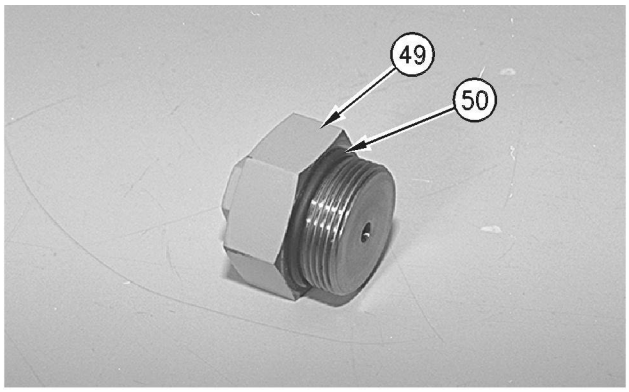


Illustration 322 g00321225

5. Install O-ring seal (50) on adapter (49). Install adapter (49). Tighten adapter (49) to a torque of 430 ± 40 N·m (317 ± 29 lb ft).

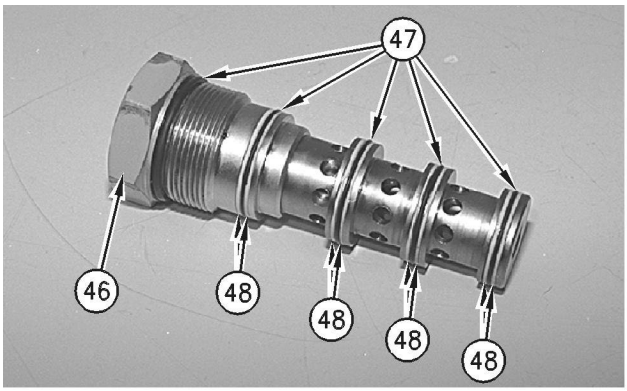


Illustration 323 g00321224

6. Install backup rings (48) and O-ring seals (47) on diverter valve (46). Install diverter valve (46). Tighten diverter valve (46) to a torque of 150 ± 7 N·m (111 ± 5 lb ft).

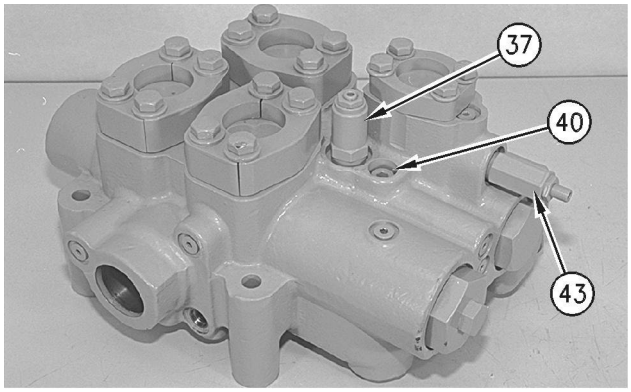


Illustration 324 g00321043

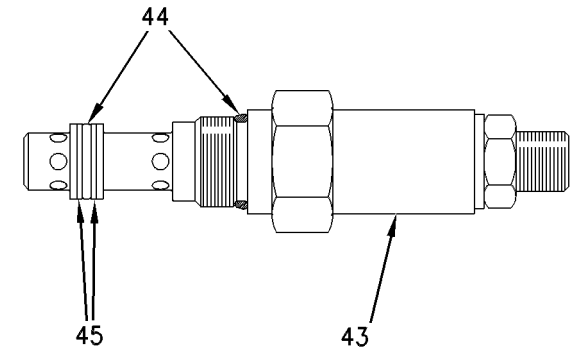


Illustration 325 g00321084

7. Install backup rings (45) and O-ring seals (44) on secondary pump relief valve (43) , if the machine is equipped with the secondary steering system.

8. Install secondary pump relief valve (43), if the machine is equipped with the secondary steering system. Tighten secondary pump relief valve (43) to a torque of 50 ± 7 N·m (37 ± 5 lb ft).

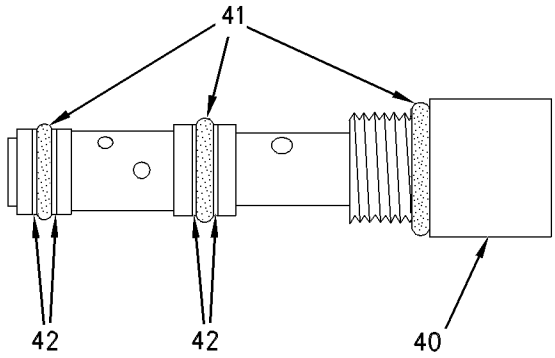


Illustration 326 g00321083

9. Install backup rings (42) and O-ring seals (41) on cylinder load shuttle valve (40). Install cylinder load shuttle valve (40). Tighten cylinder load shuttle valve (40) to a torque of 35 ± 3 N·m (26 ± 2 lb ft).

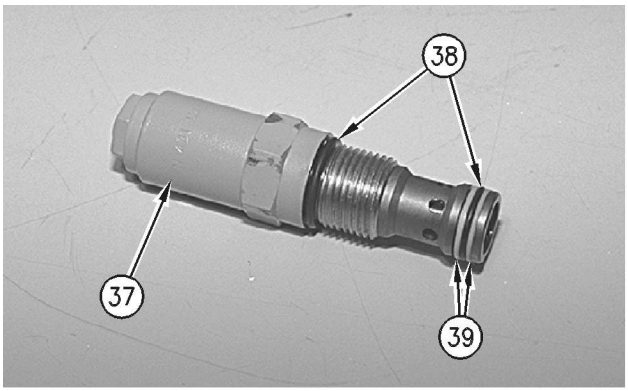


Illustration 327 g00321044

10. Install backup rings (39) and O-ring seals (38) on cylinder crossover relief valve (37). Install cylinder crossover relief valve (37). Tighten cylinder crossover relief valve (37) to a torque of 60 ± 7 N·m (44 ± 5 lb ft).

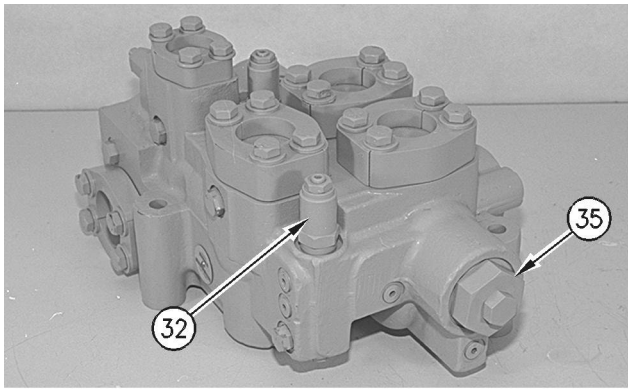


Illustration 328 g00320964

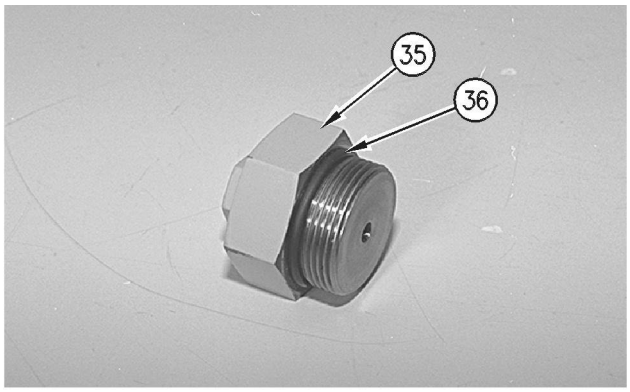


Illustration 329 g00320967

11. Install O-ring seal (36) on adapter (35). Install adapter (35). Tighten adapter (35) to a torque of 430 ± 40 N·m (317 ± 29 lb ft).

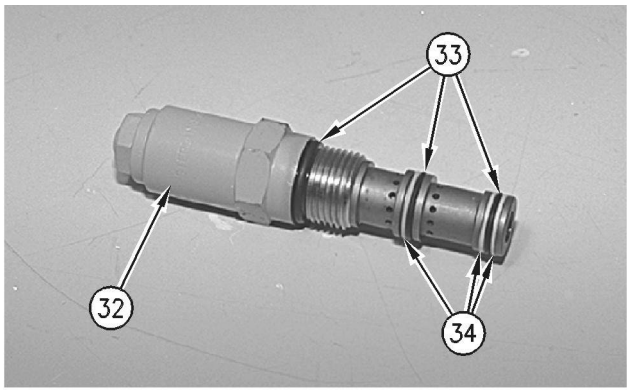


Illustration 330 g00320965

12. Install backup rings (34) and O-ring seals (33) on pressure reducing valve (32). Install pressure reducing valve (32). Tighten pressure reducing valve (32) to a torque of 60 ± 7 N·m (44 ± 5 lb ft).

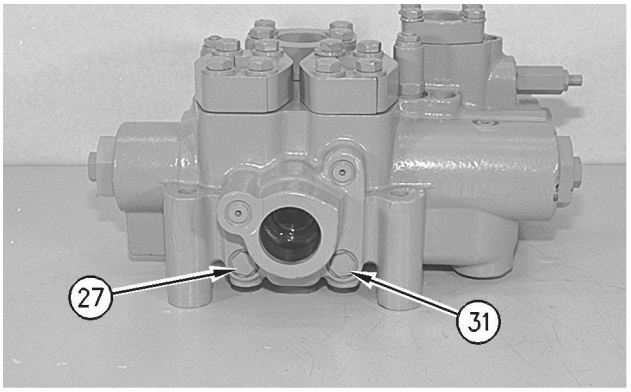


Illustration 331 g00320943

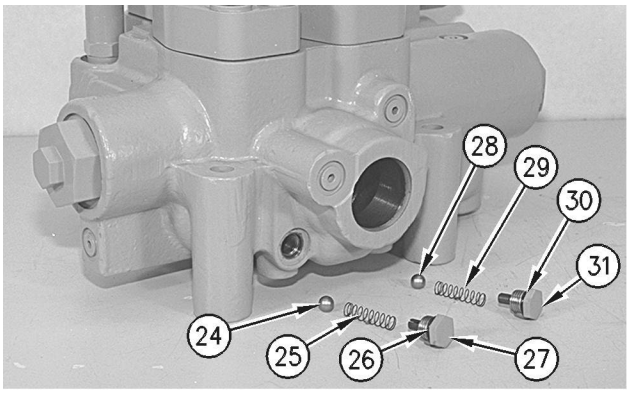


Illustration 332 g00320944

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

13. Install ball (24), spring (25), and O-ring seal (26). Install plug (27). Tighten plug (27) to a torque of 48 ± 5 N·m (35 ± 3 lb ft).

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

14. Install ball (28), spring (29), and O-ring seal (30). Install plug (31). Tighten plug (31) to a torque of 48 ± 5 N·m (35 ± 3 lb ft).

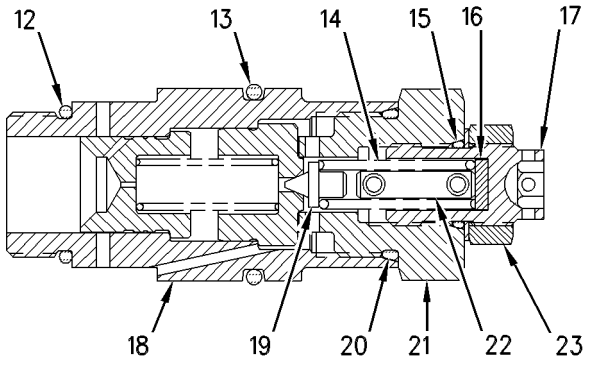


Illustration 333 g00320807

Relief Valve (11)

15. If retainer assembly (17) was removed from relief valve (11), install O-ring seal (15) on retainer assembly (17).

16. Install retainer assembly (17) in cap (21) according to the recorded measurement.

17. Install O-ring seal (20) on cap (21). Install O-ring seals (12) and (13) on valve group (18).

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

18. Install plate (16), pin (22), spring (14), valve (19) and cap (21) in the relief valve. Tighten cap (21) to a torque of 100 ± 10 N·m (74 ± 7 lb ft). Tighten nut (23) to a torque of 50 ± 7 N·m (37 ± 5 lb ft).

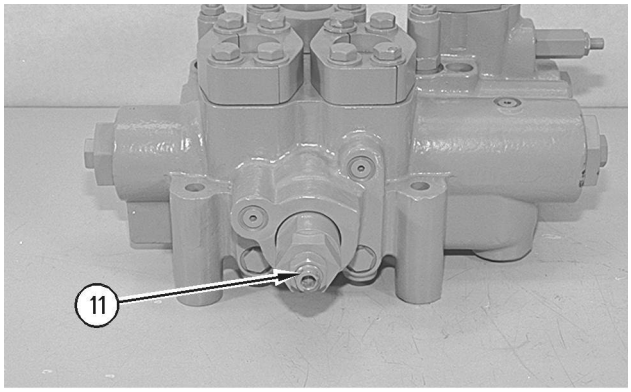


Illustration 334 g00320806

19. Install relief valve (11).

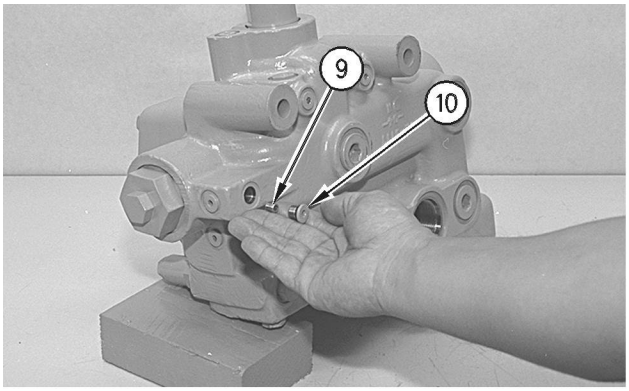


Illustration 335 g00320805

20. Install orifice (9) and plug (10).

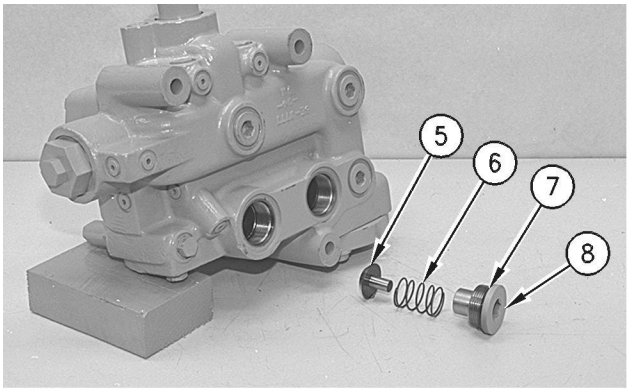


Illustration 336 g00320804

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

21. Install secondary check valve (5), spring (6), O-ring seal (7), and plug (8).

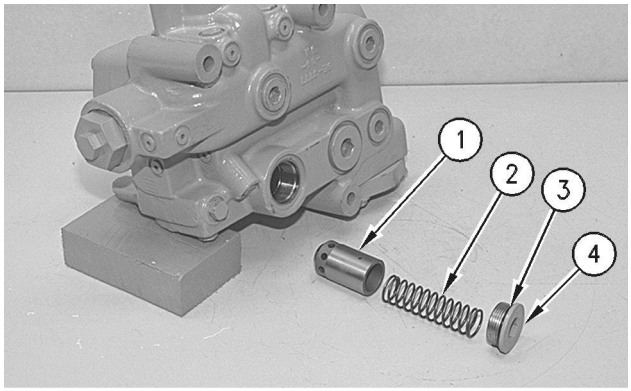


Illustration 337 g00320803

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

22. Install check valve (1), spring (2), O-ring seal (3) and plug (4).

End By:

a. Install the steering control valve. Refer to Disassembly and Assembly, “Steering Control Valve - Install”.

i02477787

Steering Control Valve - Install

SMCS Code: 4307-012

Installation Procedure

Table 14

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
B	6V-2082	Lifting Hook	1

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

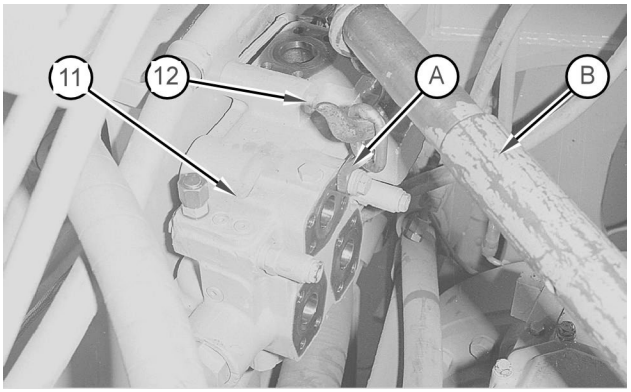


Illustration 338 g01238029

1. Attach Tooling (A) to steering control valve (11). Attach Tooling (B) and a suitable lifting device to Tooling (A). The weight of steering control valve (11) is approximately 50 kg (110 lb). Position steering control valve (11) and install bolts (12).

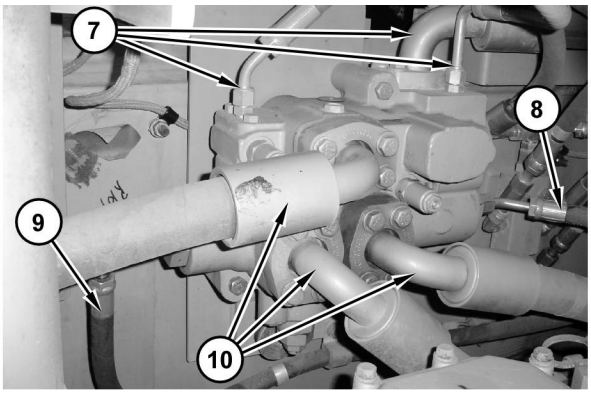


Illustration 339 g01237767

2. Connect hose assemblies (7), (8), (9), and (10).

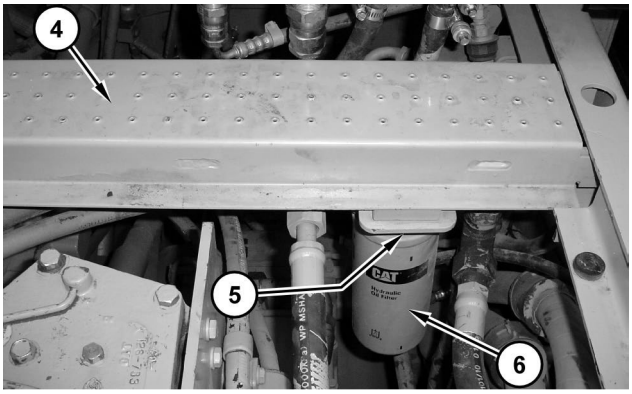


Illustration 340 g01237765

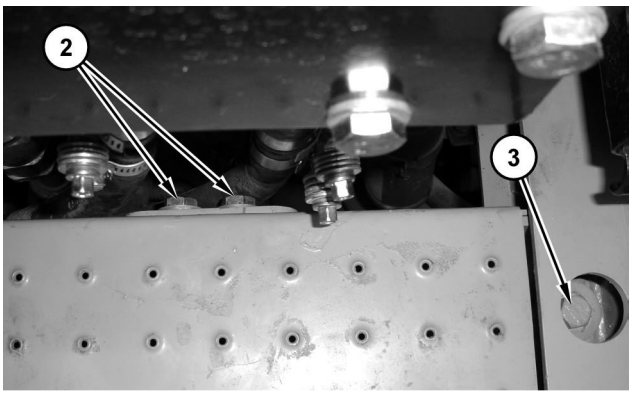


Illustration 341 g01237764

3. Install channel assembly (4). Position filter base assembly (6). Install bolts (5). Install bolts (2). Install bolts (3) for each side.

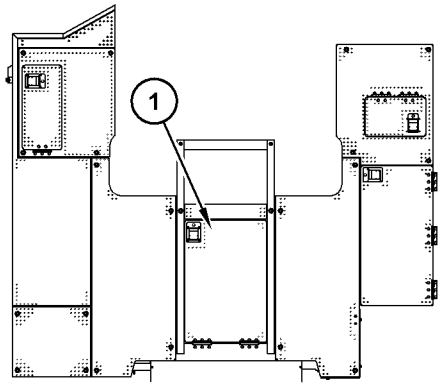


Illustration 342 g01237763

4. Close door assembly (1).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Seperate and Connect ”.

i02491805

Steering Neutralizer Valve - Remove and Install

SMCS Code: 4330-010

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the pressure in the steering system and in the braking system. Refer to Disassembly and Assembly, “System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

Note: Put identification marks on all lines. Plug all lines. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

The steering neutralizer valves are located above the upper hitch pin in the articulation joint.

1. Drain the hydraulic oil tank for the steering system. For the correct procedure, refer to Operation and Maintenance Manual, “Steering and Hydraulic Fan System Oil - Change”.

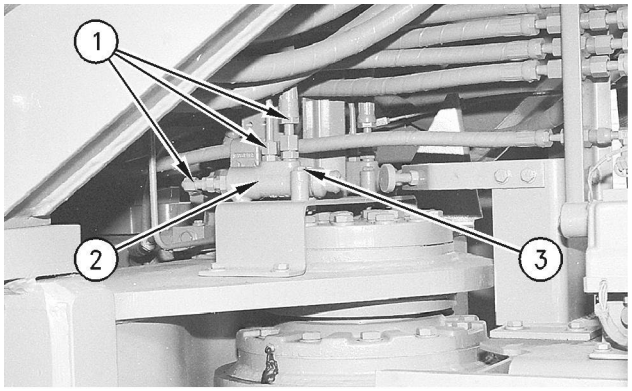


Illustration 343 g00870882

2. Disconnect tube assemblies (1) from steering neutralizer valve (2).

3. Remove bolts (3) and steering neutralizer valve (2).

4. Repeat the procedure for the other steering neutralizer valve.

Installation Procedure

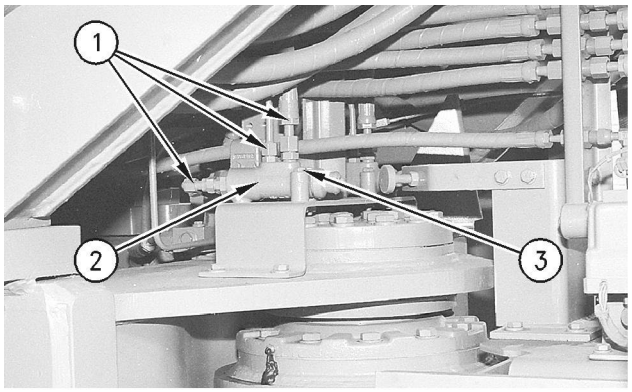


Illustration 344 g00870882

1. Install steering neutralizer valve (2) and bolts (3).

2. Connect tube assemblies (1) to steering neutralizer valve (2).

3. Repeat the procedure for the other steering neutralizer valve.

4. Fill the hydraulic tank for the steering system with oil. For the correct procedure, refer to the Operation and Maintenance Manual, “Steering and Hydraulic Fan System Oil - Change”.

5. Start the engine and check for leaks.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02514891

Selector and Pressure Control Valve (Secondary Steering) - Remove and Install

SMCS Code: 4349-010-SST

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release hydraulic system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

c. Drain the hydraulic oil tank for the steering system. For the correct procedure, refer to Operation and Maintenance Manual, “Steering and Hydraulic Fan System Oil - Change” for the machine that is being serviced.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes. Plug all lines, all hoses and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

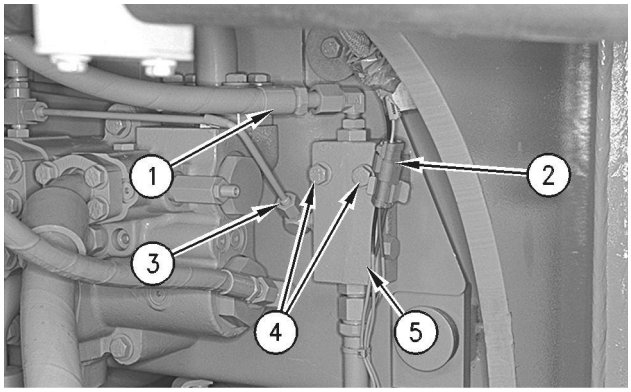


Illustration 345 g00320515

1. Disconnect hose assembly (1), tube assembly (3) and harness assembly (2) from selector and pressure control valve (5).

2. Remove bolts (4) and selector and pressure control valve (5).

Installation Procedure

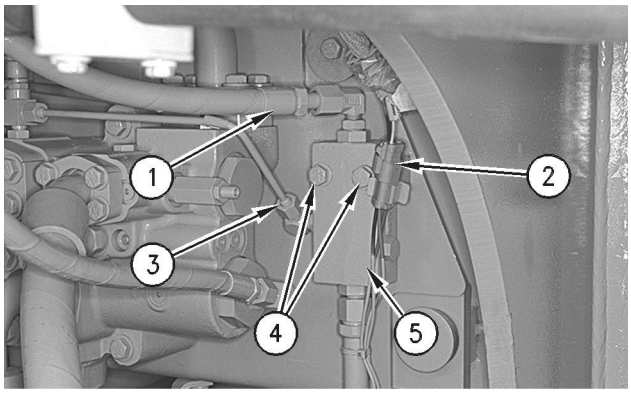


Illustration 346 g00320515

1. Install selector and pressure control valve (5) and bolts (4).

2. Connect hose assembly (1), tube assembly (3) and harness assembly (2) to selector and pressure control valve (5).

End By:

a. Fill the hydraulic system with oil. Refer to Operation and Maintenance Manual, “Steering and Hydraulic Fan System Oil - Change” for the machine that is being serviced.

b. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i03394563

Steering Cylinder - Remove and Install

SMCS Code: 4303-010

Removal Procedure

Table 15

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-9200	Lever Puller Hoist	1
B	9U-7536	Lift Stand	1
	4C-5809	Hydraulic Pump	1
	-	Bar (2.5 inch by 8.0 inch)	1
C	9U-5266	Sleeve Assembly	1
	5P-8712	Bushing	1
	9U-5346	Nut	1
	9U-5344	Stud	1
	316-1489	Hydraulic Cylinder Gp	1
	3S-6224	Hydraulic Pump	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Seperate and Connect ”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , “ Hydraulic System Pressure - Release”.

⚠ WARNING

When you are using hydraulic cylinders and puller studs, always ensure that the rated capacity of the puller stud meets or exceeds the rated capacity of the hydraulic cylinder. If the puller stud does not meet or exceed the rated capacity of the hydraulic cylinder, a sudden failure of the puller stud could occur. The sudden failure of the puller stud could result in personal injury or death.

NOTICE
Do not use threaded rods that have not been hardened as tooling with hydraulic cylinders. The maximum rated tonnage should be stamped on one end of the puller studs. Do not use threaded rods that have not been stamped with the rated tonnage.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.



Illustration 347 g01238872

1. Disconnect hose assembly (1).

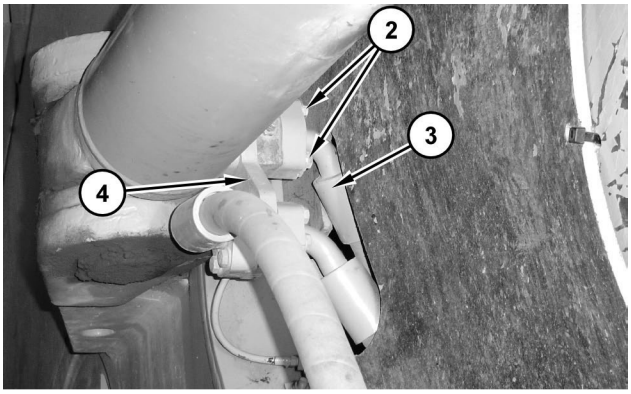


Illustration 348 g01238873

2. Remove bolts (2). Position hose assembly (3) and plate assembly (4) aside.



Illustration 349 g01238874

3. Disconnect hose assembly (5).

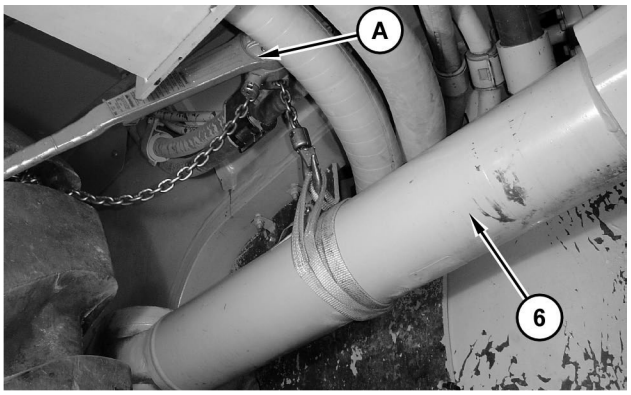


Illustration 350 g01238875

4. Attach Tooling (A) and a suitable lifting device to the machine, and to cylinder assembly (6). The weight of cylinder assembly (6) is approximately 199 kg (440 lb).

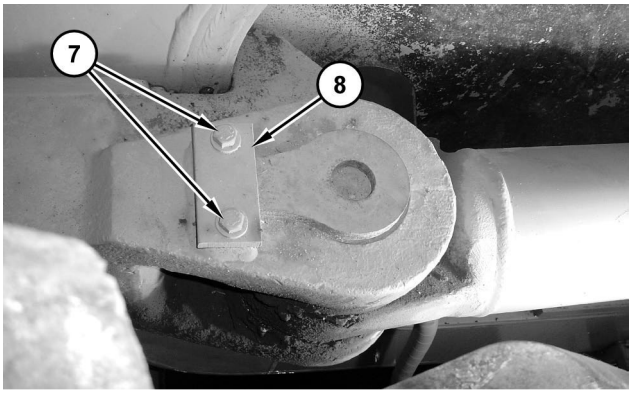


Illustration 351 g01238876

5. Remove bolts (7) and plate (8).

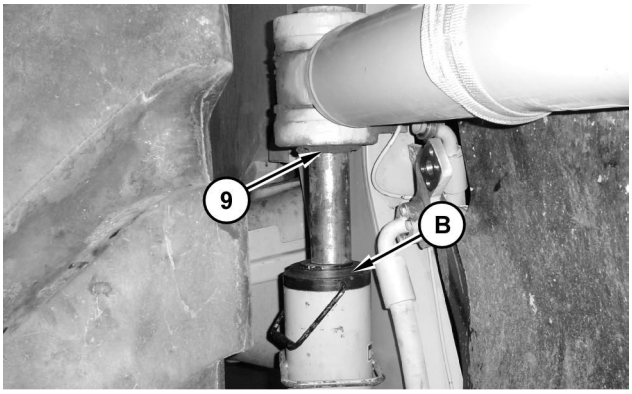


Illustration 352 g01238878

6. Retract pin assembly (9) with Tooling (B) to a distance of 19.05 cm (7.500 inch). Remove Tooling (B).

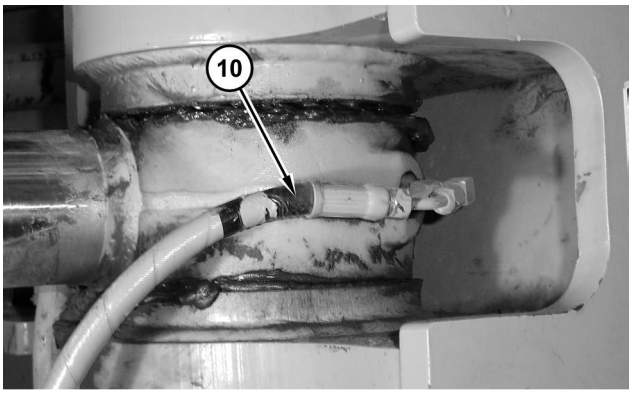


Illustration 353 g01238879

7. Disconnect hose assembly (10).

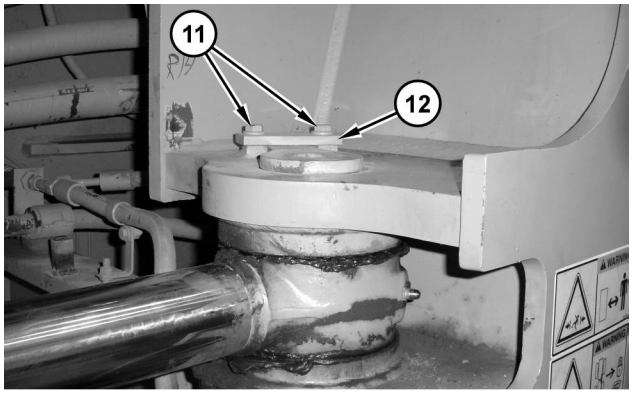


Illustration 354 g01238880

8. Remove bolts (11) and plate (12).

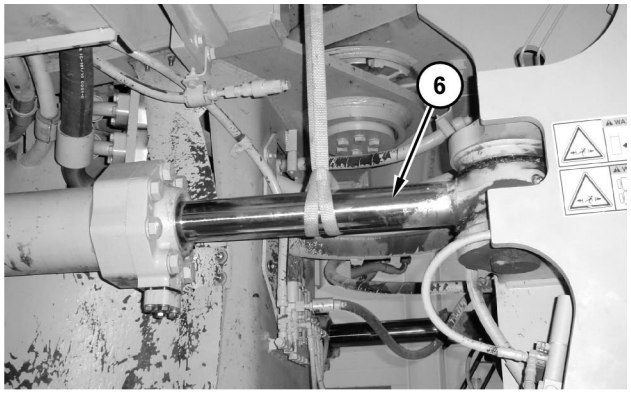


Illustration 355 g01238881

9. Attach a suitable lifting device to cylinder assembly (6). The weight of cylinder assembly (6) is approximately 199 kg (440 lb).

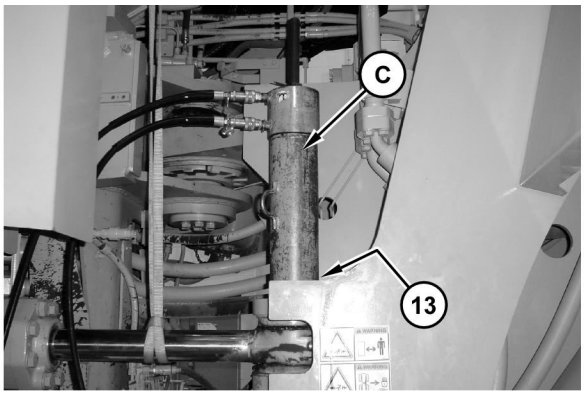


Illustration 356 g01238882

10. Assemble Tooling (C) onto pin assembly (13). Retract pin assembly (13) to a distance of 190.5 mm (7.50 inch). Remove Tooling (C).

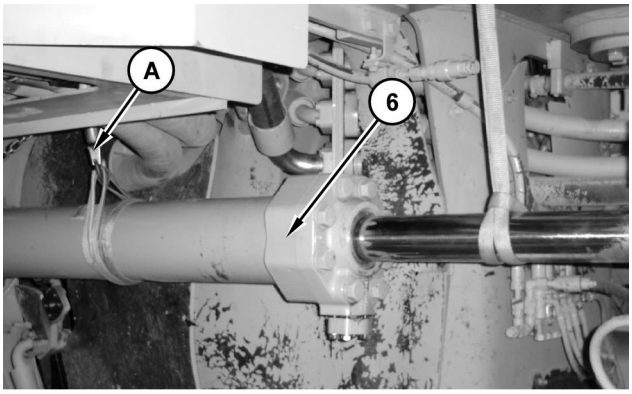


Illustration 357 g01238884

11. Use Tooling (A) and a suitable lifting device to remove cylinder assembly (6). The weight of cylinder assembly (6) is approximately 199 kg (440 lb).

Disassembly and Assembly Information

Table 16

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
D	127-4904	Repair Stand	1
E	7M-7456	Bearing Mount Compound	1
F	1P-1839	Adapter	1
	4C-9634	Puller Stud	1
	9U-6832	Full Nut	1
	316-1489	Hydraulic Cylinder Gp	1
	6V-4035	Pin Puller Sleeve As	1
	3S-6224	Electric Hydraulic Pump Gp	1
G	1P-0520	Driver Gp	1
H	1P-0772	Driver Gp	1
J	195-4609	Seal Pick	1

WARNING

When you are using hydraulic cylinders and puller studs, always ensure that the rated capacity of the puller stud meets or exceeds the rated capacity of the hydraulic cylinder. If the puller stud does not meet or exceed the rated capacity of the hydraulic cylinder, a sudden failure of the puller stud could occur. The sudden failure of the puller stud could result in personal injury or death.

NOTICE

Do not use threaded rods that have not been hardened as tooling with hydraulic cylinders. The maximum rated tonnage should be stamped on one end of the puller studs. Do not use threaded rods that have not been stamped with the rated tonnage.

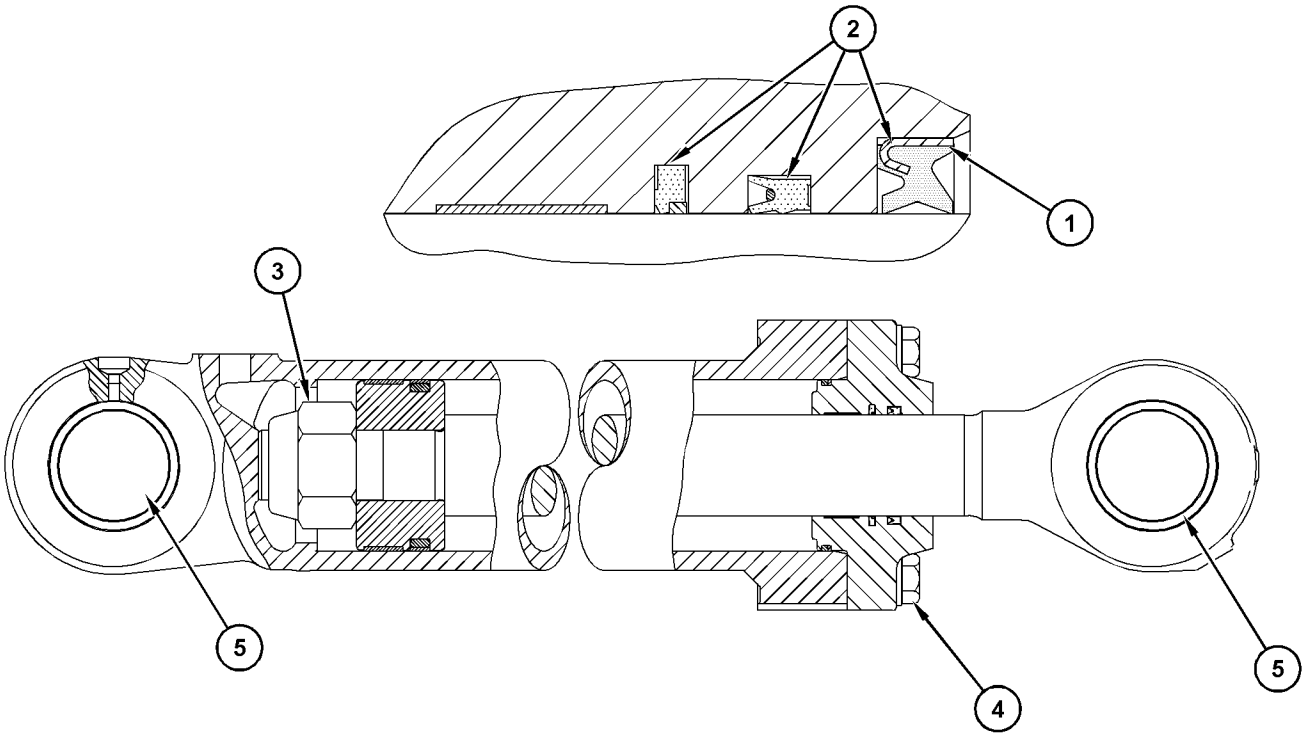


Illustration 358 g01238968

(1) Apply Tooling (E) to the seal groove prior to assembling the wiper seal.

(2) Lubricate sealing lips with a thin covering of the lubricant that is being sealed.

(3) Torque for the nut . . . . . 6000 ± 600 N·m ((4425 ± 442 lb ft))

(4) Torque for the bolt . . . . . 900 ± 100 N·m ((663 ± 73 lb ft))

(5) Apply Tooling (E) to the external surface of the bearing. Depth of bearing . . . . . .8.0 ± 0.5 mm ((0.31 ± 0.01 inch))

Note: Do not use an impact driver to install the bearings.

Installation Procedure

Table 17

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-9200	Lever Puller Hoist	1

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

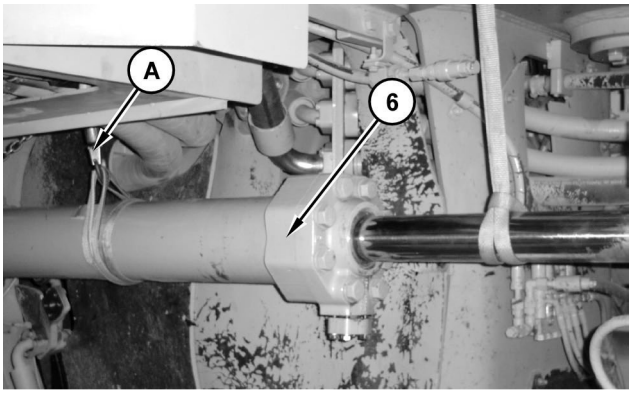


Illustration 359 g01238884

1. Attach Tooling (A) and a suitable lifting device to cylinder assembly (6). The weight of cylinder assembly (6) is approximately 199 kg (440 lb). Position cylinder assembly (6).

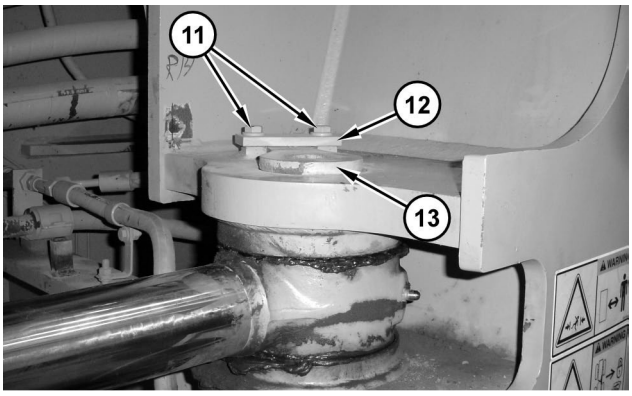


Illustration 360 g01238952

2. Install pin assembly (13), plate (12), and bolt (11).

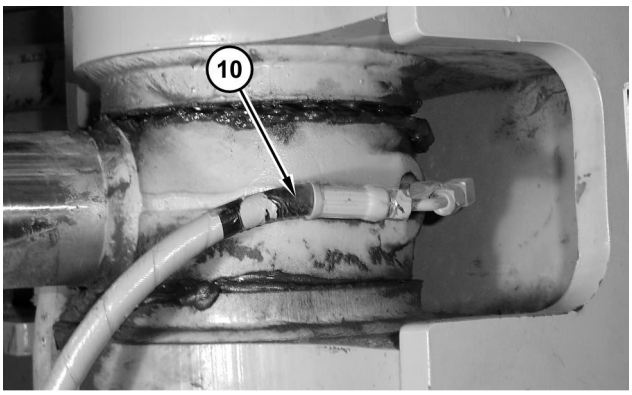


Illustration 361 g01238879

3. Connect hose assembly (10).

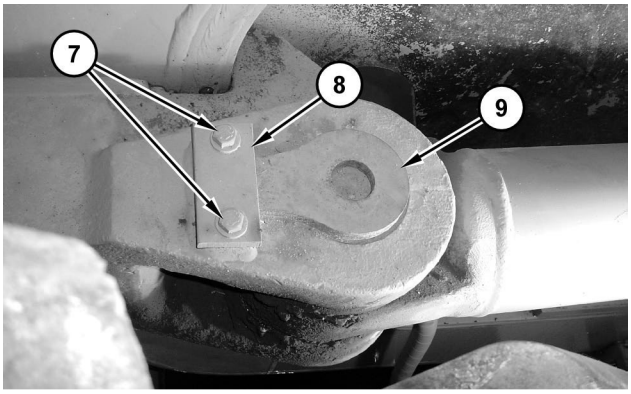


Illustration 362 g01238951

4. Install pin assembly (9), plate (8), and bolts (7).

5. Remove Tooling (A).



Illustration 363 g01238874

6. Connect hose assembly (5).

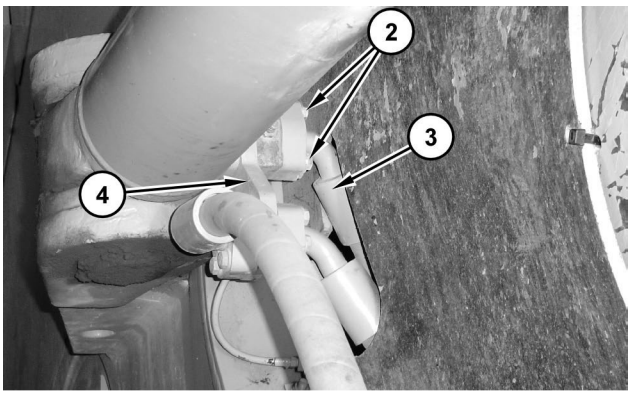


Illustration 364 g01238873

7. Position plate assembly (4) and hose assembly (3). Install bolts (2).



Illustration 365 g01238872

8. Connect hose assembly (1).

End By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

i02478950

Brake Accumulator - Remove

SMCS Code: 4263-011

Removal Procedure

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , " Hydraulic System Pressure - Release".

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Depress the brake pedal repeatedly. This will release any pressure in the brake system.

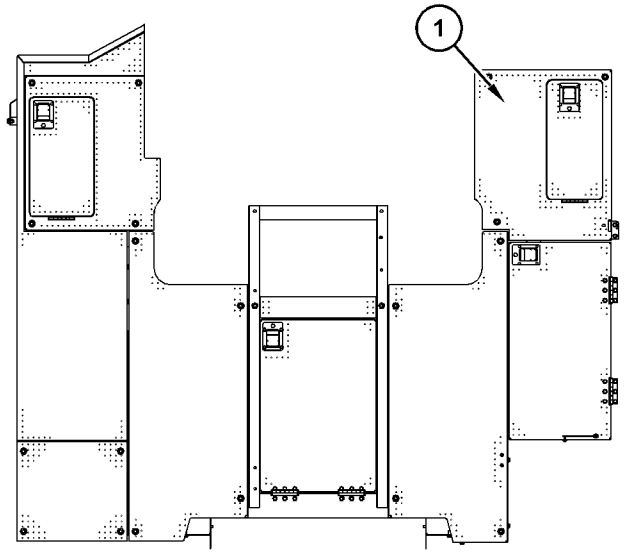


Illustration 366 g01238443

2. Use two people in order to remove panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).

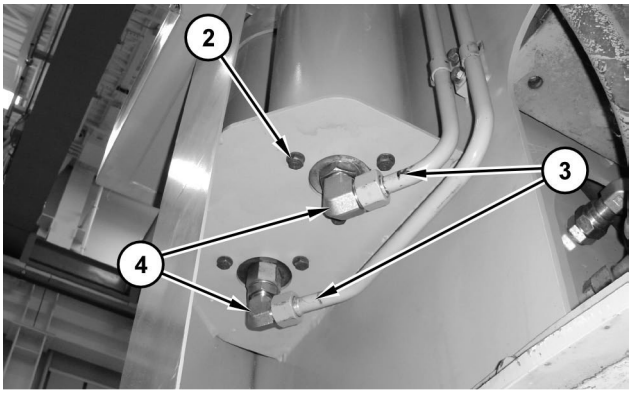


Illustration 367 g01238528

3. Disconnect tube assemblies (3). Remove fittings (4) and bolts (2).

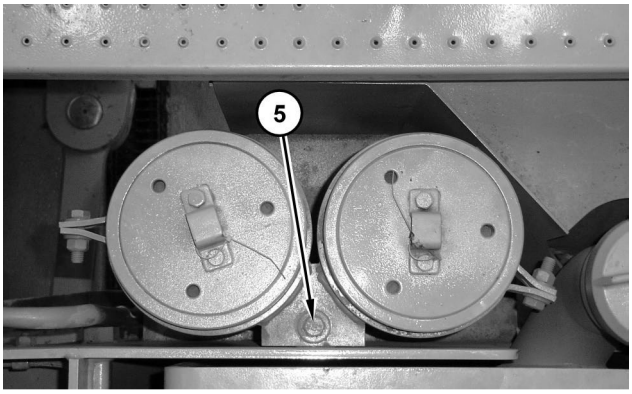


Illustration 368 g01238530

4. Remove bolts (5).



Illustration 369 g01238533

5. Attach a suitable lifting device to accumulator assemblies (6). The weight of accumulator assemblies (6) is approximately 56 kg (125 lb). Remove accumulator assemblies (6).

i02478948

Brake Accumulator - Install

SMCS Code: 4263-012

Installation Procedure

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.



Illustration 370 g01238533

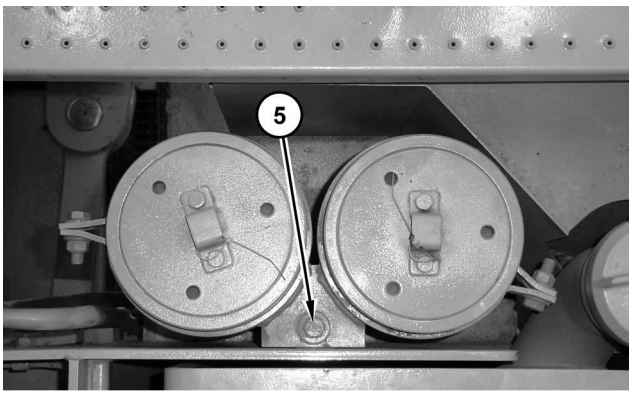


Illustration 371 g01238530

1. Attach a suitable lifting device to accumulator assemblies (6). The weight of accumulator assemblies (6) is approximately 56 kg (125 lb). Position accumulator assemblies (6) and install bolt (5).

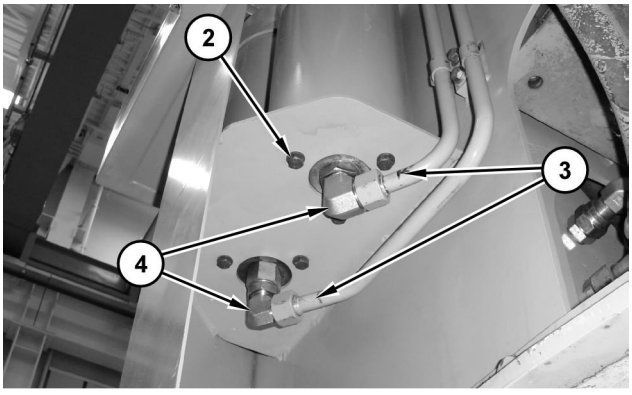


Illustration 372 g01238528

2. Install bolts (2) and fittings (4). Connect tube assemblies (3).

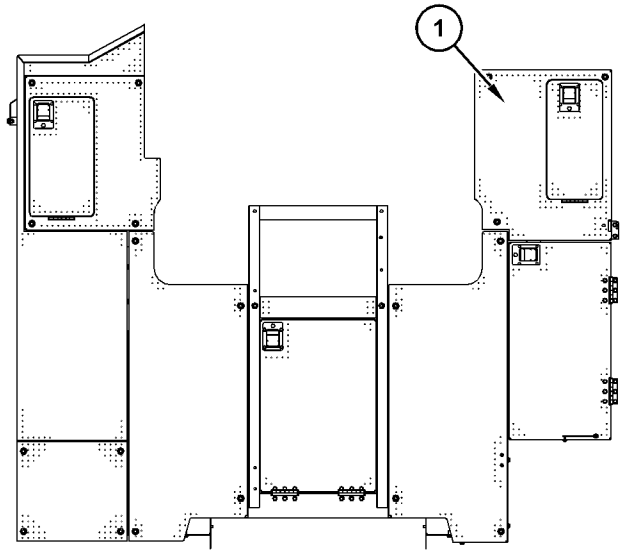


Illustration 373 g01238443

3. Use two people in order to install panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02478952

Combination Valve (Pilot, Brake) - Remove

SMCS Code: 5064-011-P&B

Removal Procedure

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , “ Hydraulic System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

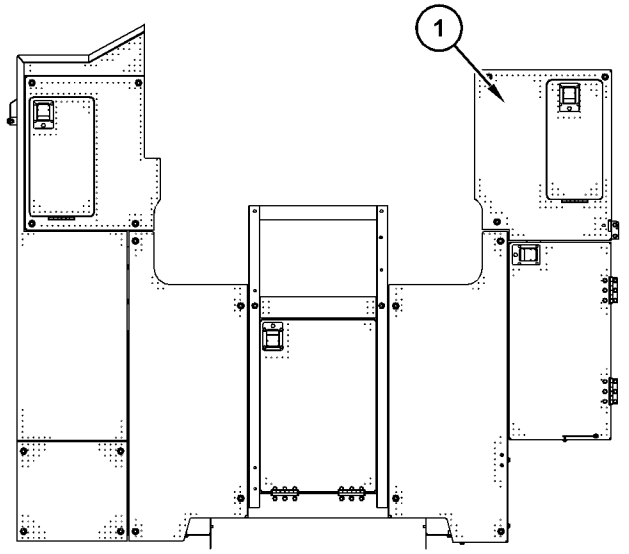


Illustration 374 g01238443

1. Use two people in order to remove panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).

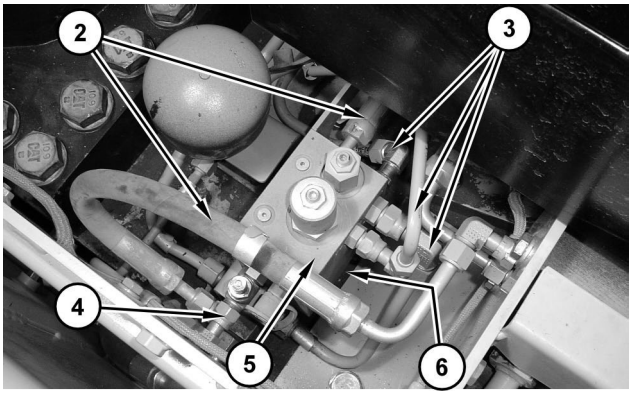


Illustration 375 g01238444

2. Disconnect hose assemblies (2). Disconnect tube assemblies (3) and (4). Remove bolts (6) and combination valve (5).

i02491393

Combination Valve (Pilot, Brake) - Disassemble

SMCS Code: 5064-015-P&B

Disassembly Procedure

Start By:

a. Remove the combination valve. Refer to Disassembly and Assembly, "Combination Valve (Pilot, Brake) - Remove".

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

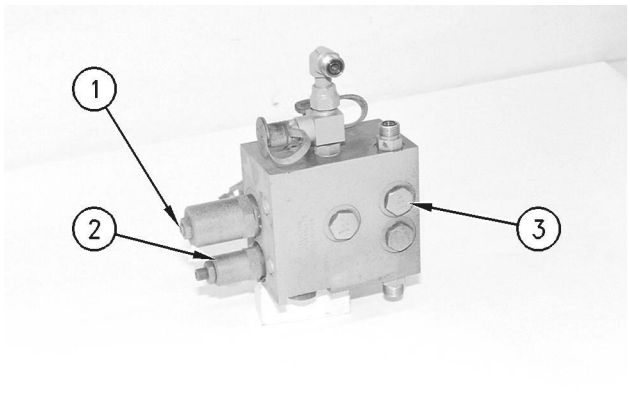


Illustration 376 g00871439

1. Remove check valves (3).

2. Remove relief valve (1).

3. Remove relief valve (2).

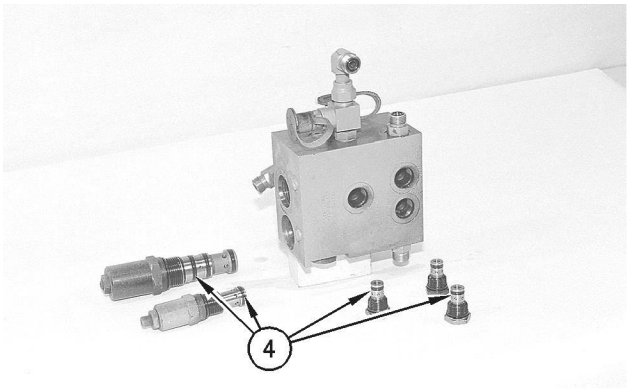


Illustration 377 g00871440

4. Remove O-ring seals (4) from the relief valve and from the check valves.

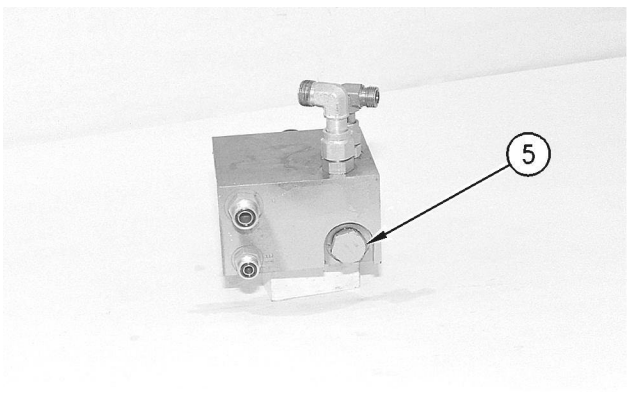


Illustration 378 g00871442

5. Remove valve (5).

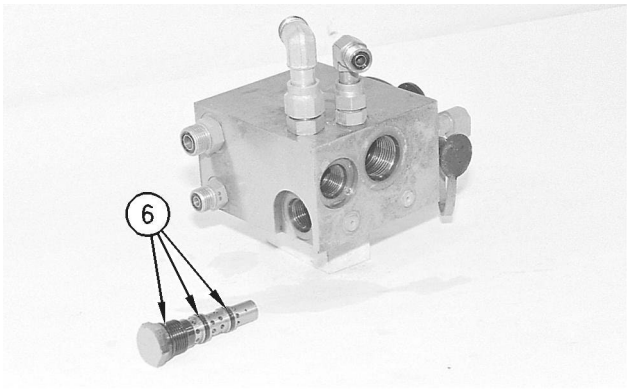


Illustration 379 g00871444

6. Remove O-rings (6).

i02491395

Combination Valve (Pilot, Brake) - Assemble

SMCS Code: 5064-016-P&B

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

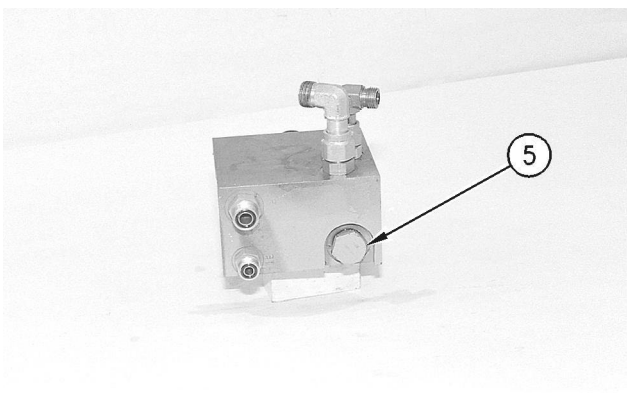


Illustration 380 g00871442

1. Install valve (5). Tighten valve (5) to a torque of 61 N·m (45 lb ft).

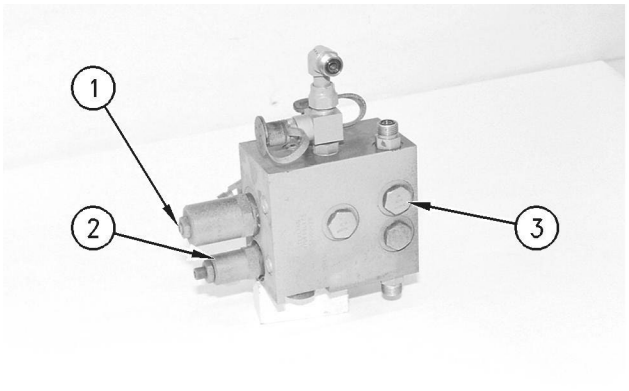


Illustration 381 g00871439

2. Install relief valve (2). Tighten valve (2) to a torque of 61 N·m (45 lb ft).

3. Install relief valve (1). Tighten valve (1) to a torque of 88 N·m (65 lb ft).

4. Install check valves (3). Tighten check valves (3) to a torque of 48 N·m (35 lb ft).

End By:

a. Install the combination valve. Refer to Disassembly and Assembly, “Combination Valve (Pilot, Brake) - Install” for the machine that is being serviced.

i02478954

Combination Valve (Pilot, Brake) - Install

SMCS Code: 5064-012-P&B

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

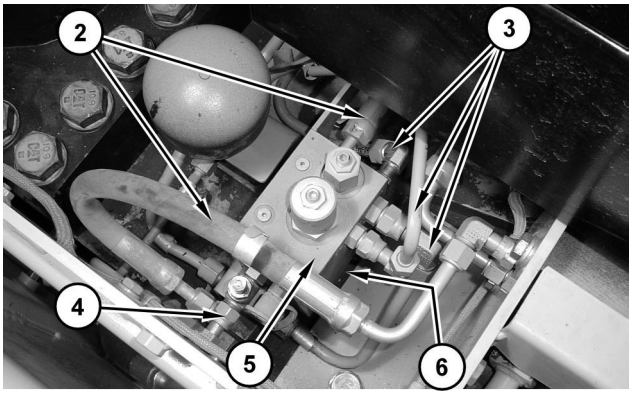


Illustration 382 g01238444

1. Position combination valve (5) and install bolts (6). Connect tube assemblies (3) and (4). Connect hose assemblies (2).

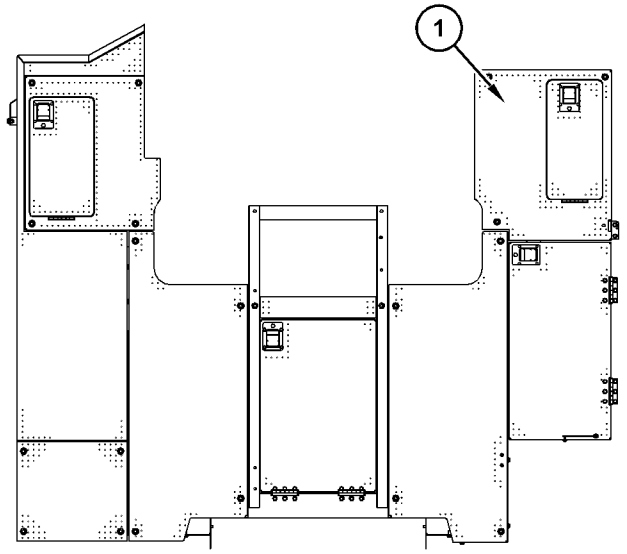


Illustration 383 g01238443

2. Use two people in order to position panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb). Install panel assembly (1).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02478946

Relief Valve (Brake System Backup) - Remove and Install

SMCS Code: 5069-010-BRK

Removal Procedure

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , “ Hydraulic System Pressure - Release”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

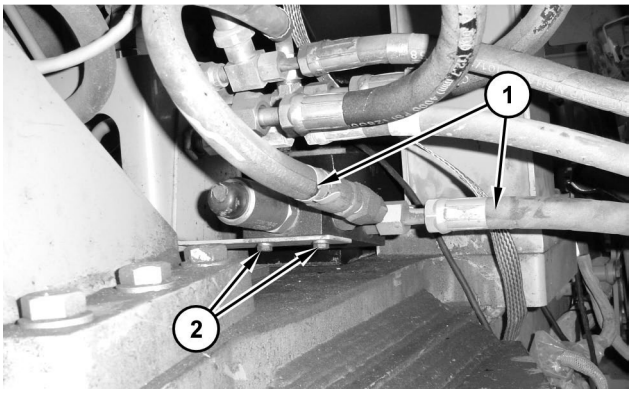


Illustration 384 g01238420

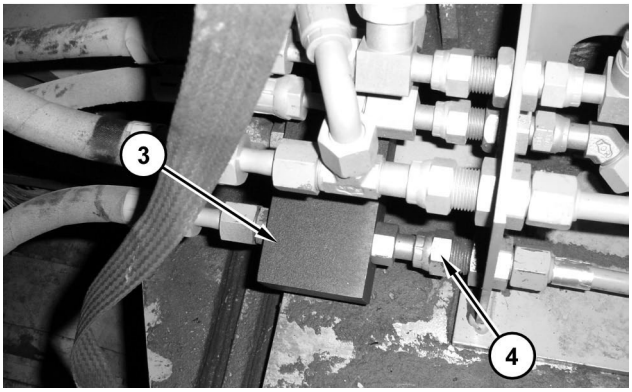


Illustration 385 g01238423

1. Disconnect hose assemblies (1) and adapter fitting (4). Remove bolts (2) and relief valve assembly (3).

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

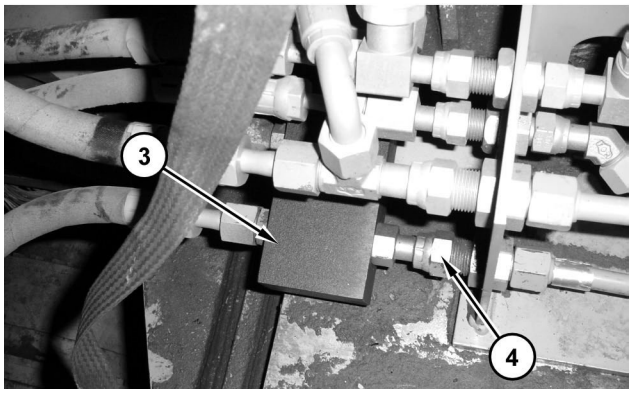


Illustration 386 g01238423

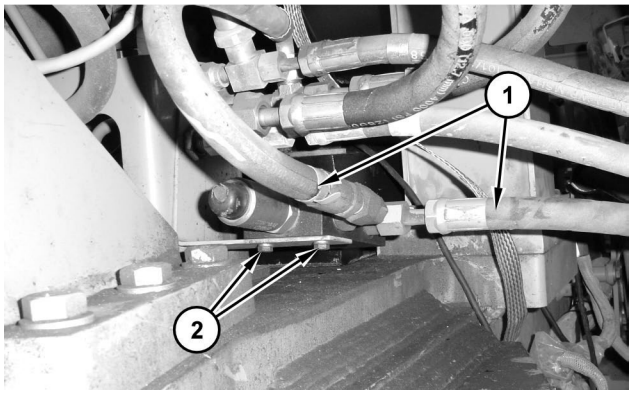


Illustration 387 g01238420

1. Position relief valve assembly (3) and install bolts (2). Connect adapter fitting (4) and hose assemblies (1).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02478956

Brake Control Valve (Service) - Remove and Install

SMCS Code: 4265-010

Removal Procedure

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , “ Hydraulic System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

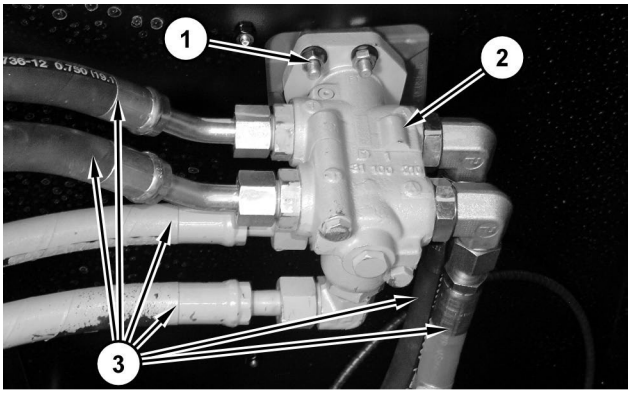


Illustration 388 g01238181

1. Disconnect hose assemblies (3). Remove nuts (1). Remove brake control valve (2).

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

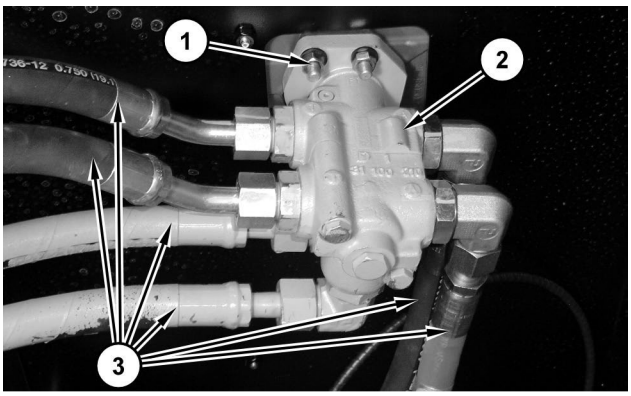


Illustration 389 g01238181

1. Position brake control valve (2) and install nuts (1). Connect hose assemblies (3).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02478957

Brake Control Valve (Parking) - Remove and Install

SMCS Code: 4282-010

Removal Procedure

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly , “ Hydraulic System Pressure - Release”.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

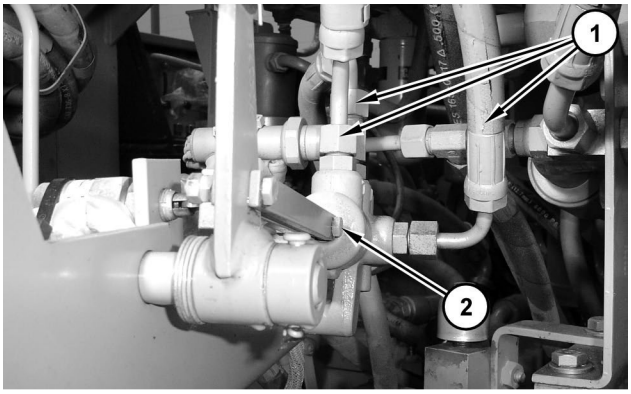


Illustration 390 g01238179

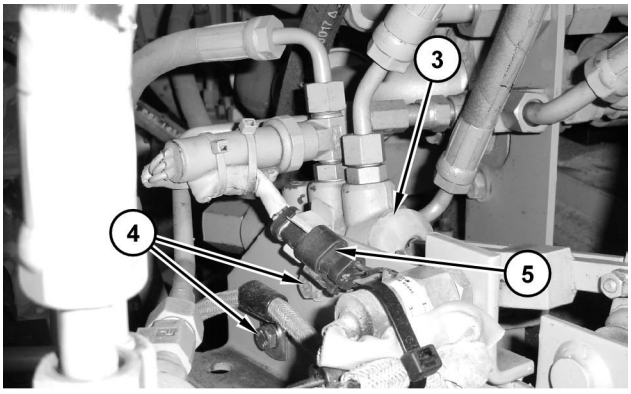


Illustration 391 g01238180

1. Disconnect hose assemblies (1). Remove bolt (2). Disconnect harness assemblies (5). Remove bolts (4) and brake control valve (3).

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

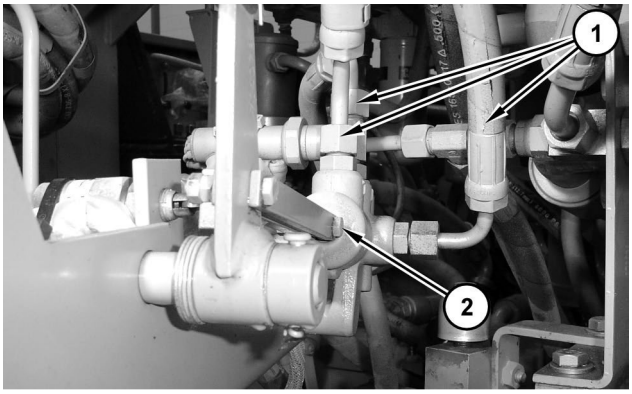


Illustration 392 g01238179

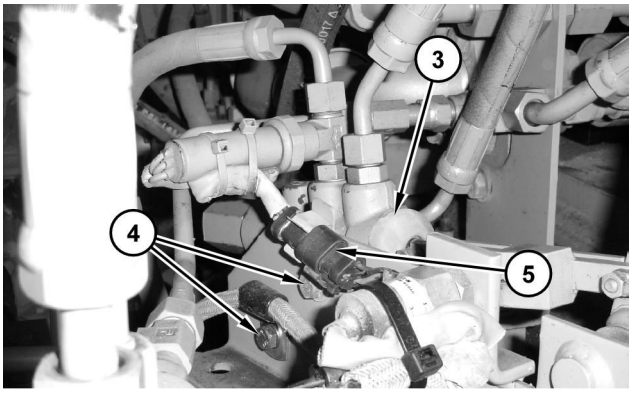


Illustration 393 g01238180

1. Position brake control valve (3) and install bolts (4). Connect harness assemblies (5). Connect hose assemblies (1) and install bolt (2).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02517418

Parking Brake - Remove

SMCS Code: 4267-011

Removal Procedure

Table 18

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	FT-2468	Threaded Rod	2
C	138-7574	Link Bracket	6
D	1U-9200	Lever Puller Hoist	2

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the oil from the hydraulic oil tank into a suitable container for storage or proper disposal. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Brake) - Change”.

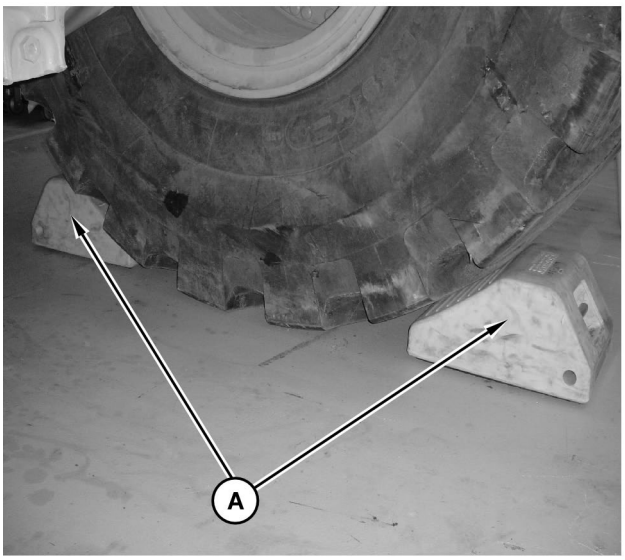


Illustration 394 g01243717

2. Install Tooling (A) in order to prevent any machine movement when the parking brake is released.

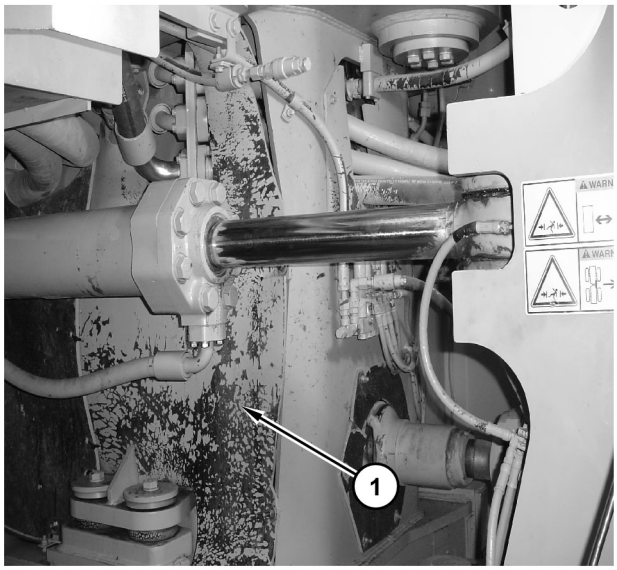


Illustration 395 g01259518

3. Remove sheet (1).

4. Repeat Step 3 for the opposite side.

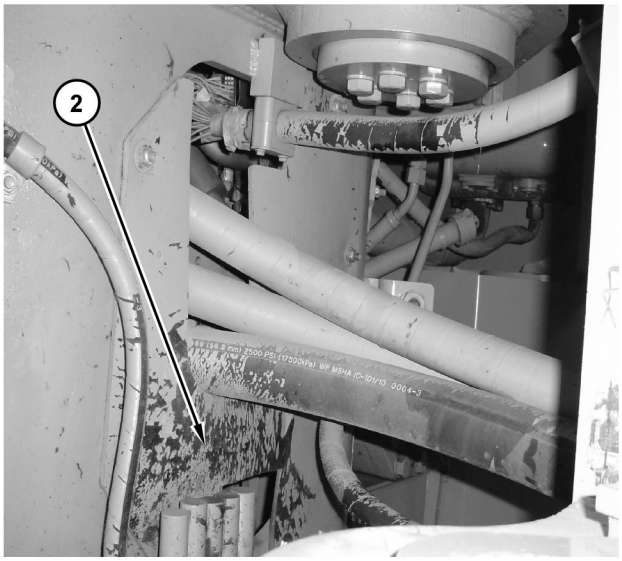


Illustration 396 g01259527

5. Remove sheet (2).

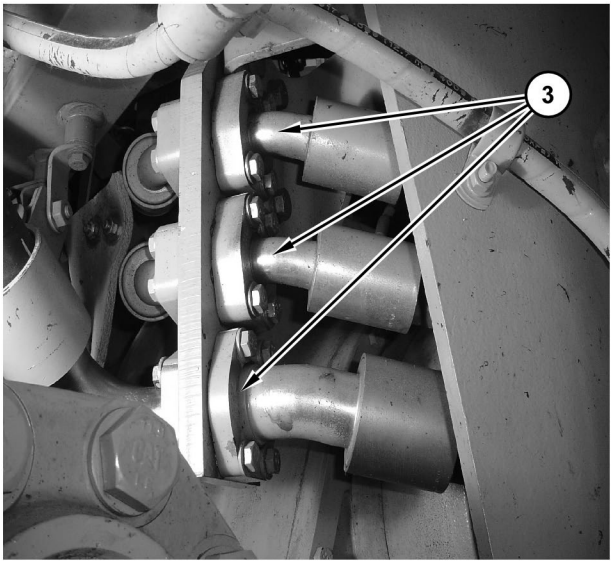


Illustration 397 g01243743

6. Remove hose assemblies (3).

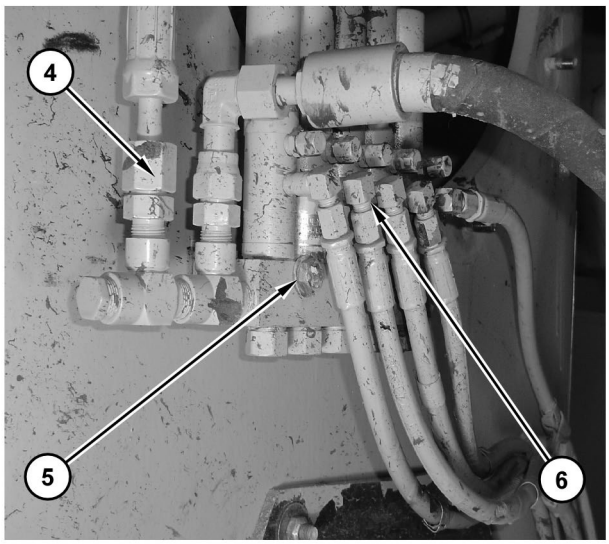


Illustration 398 g01243766

7. Disconnect hose assembly (4). Remove bolts (5) and the spacers. Position valve assembly (6) out of the way.

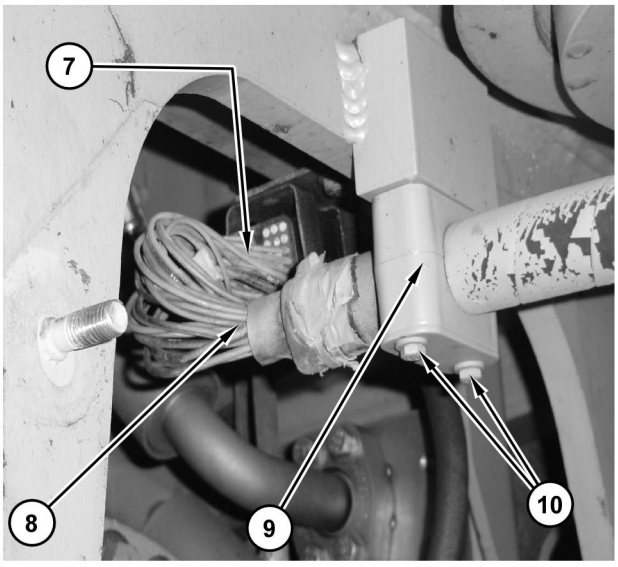


Illustration 399 g01243771

8. Loosen bolt (7). Disconnect harness assembly (8). Remove bolts (10) and clamp (9). Position harness assembly (8) out of the way.

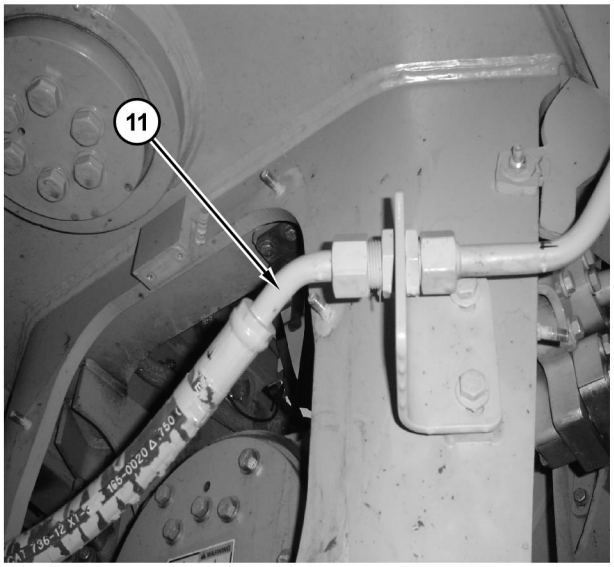


Illustration 400 g01243863

9. Disconnect hose assembly (11).

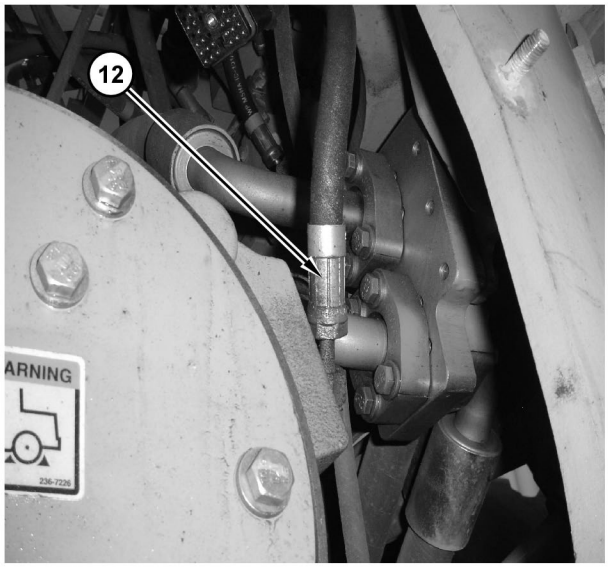


Illustration 401 g01243883

10. Disconnect hose assembly (12).

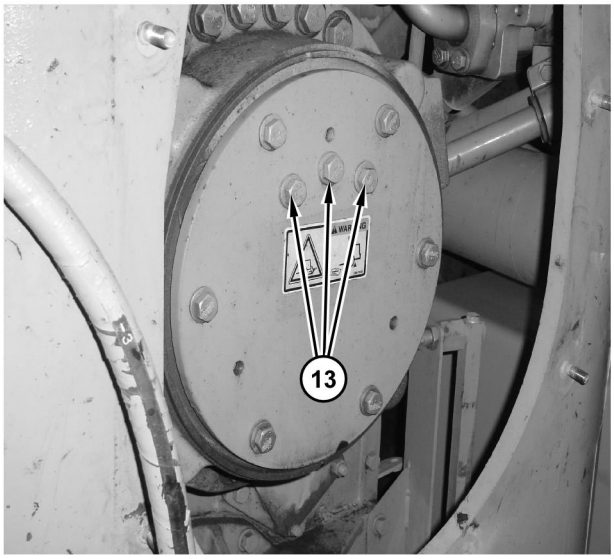


Illustration 402 g01243889

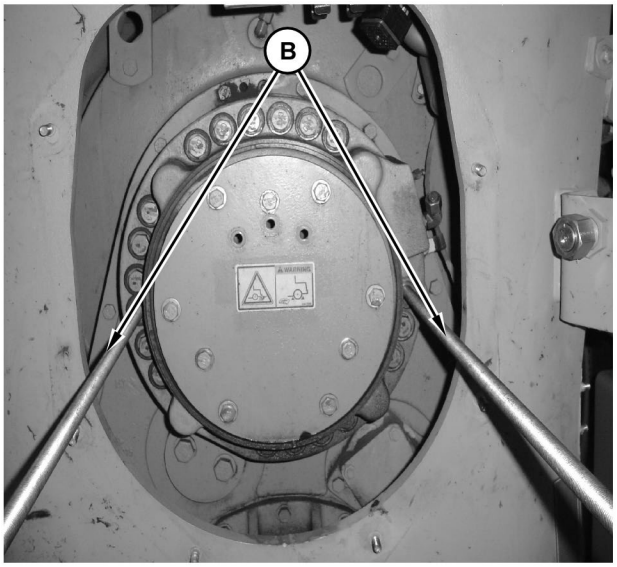


Illustration 404 g01243943

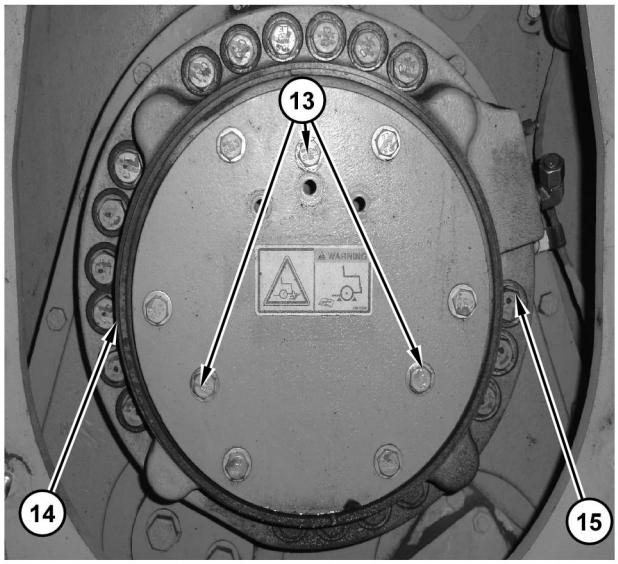


Illustration 403 g01243898

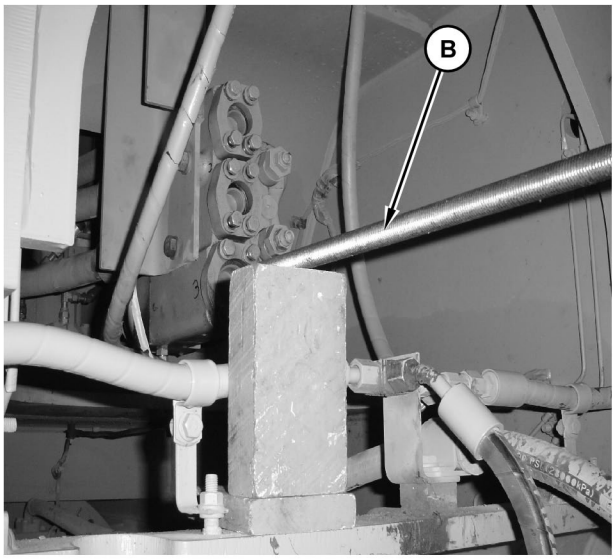


Illustration 405 g01243944

11. Remove bolts (13). Install bolts (13) into a different location in order to release the parking brake. Remove bolts (14) and (15).

12. Install Tooling (B) into the bolt holes from bolts (14) and (15). Use a suitable block in order to support the opposite end of Tooling (B).

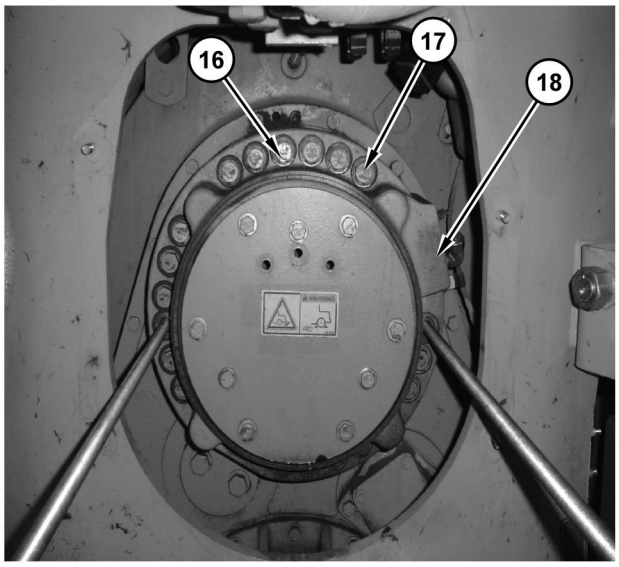


Illustration 406 g01243989

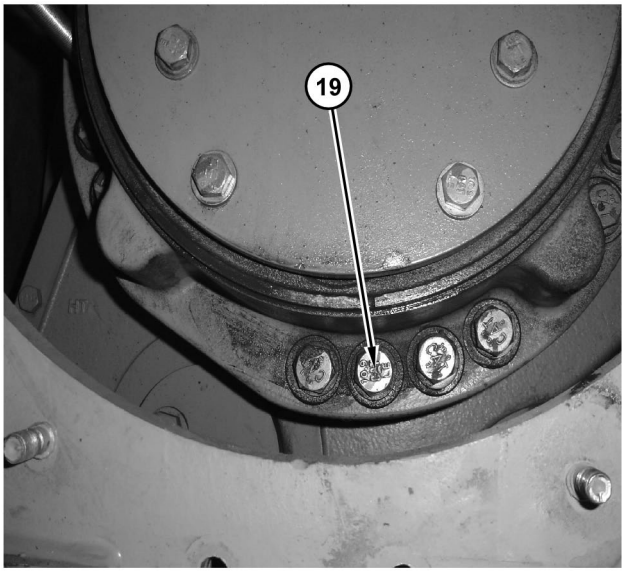


Illustration 407 g01243991

13. Do not remove bolts (16) and (19). Bolts (16) and (19) secure the parking brake assembly together. Bolts (16) and (19) are identified by the notches in the housing. Remove bolts (17) and fitting (18).

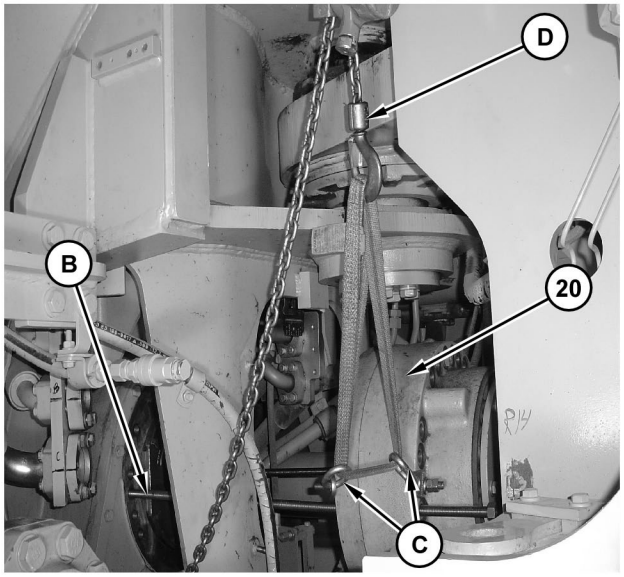


Illustration 408 g01244000

14. Retract parking brake assembly (20) on Tooling (B) for a distance of 508 mm (20.0 inch). Attach Tooling (C) to parking brake assembly (20). Attach Tooling (D) and a suitable lifting device to Tooling (C) and the machine structure. Repeat the use of Tooling (D) and Tooling (C) on the opposite side of the machine. The weight of parking brake assembly (20) is approximately 168 kg (370 lb).

15. Use Tooling (D) and Tooling (C) in order to support parking brake assembly (20). This will relieve weight from Tooling (B). Remove Tooling (B).

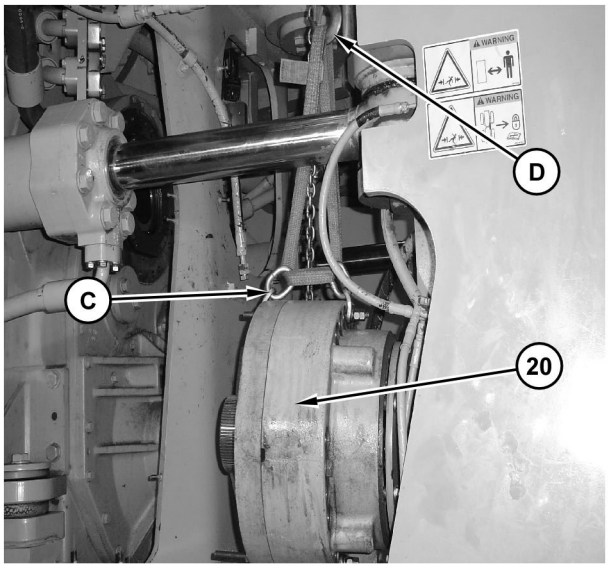


Illustration 409 g01244004

16. Carefully releaseone Tooling (D) in order to position parking brake assembly (20) under the steering cylinder.

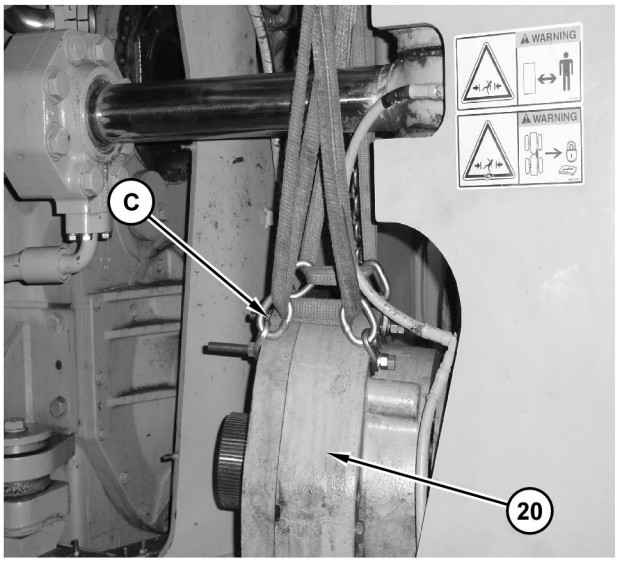


Illustration 410 g01244005

17. Attach Tooling (C) and a suitable lifting device to parking brake assembly (20). The weight of parking brake assembly (20) is approximately 168 kg (370 lb). Remove parking brake assembly (20).

i02517748

Parking Brake - Disassemble

SMCS Code: 4267-015

Disassembly Procedure

Table 19

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0074	Slide Hammer Puller	1
B	8B-7557	Adapter	1

Start By:

a. Remove the parking brake. Refer to Disassembly and Assembly, “Parking Brake - Remove”.

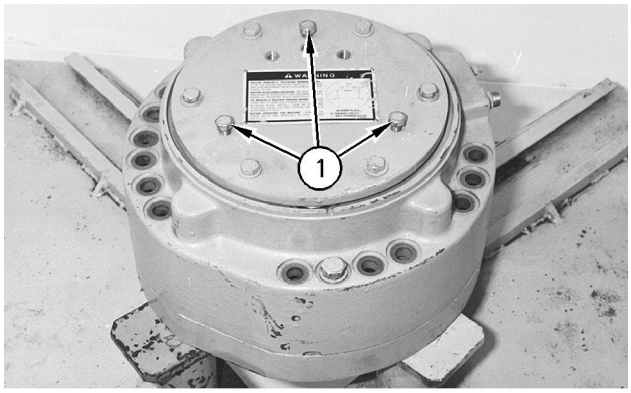


Illustration 411 g00350733

1. Remove bolts (1) that are used to disengage the parking brake.

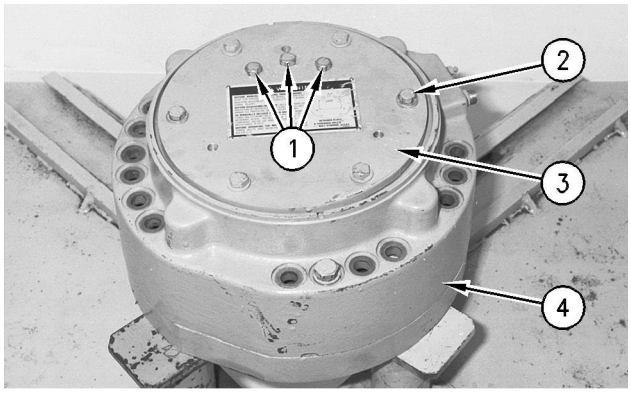


Illustration 412 g00351073

2. Install bolts (1) in the holes, as shown. Remove bolts (2) and the washers evenly.

3. Remove retaining plate (3) from brake housing (4).

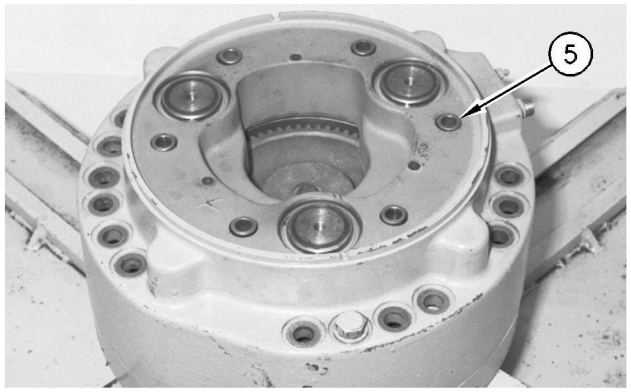


Illustration 413 g00375378

4. Remove spacers (5) from the brake housing.

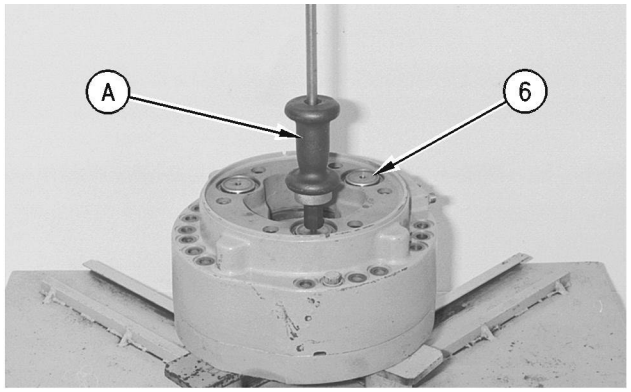


Illustration 414 g00375379

5. Use Tooling (A) and Tooling (B) in order to remove pistons (6) from the brake housing.

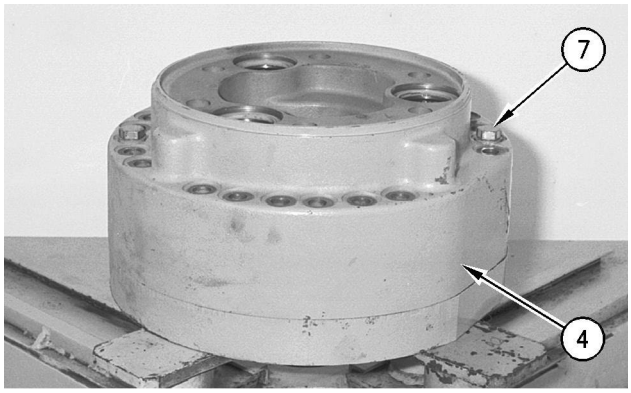


Illustration 415 g00375380

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

6. Loosen bolts (7) evenly until the spring tension against brake housing (4) is released. Then remove bolts (7) and the washers.

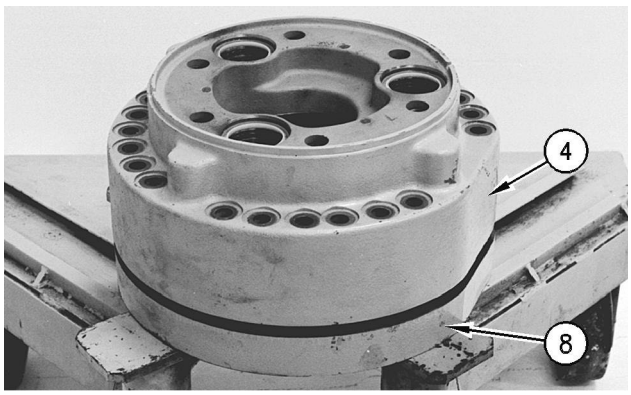


Illustration 416 g00375381

7. Use two persons to lift brake housing (4) off bearing cage assembly (8). The weight of brake housing (4) is approximately 41 kg (90 lb).

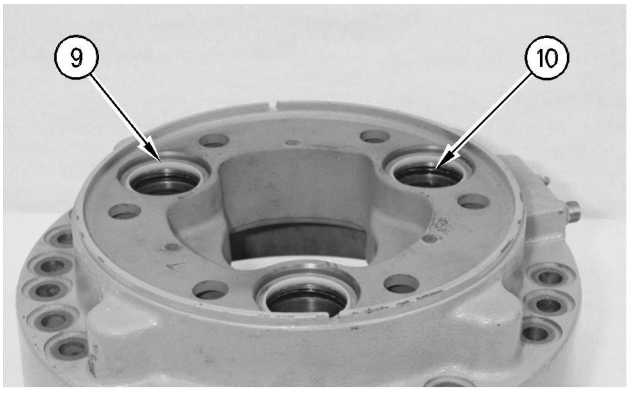


Illustration 417 g00375384

8. Remove lip seals (9) and O-ring seals (10).

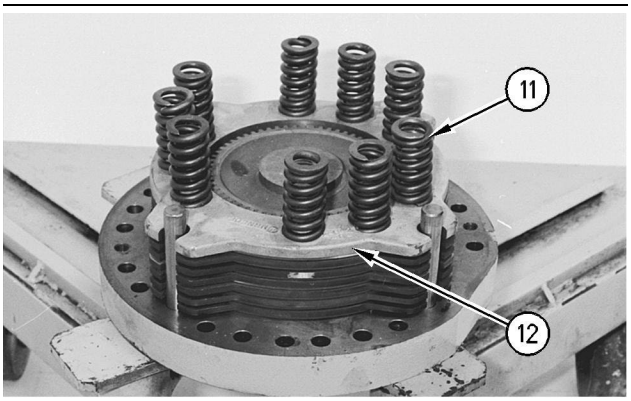


Illustration 418 g00375385

9. Remove springs (11) from pressure plate (12).

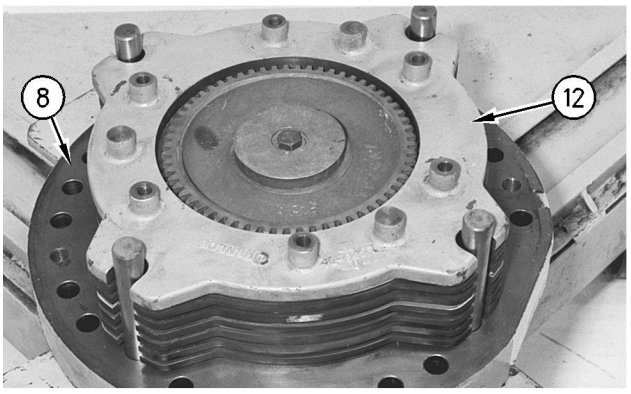


Illustration 419 g00375387

10. Remove pressure plate (12) from bearing cage assembly (8).

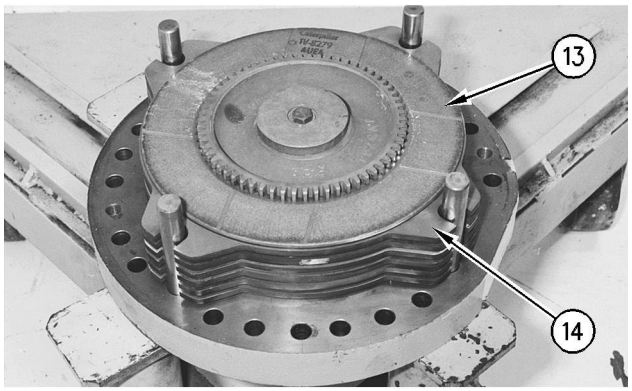


Illustration 420 g00375388

11. Remove brake discs (13) and clutch plates (14).

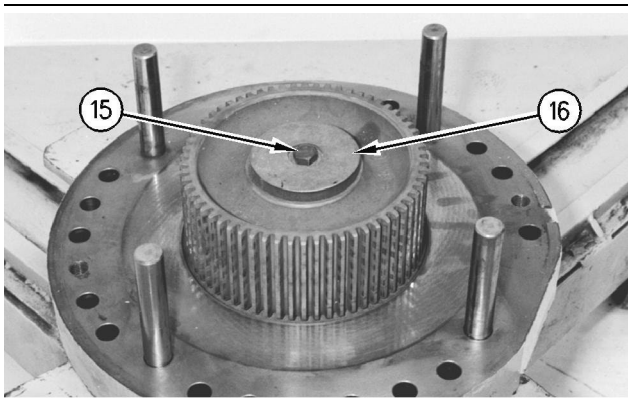


Illustration 421 g00375389

12. Remove bolt (15) and retainer (16) from the brake shaft.

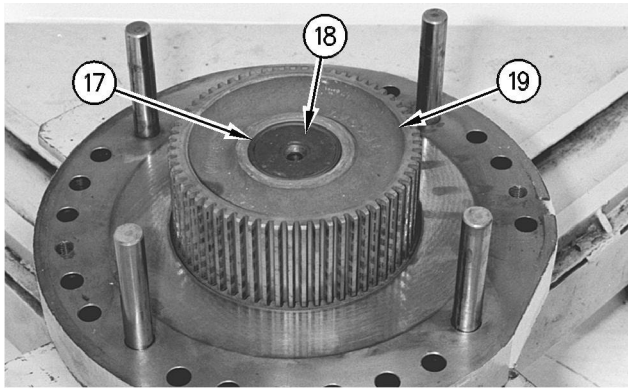


Illustration 422 g00375390

13. Remove seal (17) and hub (19) from brake shaft (18).

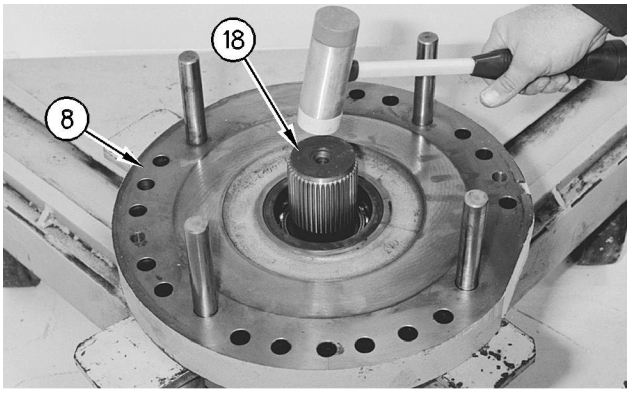


Illustration 423 g00375391

14. Use a rubber mallet to tap brake shaft (18) out of the bottom side of bearing cage assembly (8).

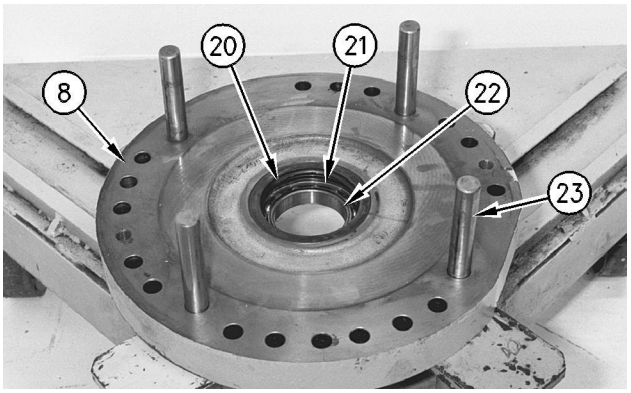


Illustration 424 g00375412

15. Remove lip seal (20), ring (21) and bearing (22) from bearing cage assembly (8).

16. If necessary, remove dowels (23).

i07352468

Parking Brake - Assemble

SMCS Code: 4267-016

Assembly Procedure

Table 20

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0074	Slide Hammer Puller Gp	1
B	8B-7557	Threaded Adapter	1
C	1P-0520	Driver Gp	1

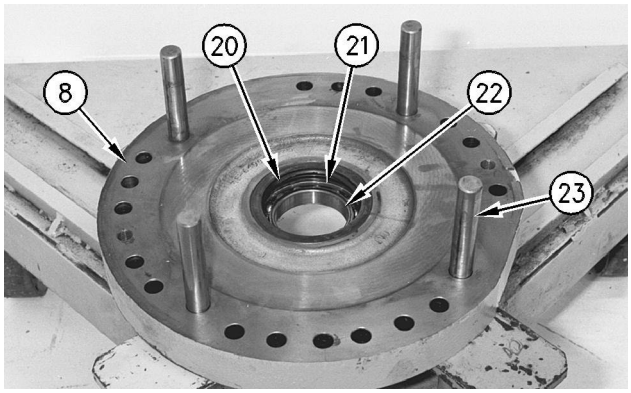


Illustration 425 g00375412

1. Use Tooling (C) to install bearing (22), ring (21), and lip seal (20) in bearing cage assembly (8).

2. If dowels (23) were removed, install the dowels.

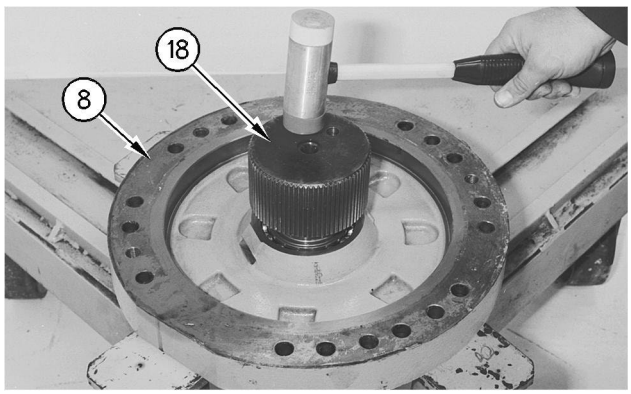


Illustration 426 g00379915

3. Turn bearing cage assembly (8) onto the opposite side. Use a rubber mallet to install brake shaft (18).

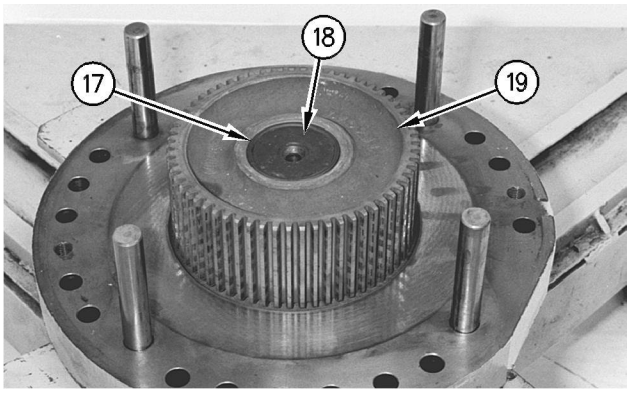


Illustration 427 g00375390

4. Turn the bearing cage assembly onto the opposite side. Install hub (19) and seal (17) on brake shaft (18).

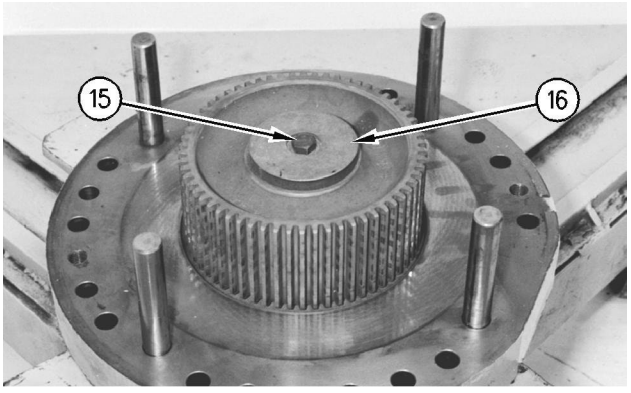


Illustration 428 g00375389

5. Install retainer (16) and bolt (15) on the brake shaft. Tighten bolt (15) to a torque of 105 ± 20 N·m (78 ± 15 lb ft).

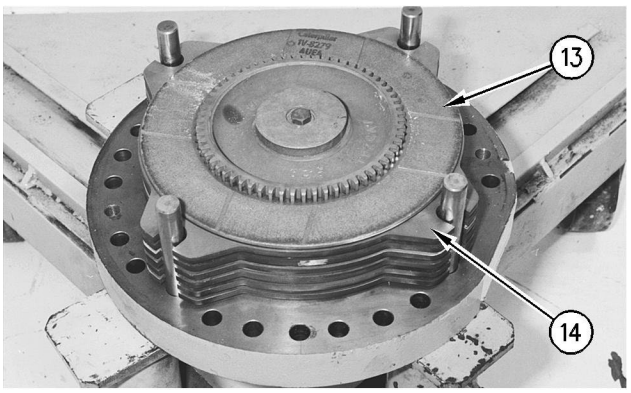


Illustration 429 g00375388

6. Install friction discs (13) and clutch plates (14) in alternating order. Start with a friction disc.

Note: BXY00435–UP and BTW00177–UP have more clutch plates than friction discs. For these machines start with a clutch plate.

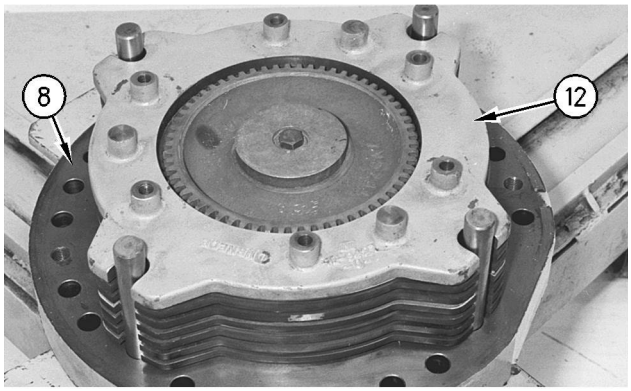


Illustration 430 g00375387

7. Install pressure plate (12) on bearing cage assembly (8).

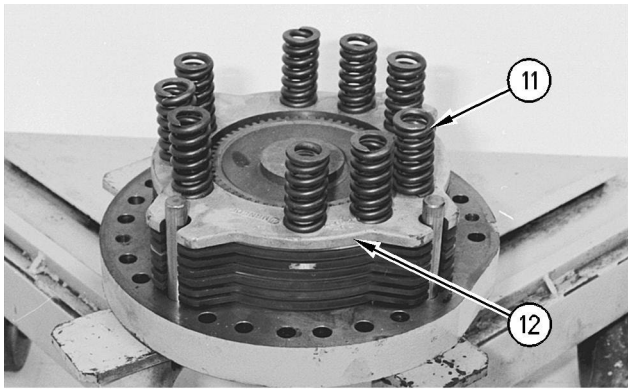


Illustration 431 g00375385

8. Install springs (11) on pressure plate (12).

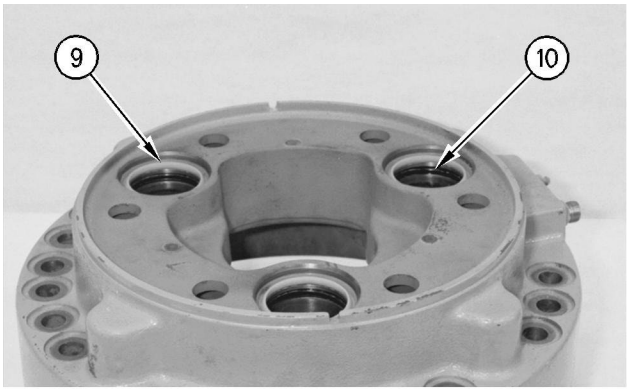


Illustration 432 g00375384

9. Install O-ring seals (10) and lip seals (9) in the bores of the brake housing.

Note: Lip seals (9) must contact the counterbore in the brake housing. Make sure that the sealing lips are facing outward. Lubricate the sealing lip with the lubricant that is being sealed.

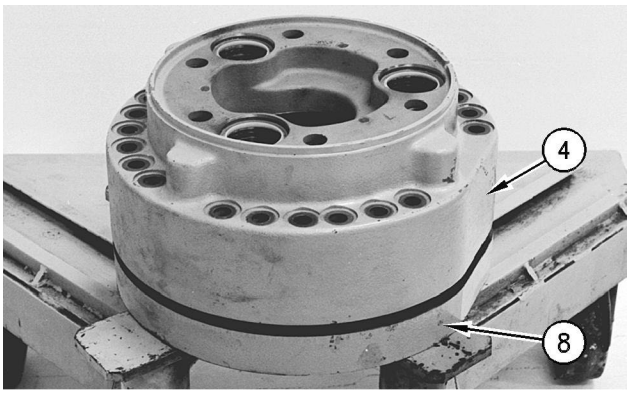


Illustration 433 g00375381

10. Use two persons to lift brake housing (4) onto bearing cage assembly (8). The weight of brake housing (4) is approximately 41 kg (90 lb).

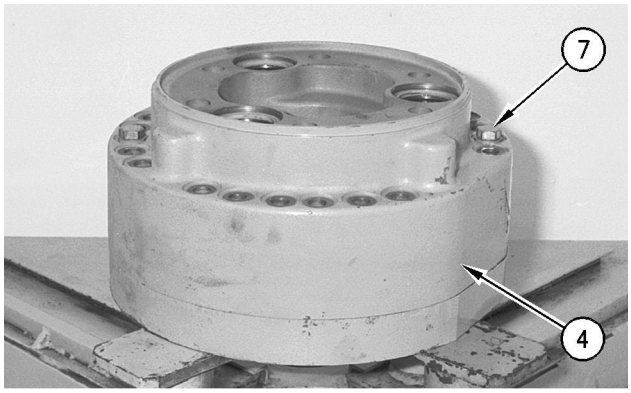


Illustration 434 g00375380

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

11. Install the washers and bolts (7) in brake housing (4). Tighten bolts (7) evenly to a torque of 270 ± 40 N·m (200 ± 30 lb ft).

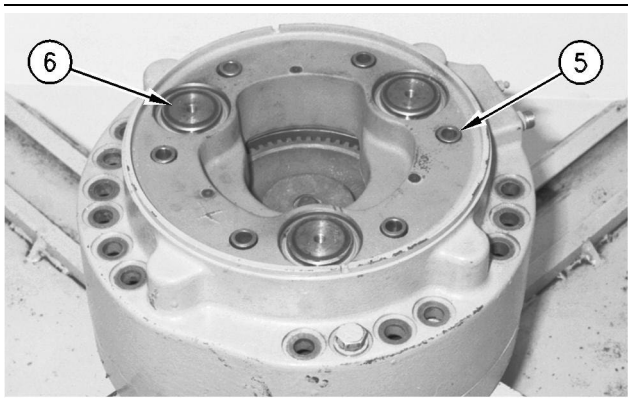


Illustration 435 g00380075

12. Lubricate pistons (6) lightly with the lubricant that is being sealed. Use Tooling (A) and Tooling (B) to install pistons (6) in the brake housing.

13. Install spacers (5) in the brake housing.

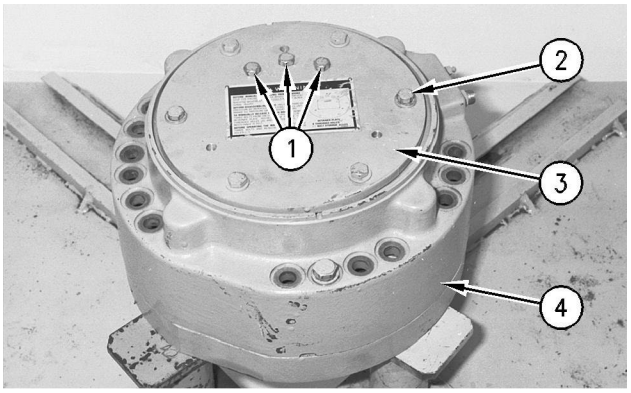


Illustration 436 g00351073

14. Install retaining plate (3) on brake housing (4).

15. Install the washers and bolts (2) that secure retaining plate (3) to brake housing (4). Tighten the bolts (2) evenly to a torque of 105 ± 20 N·m (78 ± 15 lb ft).

16. Remove bolts (1).

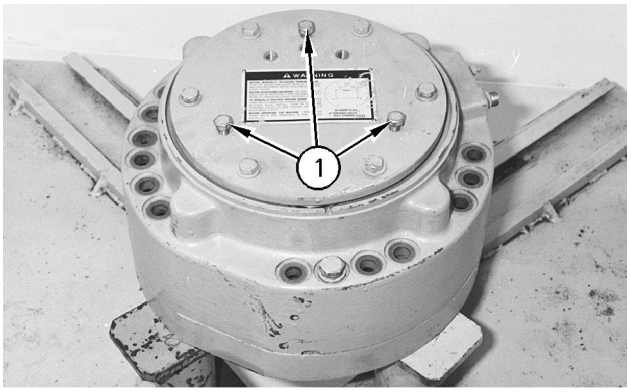


Illustration 437 g00350733

17. Install bolts (1) into a different location. Bolts (1) are used to disengage the parking brake.

End By:

a. Install the parking brake. Refer to Disassembly and Assembly, “Parking Brake - Install”.

i02517458

Parking Brake - Install

SMCS Code: 4267-012

Installation Procedure

Table 21

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	155-3597	Wheel Chock	2
B	FT-2468	Threaded Rod	2
C	138-7574	Link Bracket	6
D	1U-9200	Lever Puller Hoist	2

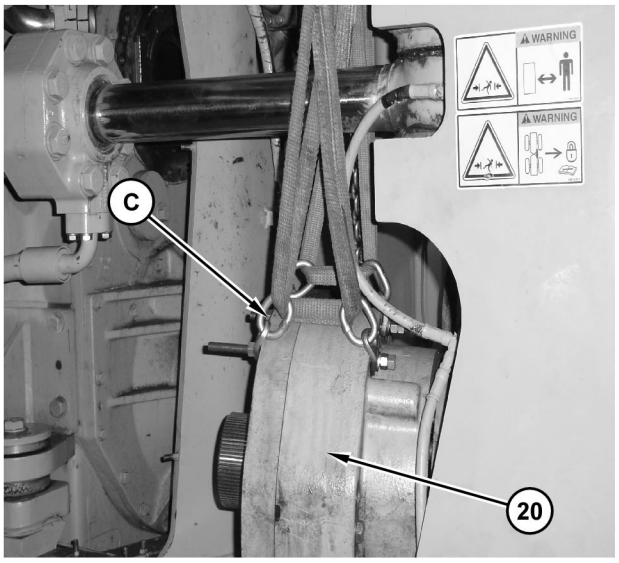


Illustration 438 g01244005

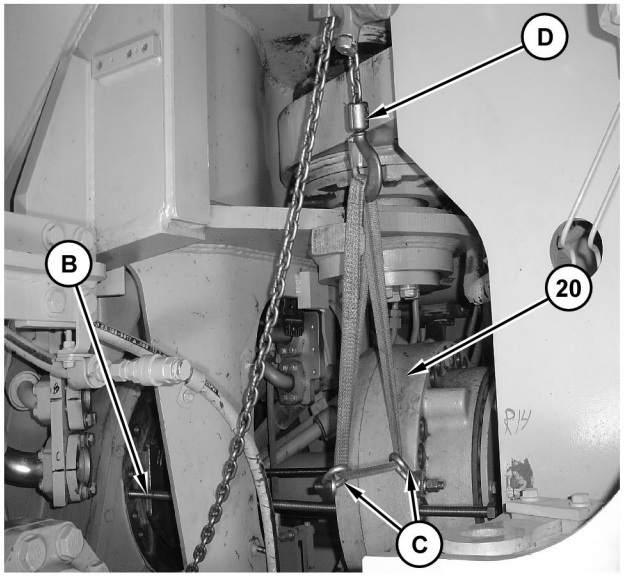


Illustration 439 g01244000

1. Attach Tooling (C) and a suitable lifting device to parking brake assembly (20). The weight of parking brake assembly (20) is approximately 168 kg (370 lb). Raise and position parking brake assembly (20) to the proper level. Attach Tooling (C) and Tooling (D) to parking brake assembly (20).

2. Carefully attach Tooling (C) and Tooling (D) in order to position parking brake assembly (20) under the steering cylinder.

3. Use Tooling (D) and Tooling (C) in order to support parking brake assembly (20). Install Tooling (B).

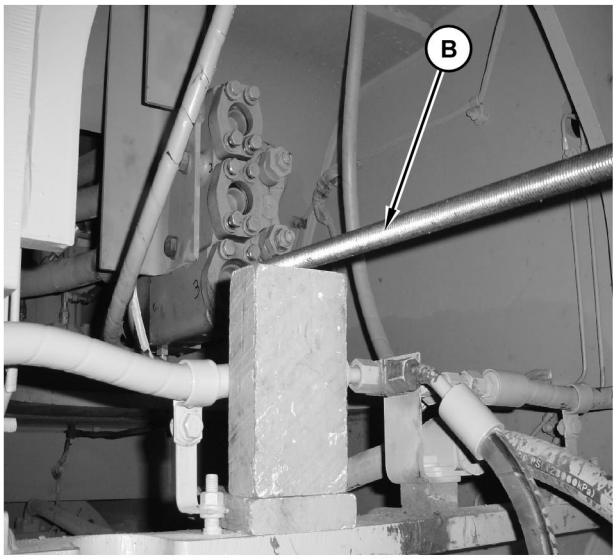


Illustration 440 g01243944

4. Support Tooling (B) with a suitable blocking.

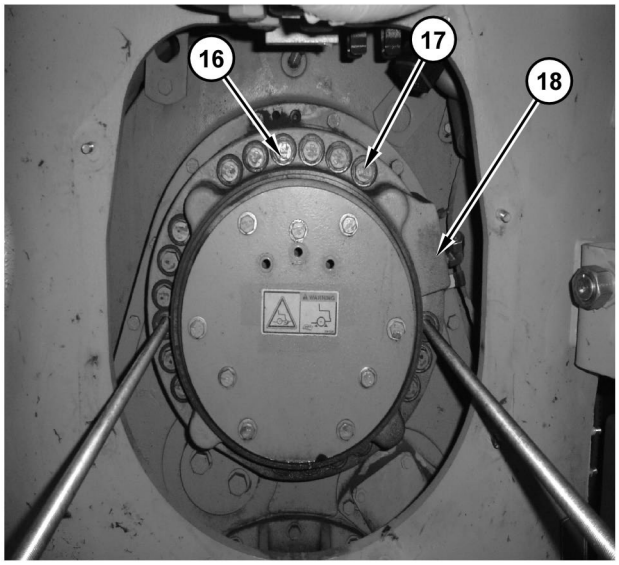


Illustration 441 g01243989

5. Position parking brake assembly (20) into the proper location. Install bolts (17) and fitting (18). Tighten bolts (17) to a torque of 270 ± 40 N·m (199 ± 30 lb ft).

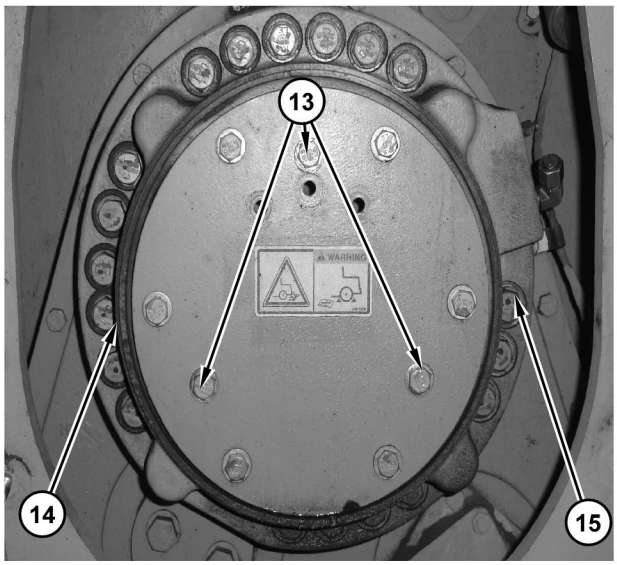


Illustration 442 g01243898

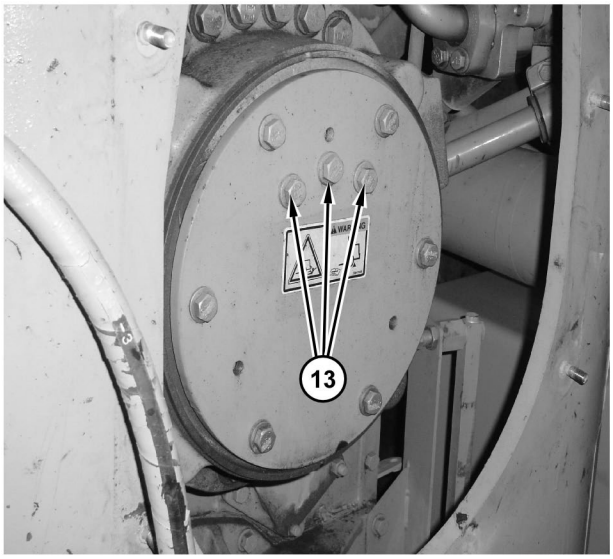


Illustration 443 g01243889

6. Remove Tooling (B). Install bolts (14) and (15). Remove bolts (13). Tighten bolts (14) and (15) to a torque of 270 ± 40 N·m (199 ± 30 lb ft). Install bolts (13) into a different location.

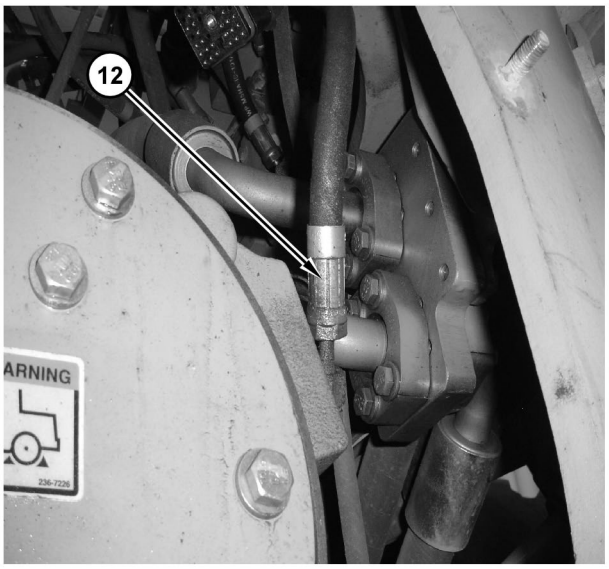


Illustration 444 g01243883

7. Connect hose assembly (12).

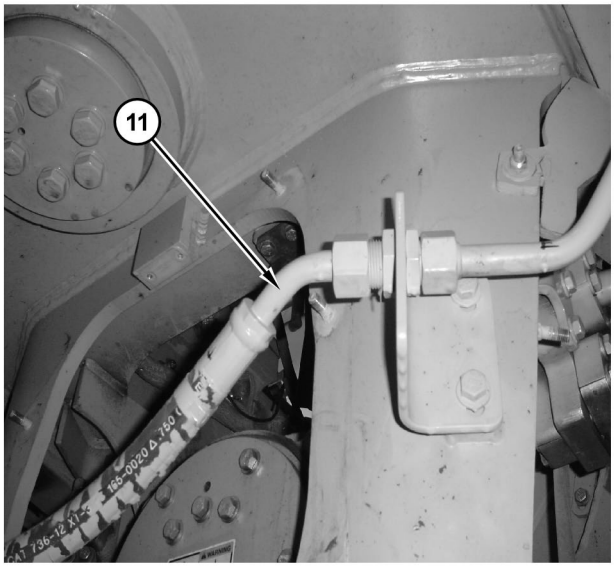


Illustration 445 g01243863

8. Connect hose assembly (11).

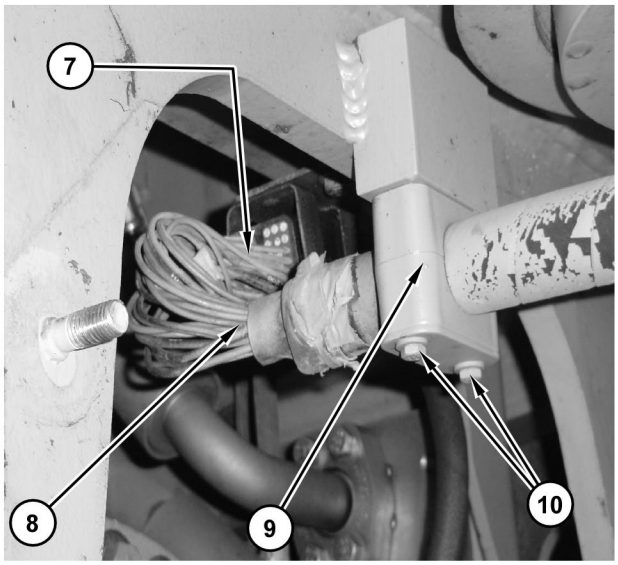


Illustration 446 g01243771

9. Connect harness assembly (8). Install clamp (9). Install bolts (10). Tighten bolt (7).

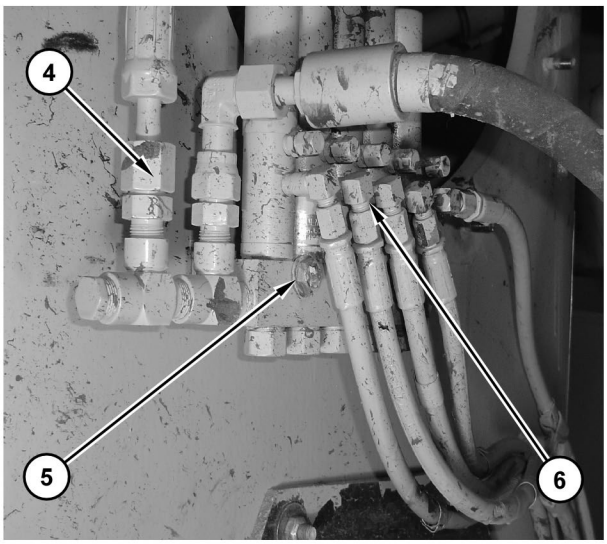


Illustration 447 g01243766

10. Install valve assembly (6) into position. Install bolts (5) and the spacers. Connect hose assembly (4).

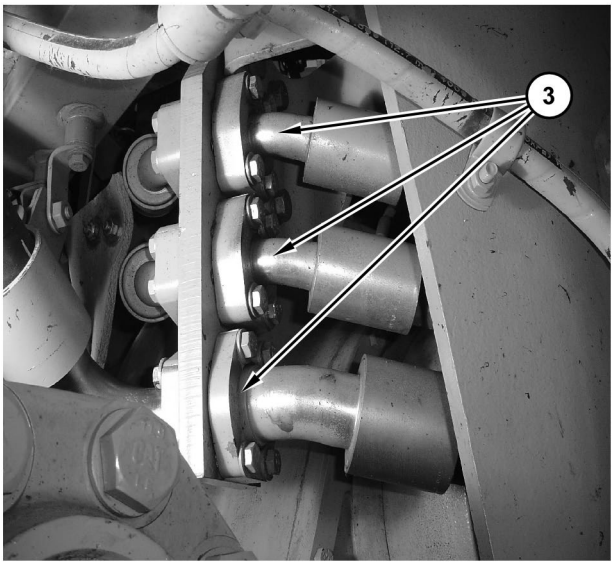


Illustration 448 g01243743

11. Install hose assemblies (3).

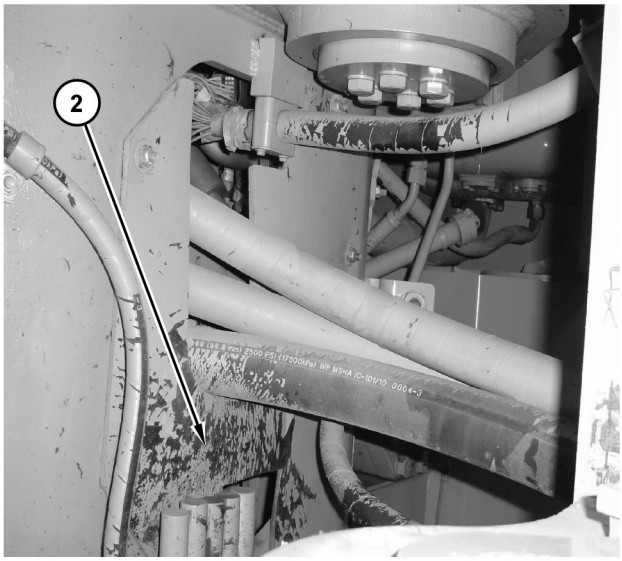


Illustration 449 g01259527

12. Install sheet (2).

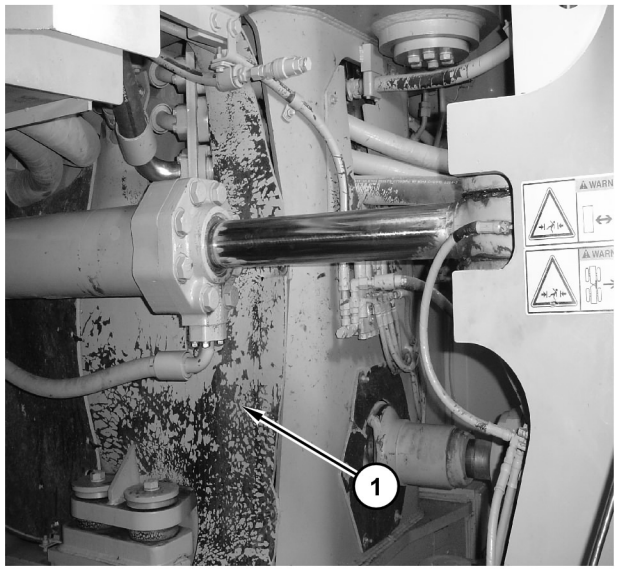


Illustration 450 g01243718

13. Install sheet (1).

14. Repeat Step 13 for the opposite side.

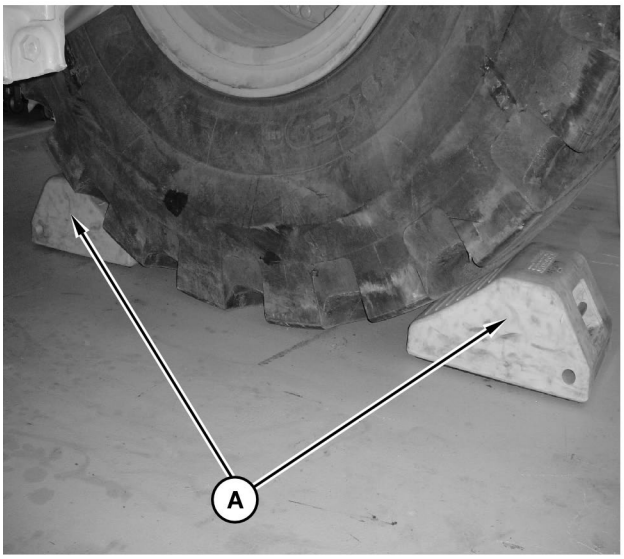


Illustration 451 g01243717

15. Remove Tooling (A) from the wheels of the machine.

16. Fill the hydraulic oil tank. Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Brake) - Change”.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02474032

Gear Pump (Pilot, Brake) - Remove

SMCS Code: 4014-011-GT; 5073-011-P&B

Removal Procedure

Start By:

a. Connect the steering frame lock link. Refer to Disassembly and Assembly Manual, “Steering Frame Lock - Connect”.

b. Release the system hydraulic pressure. Refer to Disassembly and Assembly Manual, “System Pressure - Release”.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses, and all tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the removal procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

1. Drain the implement and braking hydraulic oil. Refer to Operation and Maintenance Manual, “Hydraulic system Oil (Implement and Braking) - Change”. Drain the hydraulic oil in the steering and the hydraulic fan. Refer to Operation and Maintenance Manual, “Hydraulic system Oil (System and Hydraulic Fan) - Change”.

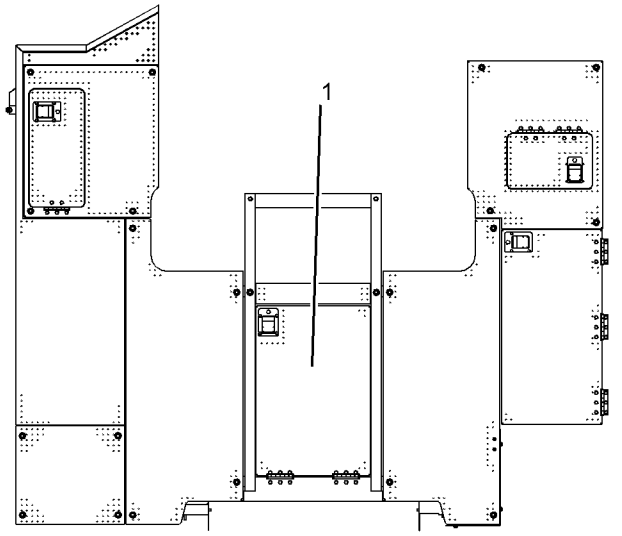


Illustration 452 g01234631

2. Open door assembly (1).

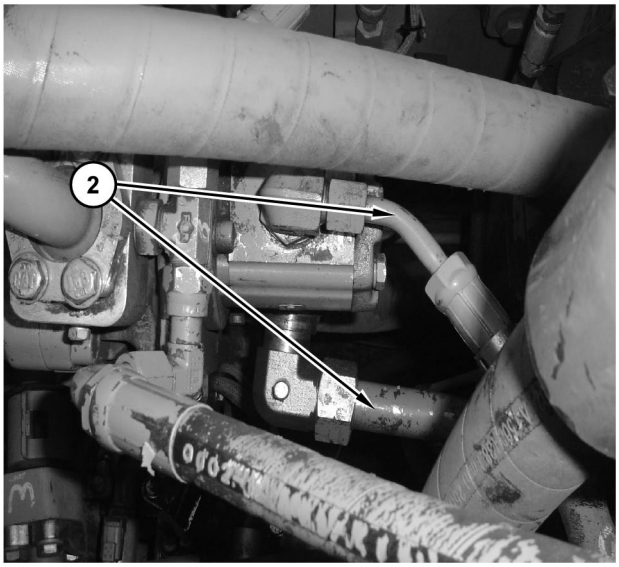


Illustration 453 g01234591

3. Disconnect hose assemblies (2).

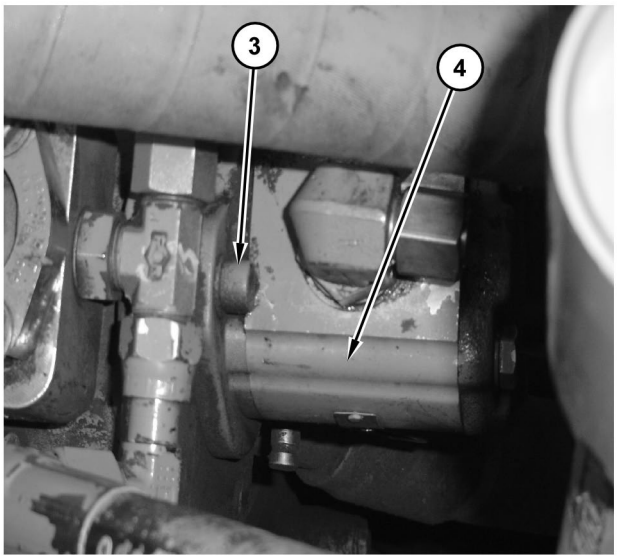


Illustration 454 g01234592

4. Remove bolts (3). Remove gear pump assembly (4).

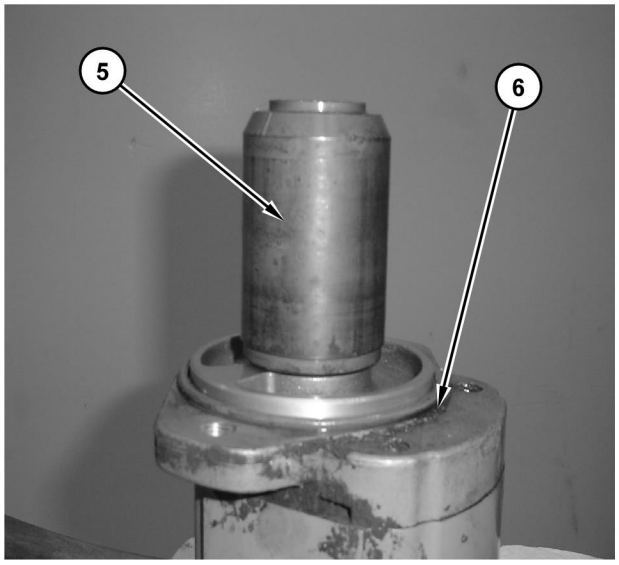


Illustration 455 g01234613

5. Remove coupling (5). Remove O-ring seal (6).

i02479978

Gear Pump (Pilot, Brake) - Disassemble

SMCS Code: 4014-015-GT; 5073-015-P&B

Disassembly Procedure

Table 22

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1857	Retaining Ring Pliers	1

Start By:

a. Remove the gear pump. Refer to Disassembly and Assembly, “Gear Pump (Pump, Brake) - Remove”.

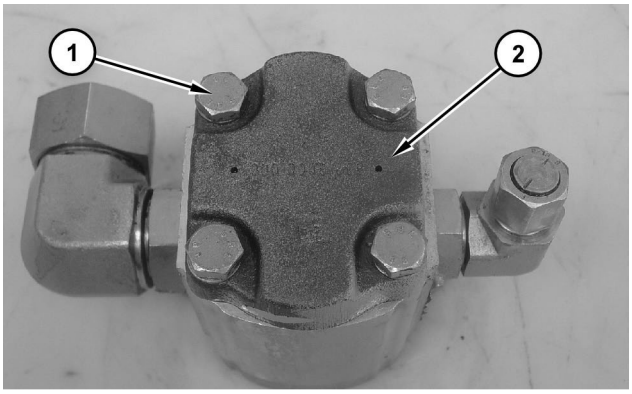


Illustration 456 g01238555

1. Remove bolts (1) and cover (2).

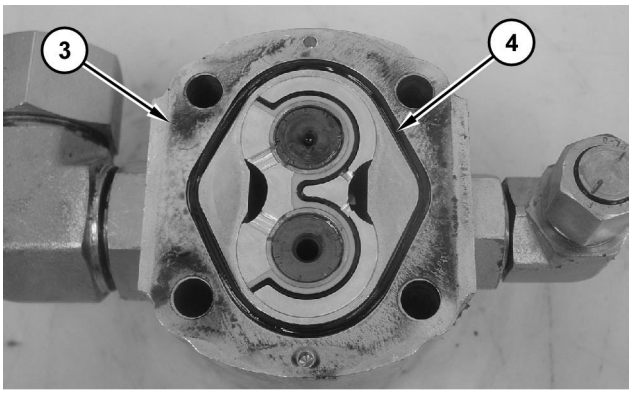


Illustration 457 g01238558

2. Remove housing (3) and O-ring seal (4).

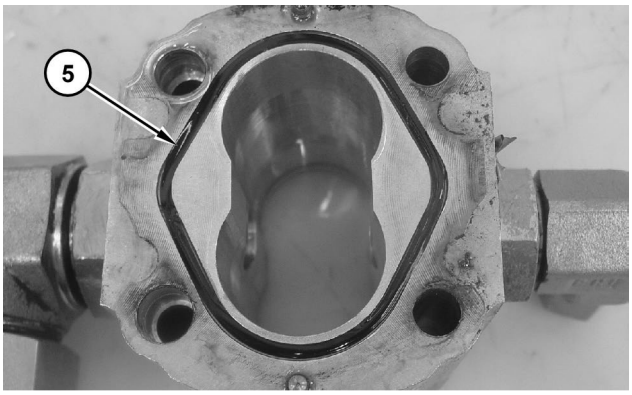


Illustration 458 g01238559

3. Remove O-ring seal (5).

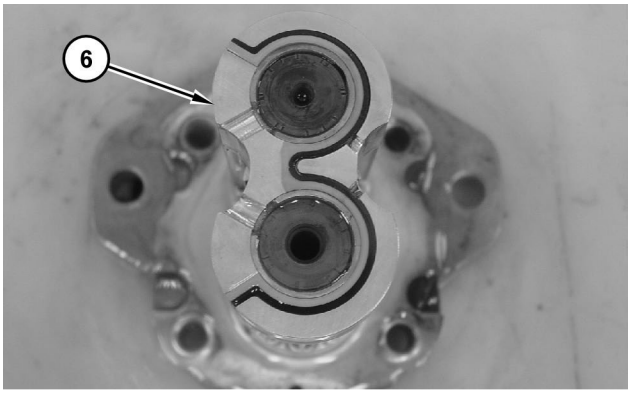


Illustration 459 g01238560

4. Remove bearing (6).

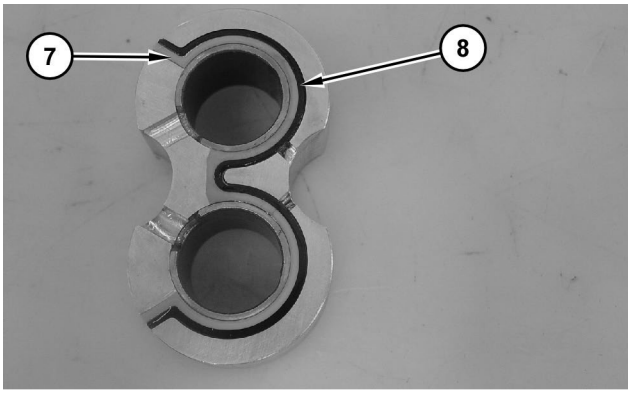


Illustration 460 g01238564

5. Remove seal (7) and seal (8).

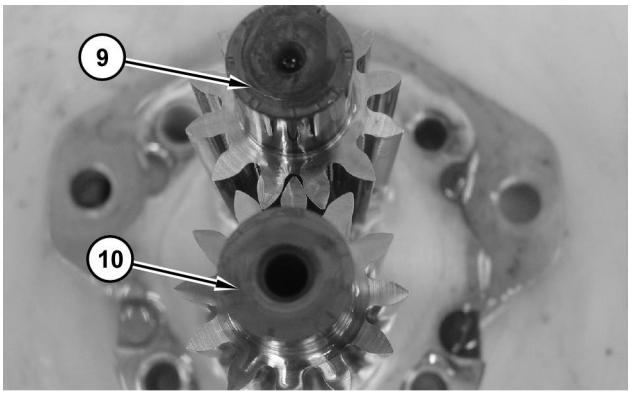


Illustration 461 g01238565

6. Remove gear (9) and gear (10).

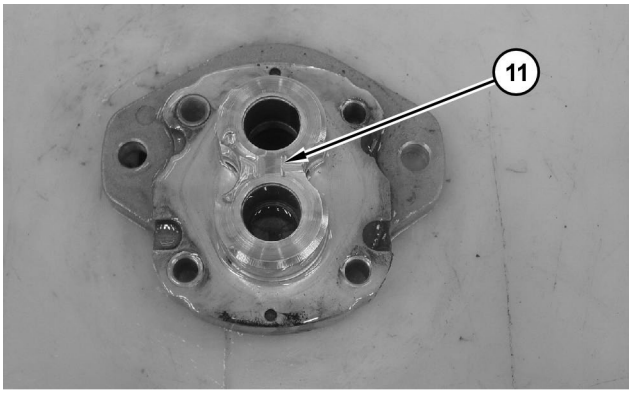


Illustration 462 g01238566

7. Remove bearing (11).

8. Repeat Step 1 from bearing (11).

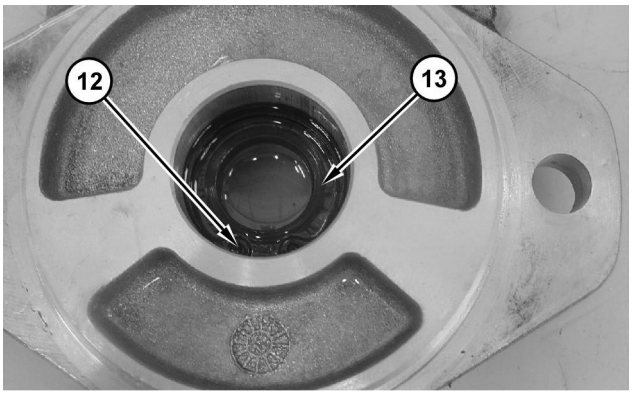


Illustration 463 g01238567

9. Use Tooling (A) in order to remove retaining ring (12).

10. Remove lip seal (13).

i02479980

Gear Pump (Pilot, Brake) - Assemble

SMCS Code: 4014-016-GT; 5073-016-P&B

Assembly Procedure

Table 23

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1857	Retaining Ring Pliers	1

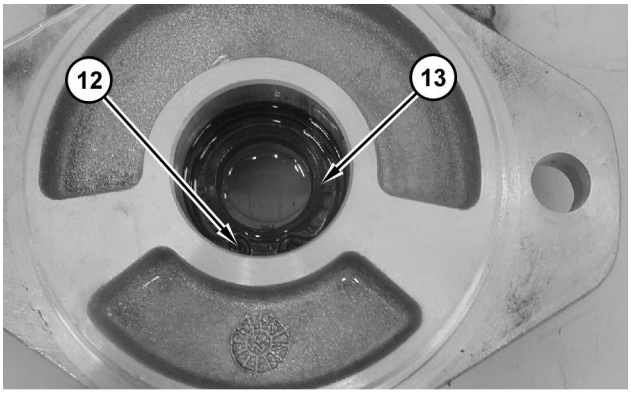


Illustration 464 g01238567

1. Install lip seal (13).

2. Use Tooling (A) in order to install retaining ring (12).

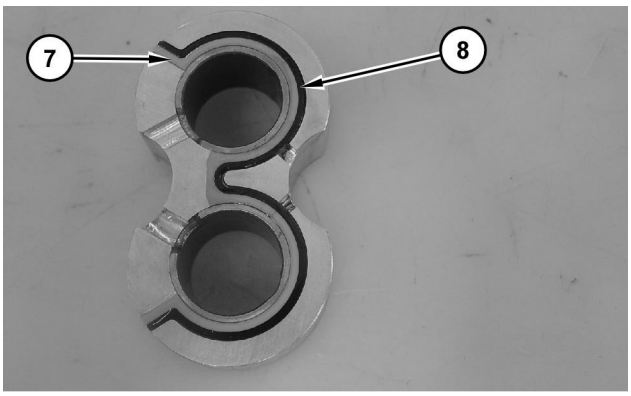


Illustration 465 g01238564

3. Install seal (7) and seal (8).

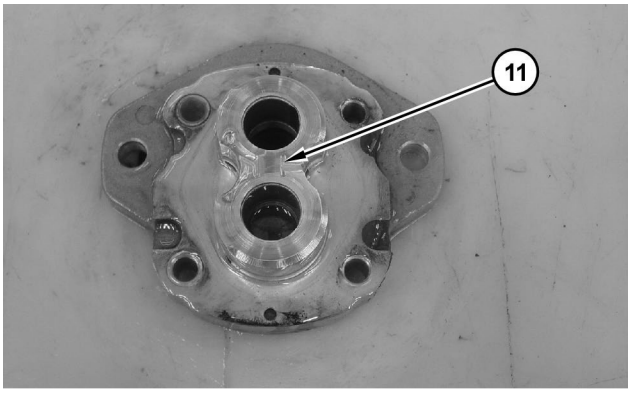


Illustration 466 g01238566

4. Install bearing (11).

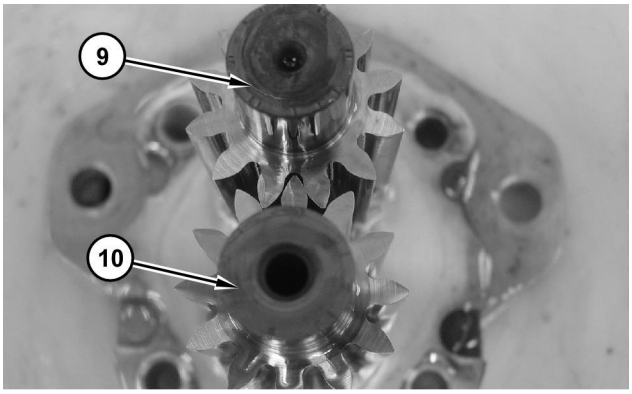


Illustration 467 g01238565

5. Install gear (9) and gear (10).

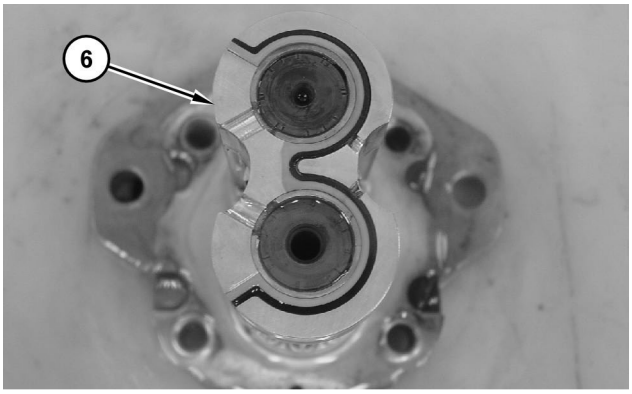


Illustration 468 g01238560

6. Install bearing (6).

7. Repeat Step 10 for bearing (6).

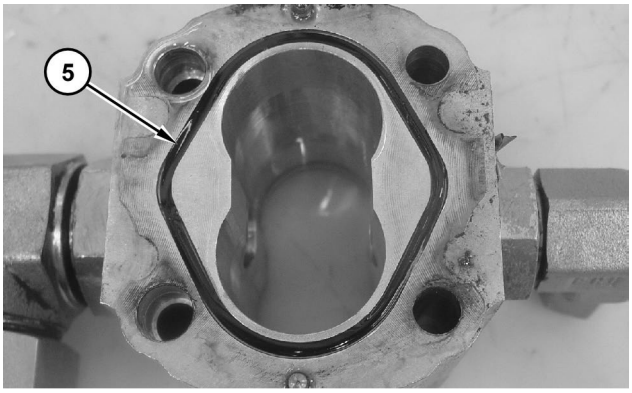


Illustration 469 g01238559

8. Install O-ring seal (5).

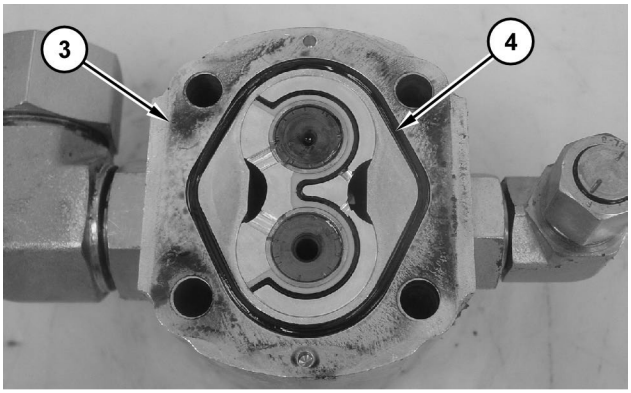


Illustration 470 g01238558

9. Install housing (3) and O-ring seal (4).

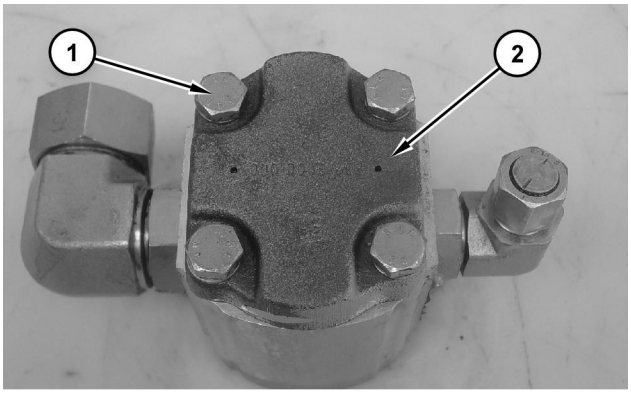


Illustration 471 g01238555

10. Install cover (2) and bolts (1).

End By:

a. Install the gear pump. Refer to Disassembly and Assembly, “Gear Pump (Pump, Brake) - Install”.

i02474603

Gear Pump (Pilot, Brake) - Install

SMCS Code: 4014-012-GT; 5073-012-P&B

Installation Procedure

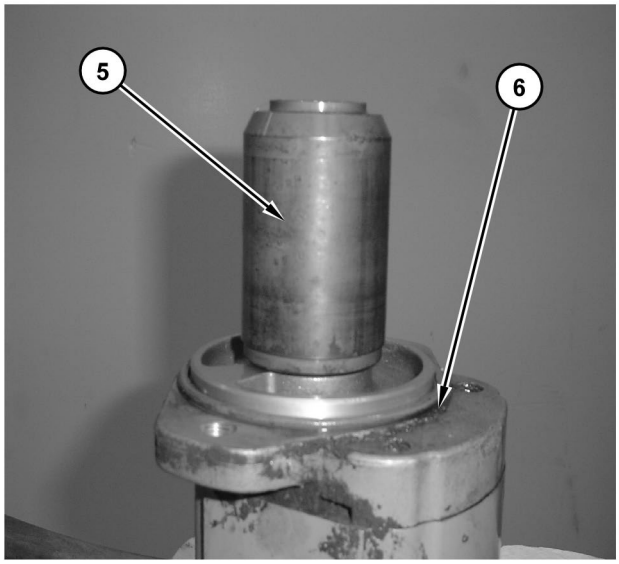


Illustration 472 g01234613

1. Install O-ring seal (6). Install coupling (5).

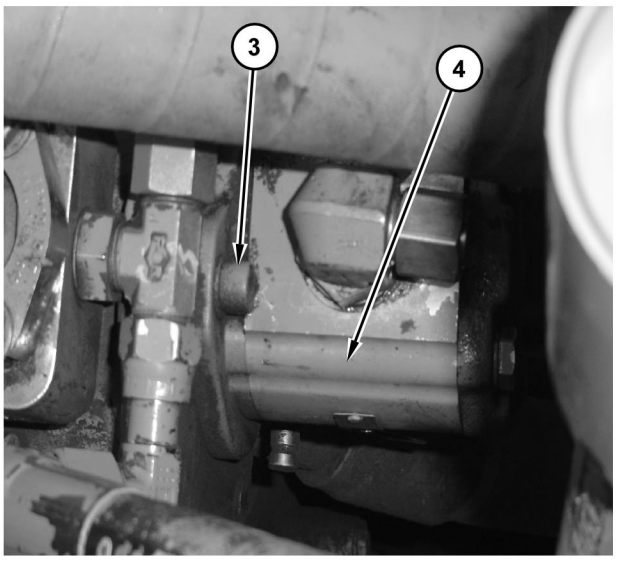


Illustration 473 g01234592

2. Install gear pump assembly (4). Install bolts (3).

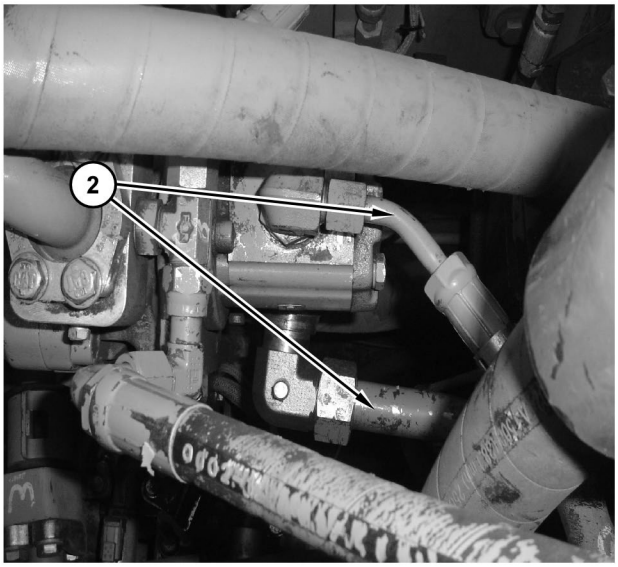


Illustration 474 g01234591

3. Connect hose assemblies (2).

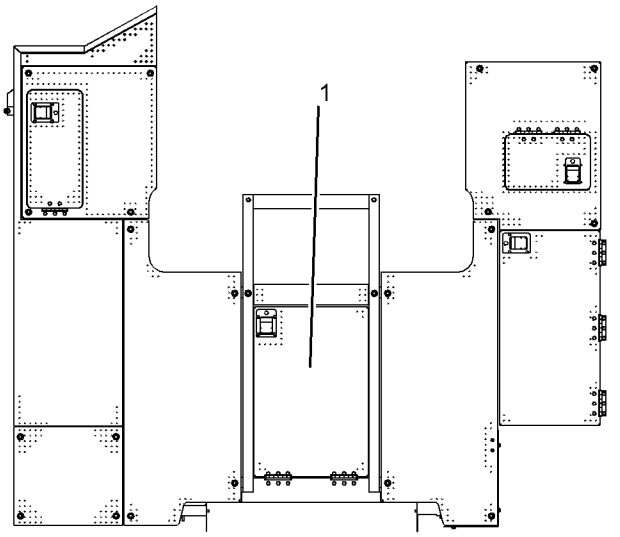


Illustration 475 g01234631

4. Close door assembly (1).

5. Fill the hydraulic oil to the proper level. Refer to Operation and Maintenance Manual, “Hydraulic system Oil (Implement and Braking) - Change”. Fill the hydraulic oil to the proper level. Refer to Operation and Maintenance Manual, “Hydraulic system Oil (System and Hydraulic Fan) - Change”.

End By:

a. Separate the steering frame lock link. Refer to Disassembly and Assembly Manual, “Steering Frame Lock - Separate ”.

i02512650

Vane Pump (Implement) - Remove

SMCS Code: 5055-011-II; 5084-011-VA

Removal Procedure

Start By:

a. Release the system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

b. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the oil from the hydraulic tank for the implement and the braking system into a suitable container for storage or disposal.

2. Drain the oil from the hydraulic tank for the steering system and for the hydraulic fan into a suitable container for storage or disposal.

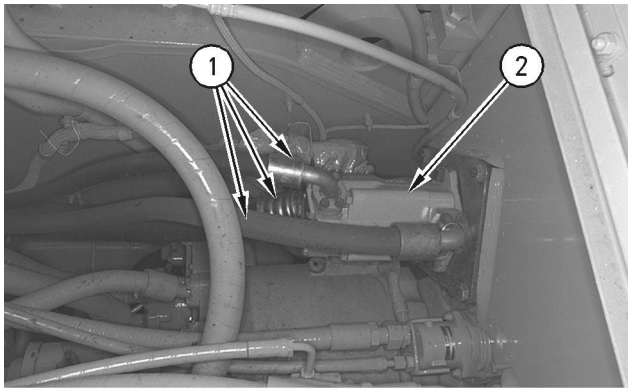


Illustration 476 g00882425

3. Disconnect hose assemblies (1) from vane pump (2).

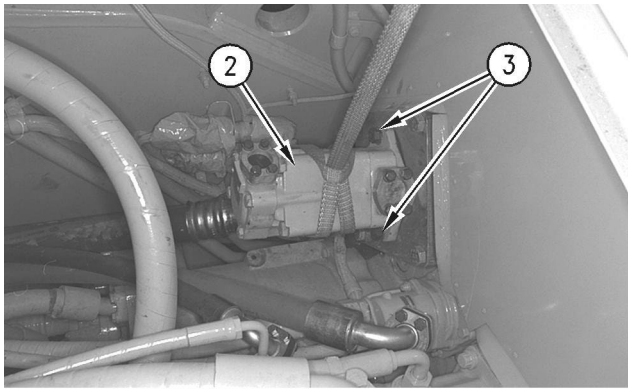


Illustration 477 g00882432

4. Attach a suitable lifting device to vane pump (2), as shown. The weight of vane pump (2) is approximately 36 kg (80 lb).

5. Remove two bolts (3) and vane pump (2).

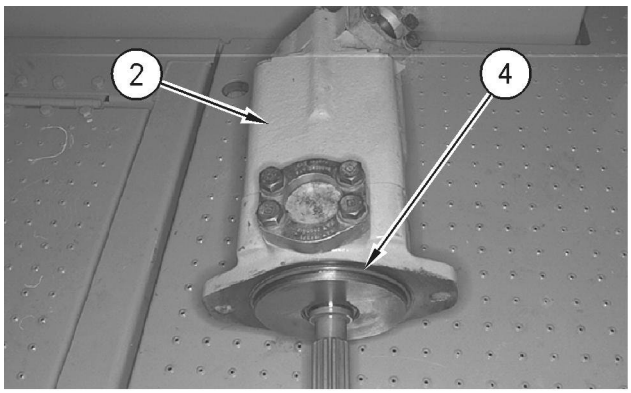


Illustration 478 g00882435

6. Remove O-ring seal (4) from vane pump (2).

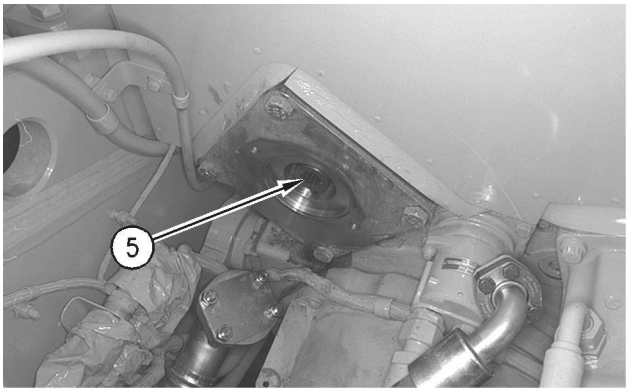


Illustration 479 g00882440

7. Remove coupling (5) from the pump drive.

i01715238

Vane Pump (Implement) - Disassemble

SMCS Code: 5055-015-II; 5084-015-VA

Disassembly Procedure

Table 24

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1859	Snap Ring Pliers	1

Start By:

a. Remove the implement pump. Refer to Disassembly and Assembly, “Vane Pump (Implement) - Remove” for the machine that is being serviced.

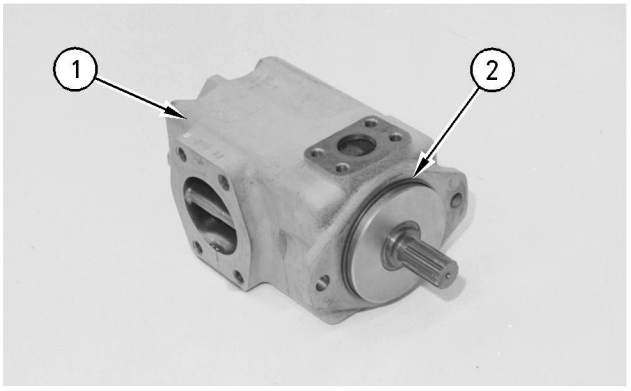


Illustration 480 g00882614

1. Remove O-ring seal (2) from implement pump (1).

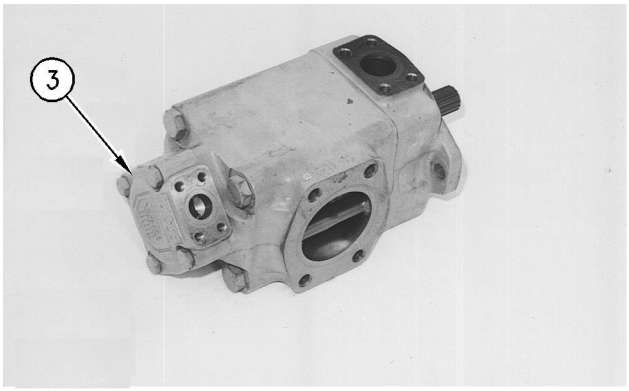


Illustration 481 g00882615

2. Remove the bolts and cover (3) from the implement pump.

3. Remove the O-ring seal from cover (3).

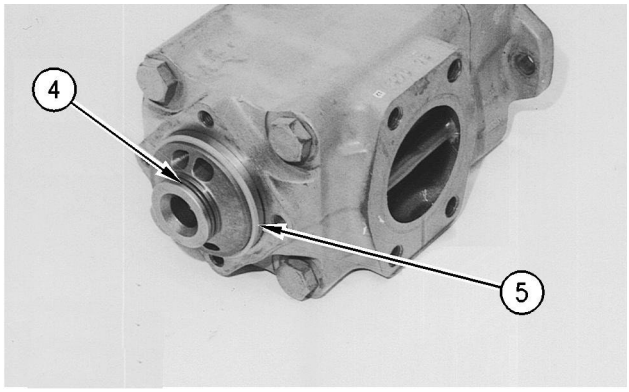


Illustration 482 g00882616

4. Remove the back up ring, O-ring seal (4) and seal (5) from the small cartridge.

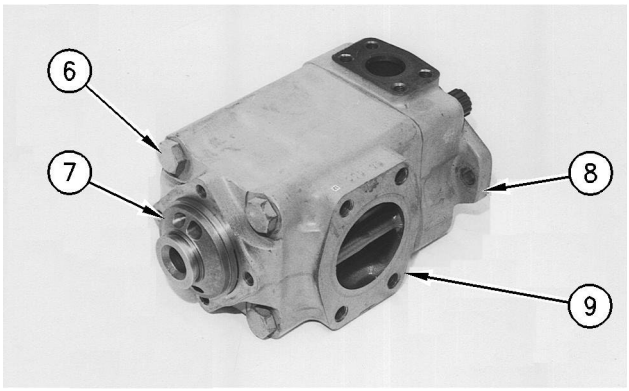


Illustration 483 g00882617

5. Pull the small cartridge (7) out of pump housing (9).

6. Remove bolts (6) and remove pump housing (9) from the pump shaft and body (8).

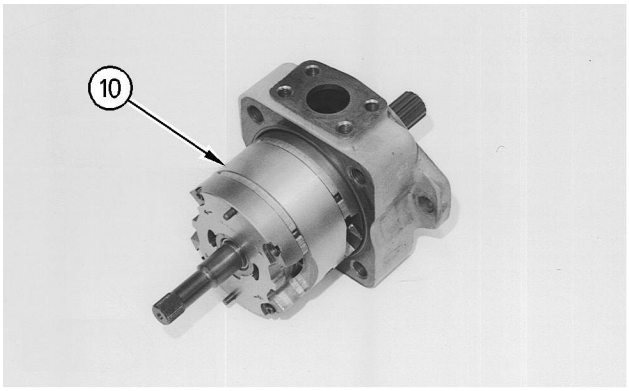


Illustration 484 g00882618

7. Remove large cartridge (10) from the pump shaft.

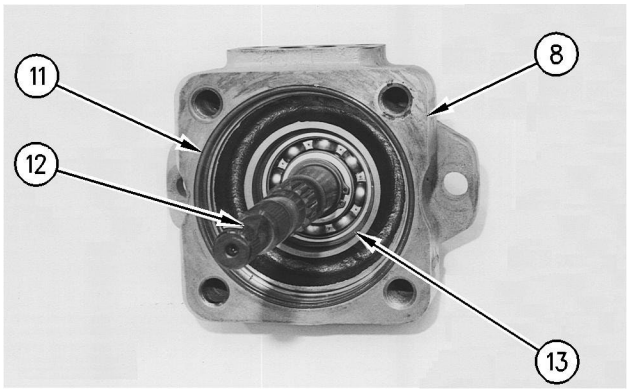


Illustration 485 g00882620

8. Remove O-ring seal (11) from body (8).

9. Remove lockring (13), the bearing, and shaft (12) as a unit from body (8).

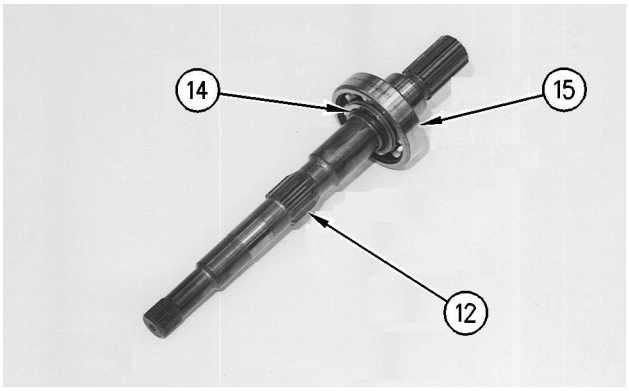


Illustration 486 g00882621

10. Use Tooling (A) in order to remove snap ring (14) from shaft (12).

11. Use a suitable press in order to push shaft (12) out of bearing (15).

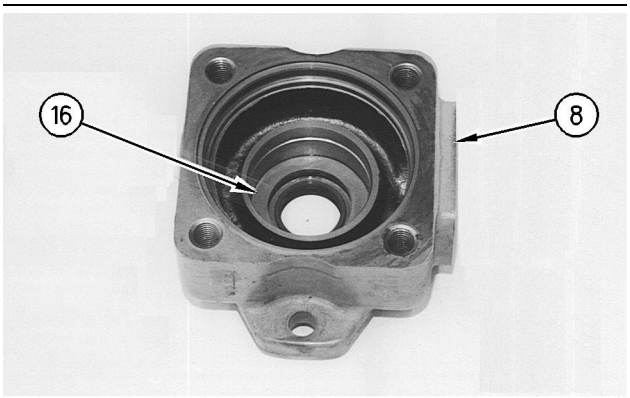


Illustration 487 g00882623

12. Remove thrust washer (16) from body (8).

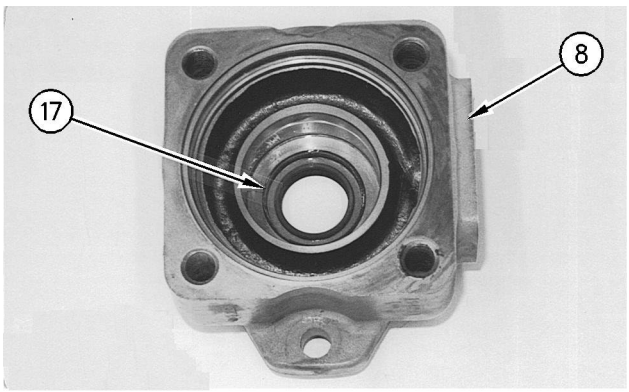


Illustration 488 g00882624

13. Remove two lip seals (17) from body (8).

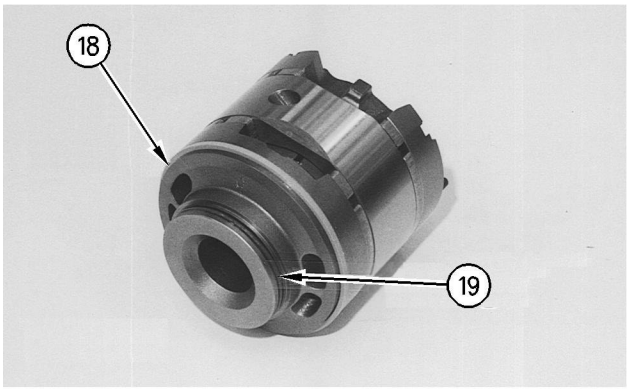


Illustration 489 g00882625

14. Remove the back up ring, O-ring seal (19), and seal (18) from the large cartridge assembly.

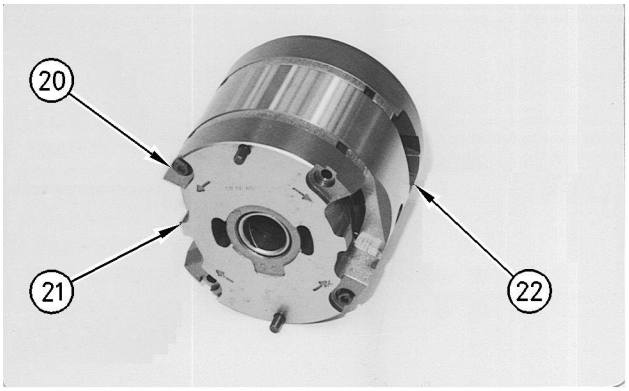


Illustration 490 g00882626

15. Remove bolts (20) and plate (21) from ring (22).

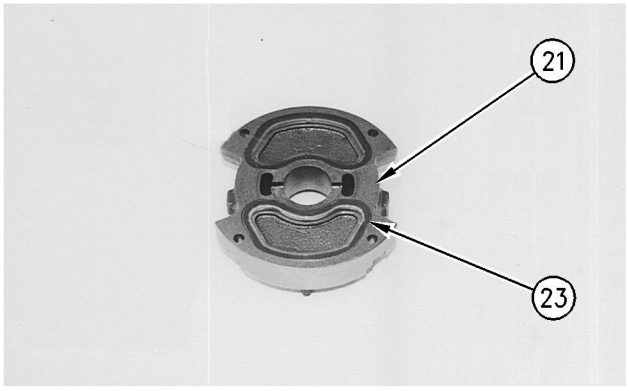


Illustration 491 g00882628

16. Remove seal retainers (23) and the seals from plate (21).

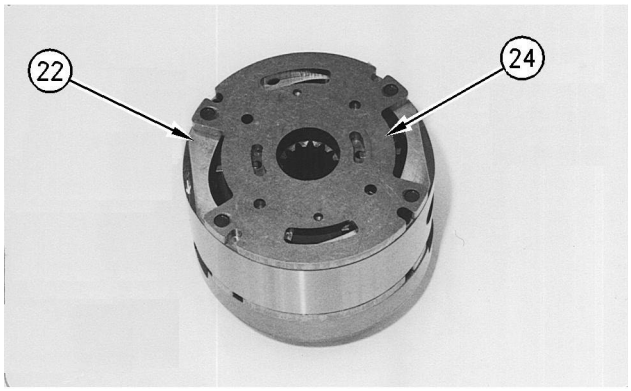


Illustration 492 g00882630

17. Remove plate (24) from ring (22).

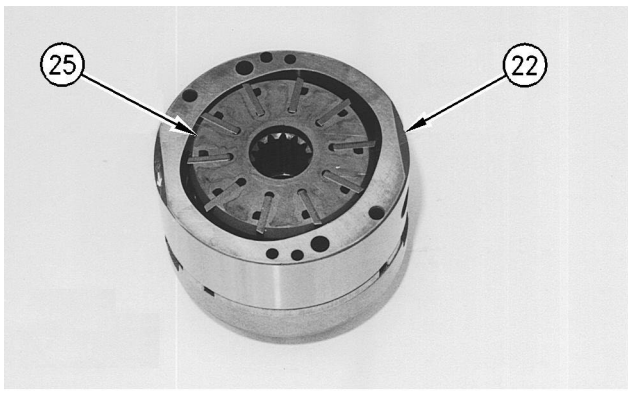


Illustration 493 g00882631

18. Remove ring (22) and rotor (25).

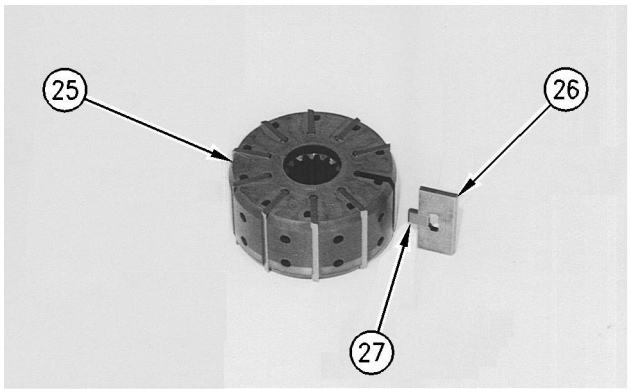


Illustration 494 g00882632

19. Remove vanes (26) and inserts (27) from rotor (25).

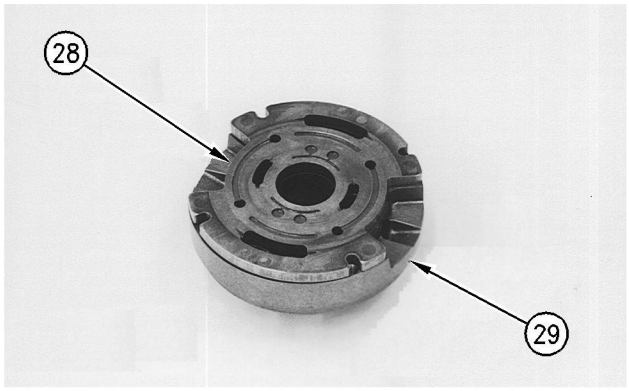


Illustration 495 g00882633

20. Remove plate (28) from end plate (29).

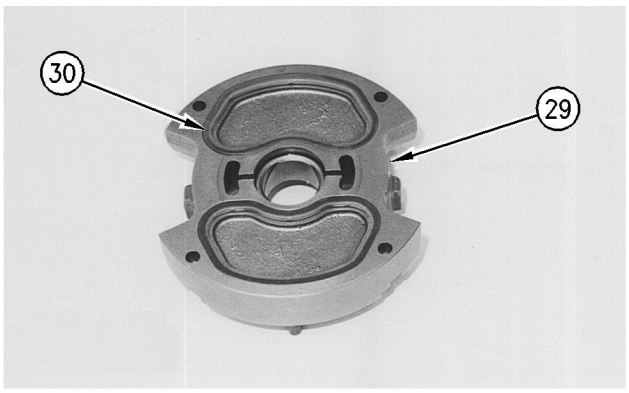


Illustration 496 g00882634

21. Remove seal retainers (30) and the seals from end plate (29).

i01715534

Vane Pump (Implement) - Assemble

SMCS Code: 5055-016-II; 5084-016-VA

Installation Procedure

Table 25

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Group	1
B	1P-1859	Snap Ring Pliers	1

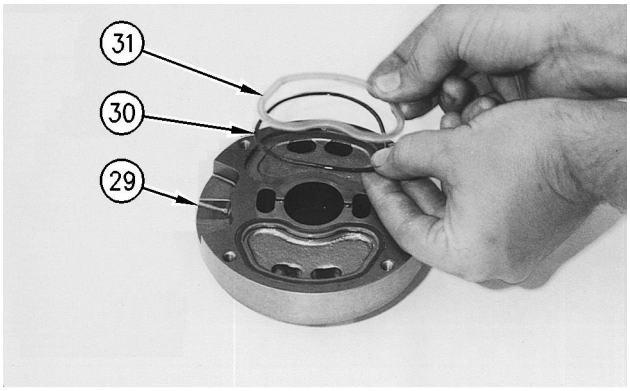


Illustration 497 g00882788

1. Install seals (31) and retainers (30) in end plate (29).

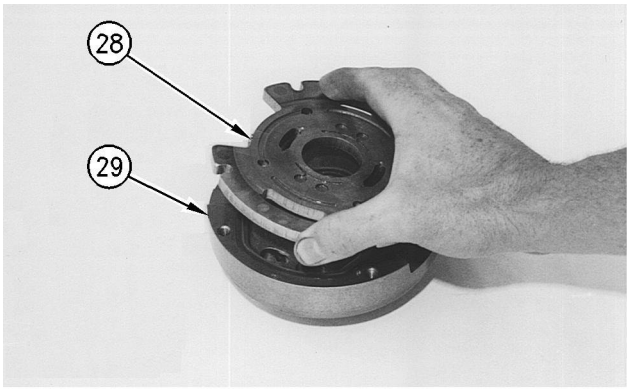


Illustration 498 g00882789

2. Install plate (28) on end plate (29) with the grooves in plate (28) toward the rotor.

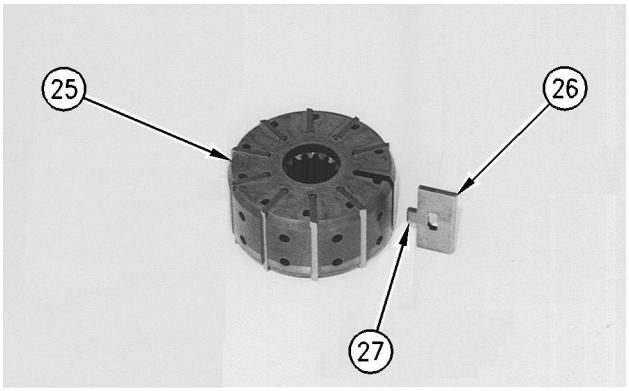


Illustration 499 g00882632

3. Put inserts (27) and vanes (26) in position in rotor (25).

Note: Install all of the vanes with the sharp edge of the vane in the direction of the arrow on ring (22).

4. Put rotor (25) into position on the end plate.

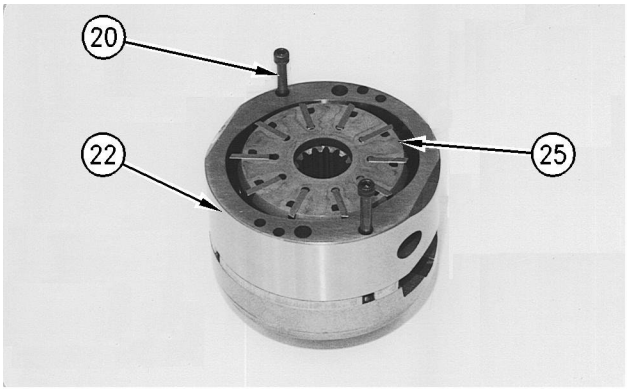


Illustration 500 g00882791

5. Install ring (22) over the rotor.

6.

Note: The arrow on ring (22) must point the same direction as the rotation of the pump shaft. From the drive end of the pump, the rotation of the pump shaft is clockwise.

7. Use bolts (20) in order to align the ring with the threads in the end plate.

8. Remove bolts (20).

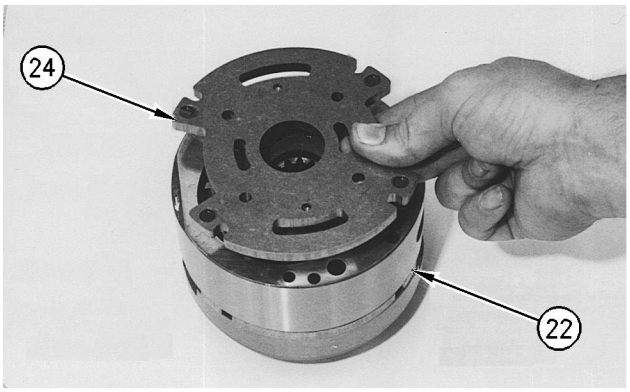


Illustration 501 g00882793

9. Install plate (24) on ring (22) with the grooves in plate (24) toward the rotor.

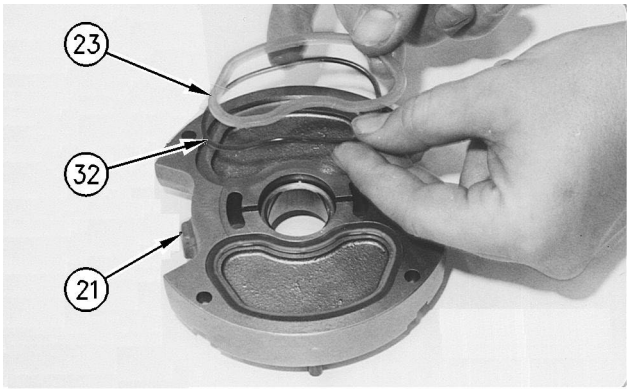


Illustration 502 g00882794

10. Install seals (32) and retainers (23) in end plate (21).

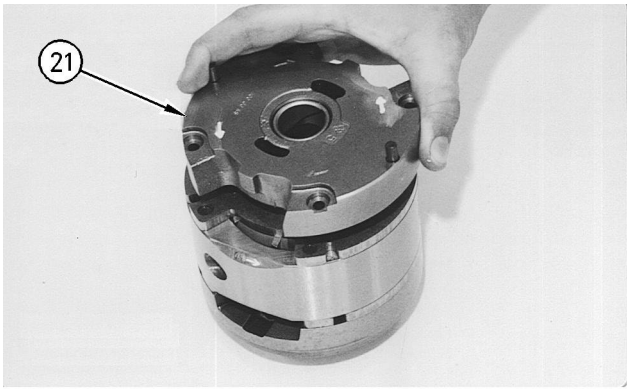


Illustration 503 g00882795

11. Install end plate (21) on the plate.

Note: The arrows on the plate near the bolts must be in the same direction as the arrow on ring (22).

12. Align the bolt holes with the holes in the ring.

13. Install the bolts that hold the cartridge together.

14. Tighten the bolts for the large cartridge to a torque of 11 ± 1 N·m (97 ± 9 lb in).

15. Tighten the bolts for the small cartridge to a torque of 6 ± 0.5 N·m (53 ± 4 lb in).

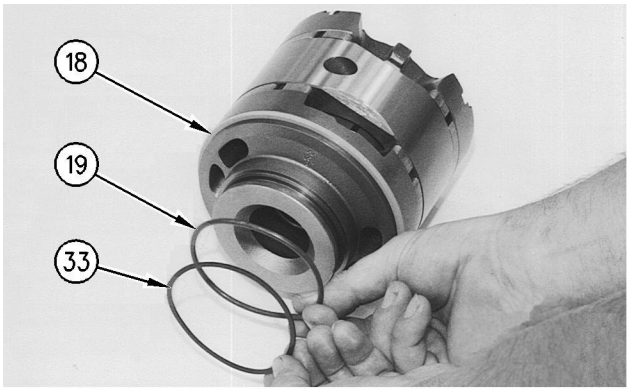


Illustration 504 g00882796

16. Install seal (18), O-ring seal (19), and back up ring (33) on the large cartridge.

Note: The back up ring must be installed toward the outside of the cartridge, as shown.

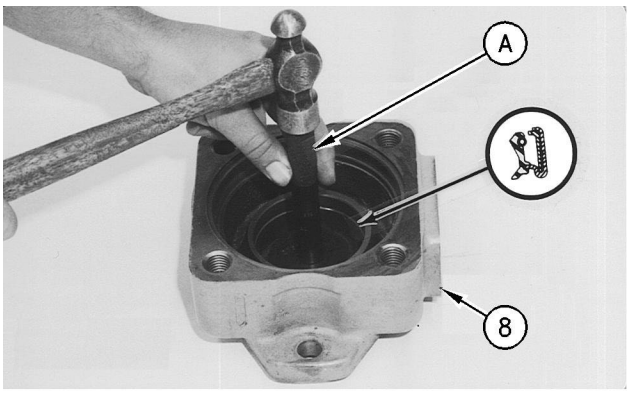


Illustration 505 g00882797

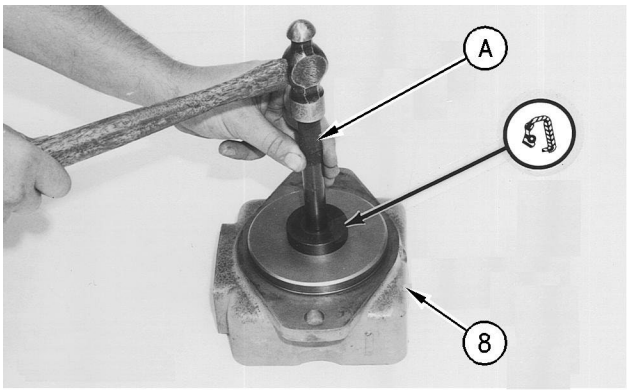


Illustration 506 g00882798

17. Use Tooling (A) in order to install the inner lip seal and the outer lip seal in pump body (8).

Note: The lip of the two seals must face toward the inside of the pump, as shown.

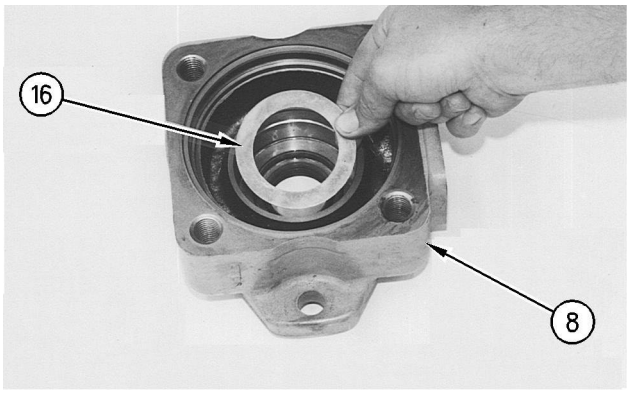


Illustration 507 g00882800

18. Install thrust washer (16) in pump body (8).

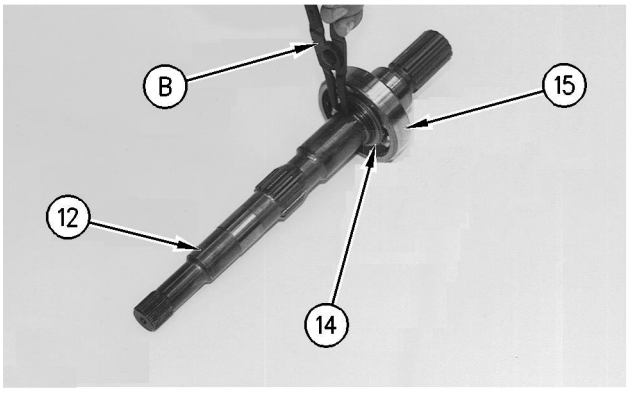


Illustration 508 g00882801

19. Heat bearing (15) to a temperature of 135 °C (275 °F).

20. Use the proper protective equipment in order to handle bearing (15).

21. Install bearing (15) on shaft (12).

22. Use Tooling (B) in order to install snap ring (14) on the shaft.

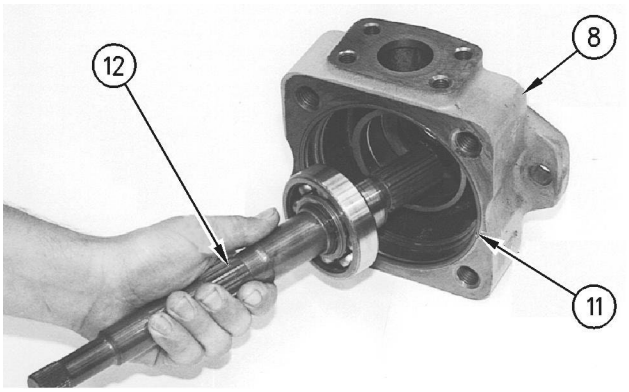


Illustration 509 g00882802

23. Install shaft (12) and the bearing in pump body (8), as shown.

24. Install the ring that holds the bearing in position in body (8).

25. Install O-ring seal (11) in pump body (8).

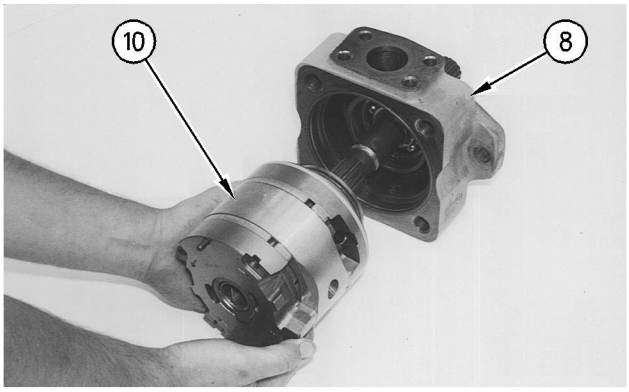


Illustration 510 g00882803

26. Install large cartridge (10) over the pump shaft in body (8).

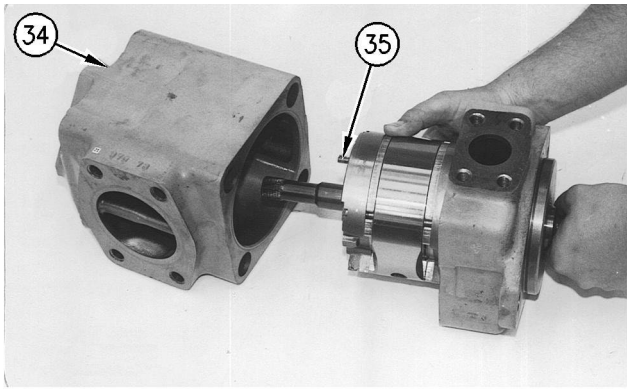


Illustration 511 g00882804

27. Put the cartridge and the pump body in position in cover (34).

28. Align dowels (35) with the holes in cover (34).

29. Install the bolts that hold the unit together.

30. Tighten the bolts to a torque of 360 ± 14 N·m (265 ± 10 lb ft).

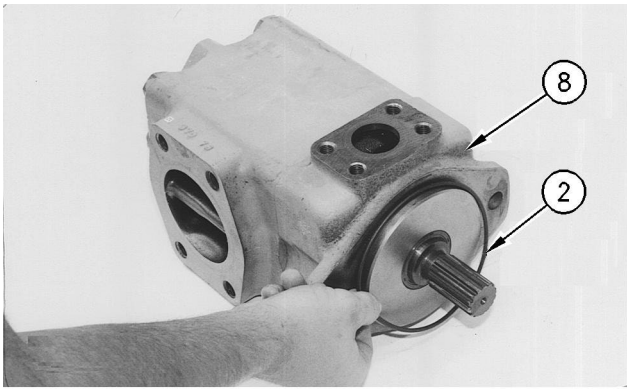


Illustration 512 g00882805

31. Install O-ring seal (2) on pump body (8).

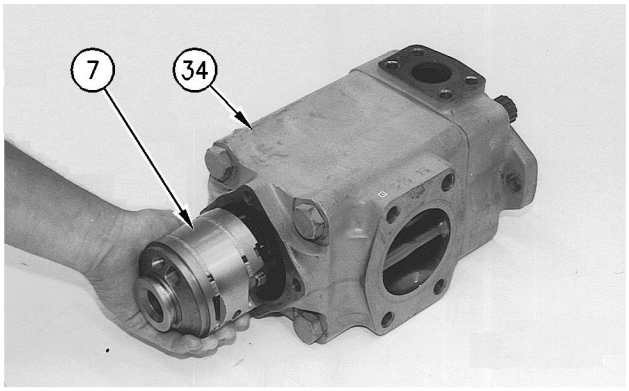


Illustration 513 g00882807

32. Install small cartridge (7) in the pump cover over the pump shaft.

Note: Ensure that the dowels in the end of cartridge (7) are engaged correctly with the holes in cover (34).

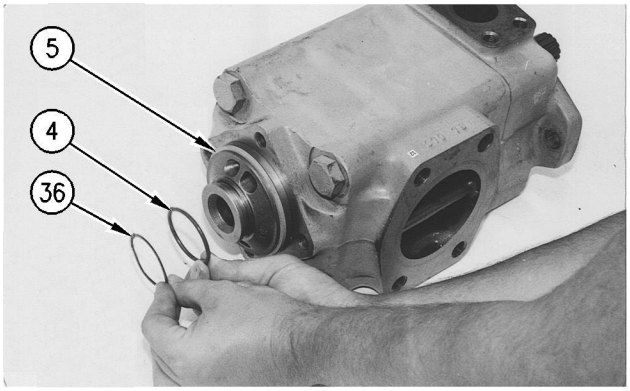


Illustration 514 g00882809

33. Install seal (5), O-ring seal (4), and back up ring (36) on the small cartridge.

Note: The back up ring must be installed toward the outside, as shown.

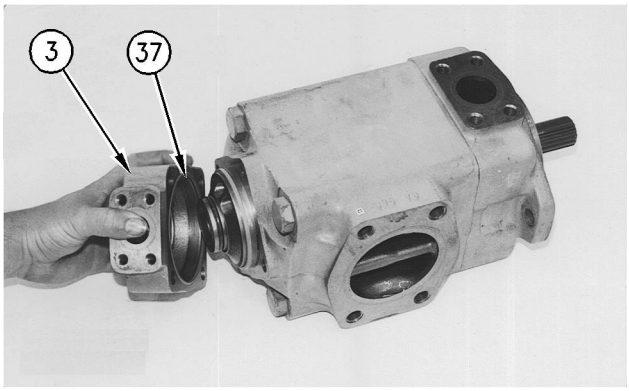


Illustration 515 g00882810

34. Put O-ring seal (37) in cover (3).

35. Install cover (3) and the bolts.

36. Tighten the bolts to a torque of 95 ± 7 N·m (70 ± 5 lb ft).

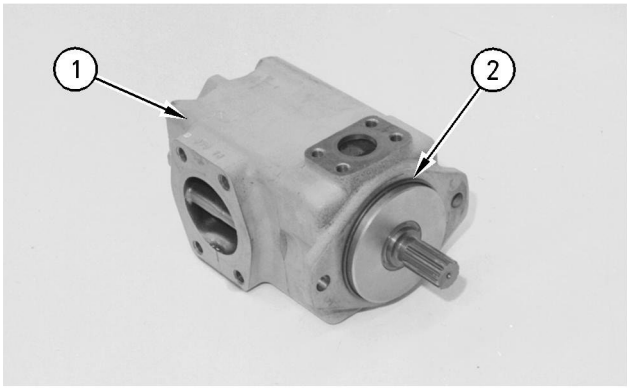


Illustration 516 g00882614

37. Install O-ring seal (2) on implement pump (1).

End By:

a. Install the implement pump. Refer to Disassembly and Assembly, “Vane Pump (Implement) - Install” for the machine that is being serviced.

i02512652

Vane Pump (Implement) - Install

SMCS Code: 5055-012-II; 5084-012-VA

Installation Procedure

1. Check the condition of all O-ring seals that are used in the installation of the implement pump. Thoroughly clean the mounting surfaces of the implement pump and the pump drive prior to installation.

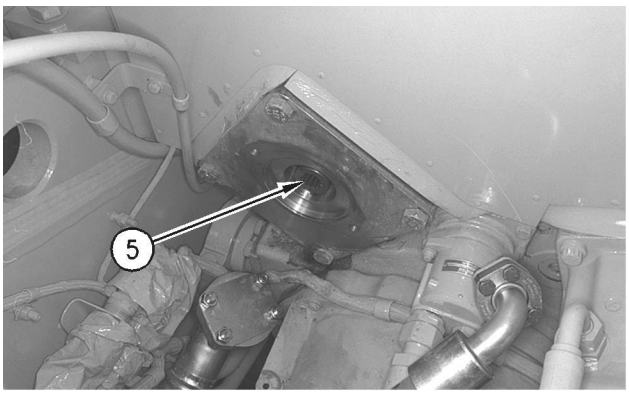


Illustration 517 g00882440

2. Install coupling (5) in the pump drive.

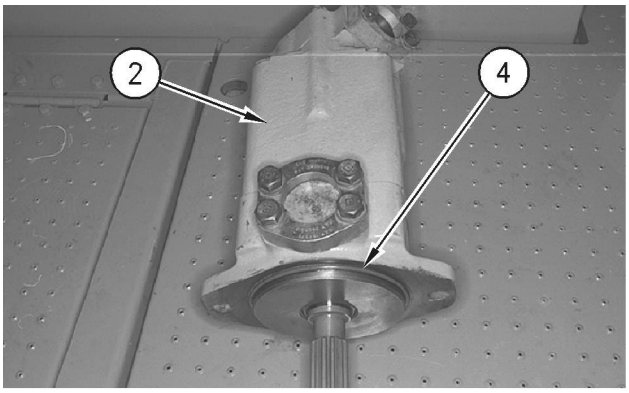


Illustration 518 g00882435

3. Install O-ring seal (4) in vane pump (2). Lubricate O-ring seal (4) lightly with the lubricant that is being sealed.

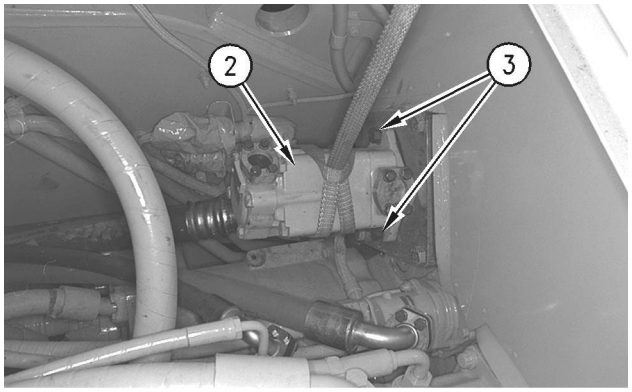


Illustration 519 g00882432

4. Attach a suitable lifting device to vane pump (2), as shown. The weight of vane pump (2) is approximately 36 kg (80 lb).

5. Install vane pump (2) into the machine.

6. Install bolts (3).

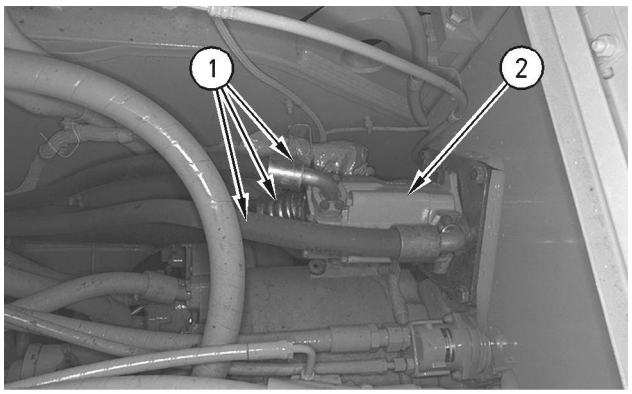


Illustration 520 g00882425

7. Connect hose assemblies (1) to vane pump (2).

8. Fill the hydraulic tank for the steering system and for the hydraulic fan.

9. Fill the hydraulic tank for the implement and the braking system.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02473933

Piston Pump (Hydraulic Fan) - Remove

SMCS Code: 1387-011-QP; 5070-011-HFN

Removal Procedure

Start By:

a. Remove the gear pump (pilot brake). Refer to Disassembly and Assembly Manual, “Gear Pump (Pilot Brake) - Remove”.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses, and all tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the removal procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

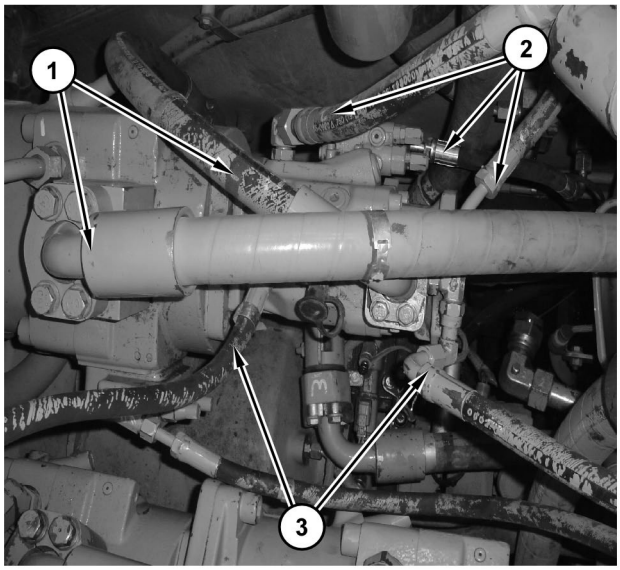


Illustration 521 g01234342

1. Disconnect hose assemblies (1), (2) and (3).

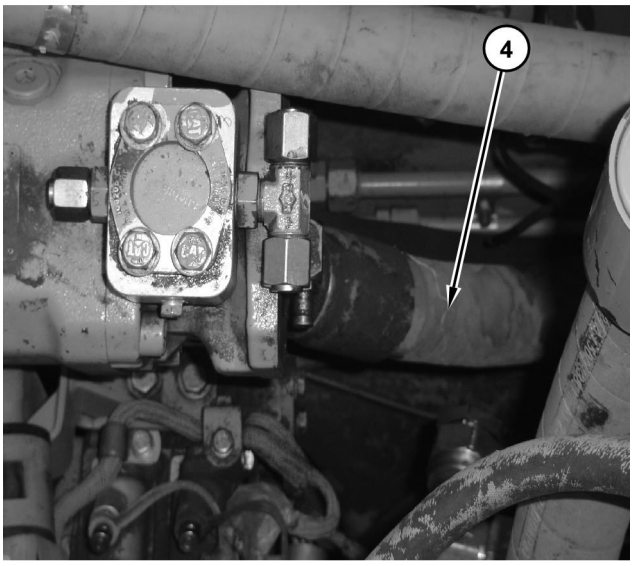


Illustration 522 g01234344

2. Disconnect hose assembly (4).

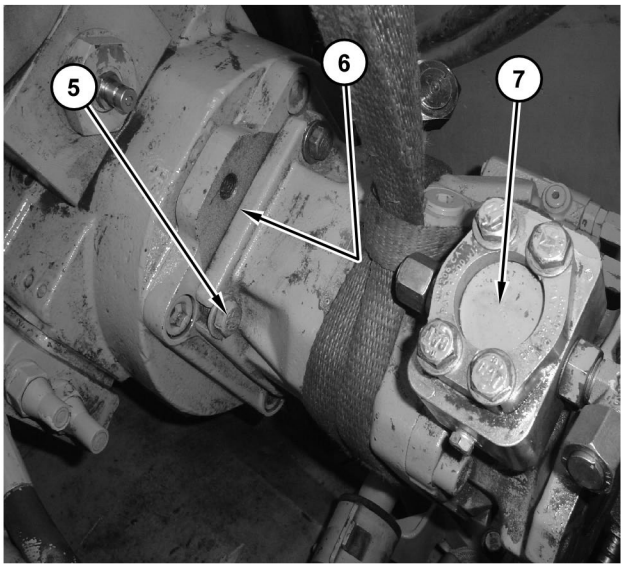


Illustration 523 g01234345

3. Attach a suitable lifting device to pump assembly (7). The weight of pump assembly (7) is approximately 39 kg (85 lb). Remove bolts (5). Remove pump assembly (7). Remove O-ring seal (6).

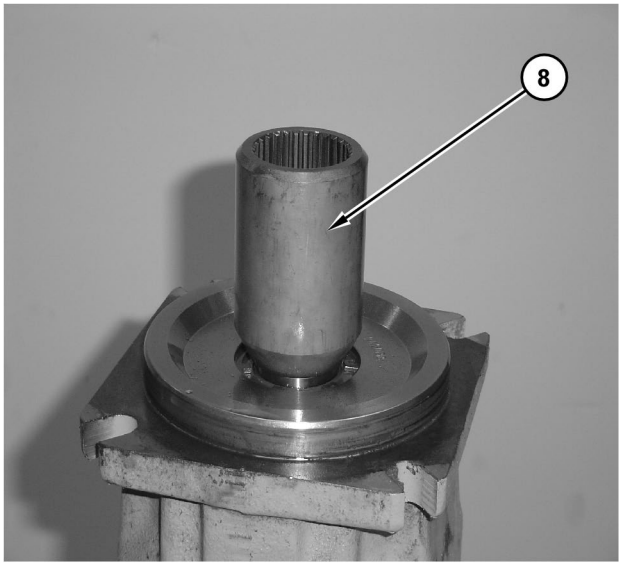


Illustration 524 g01234348

4. Remove coupling (8).

i02478973

Piston Pump (Hydraulic Fan) - Disassemble

SMCS Code: 1387-015-QP; 5070-015-HFN

Disassembly Procedure

Table 26

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Gp	1
B	1P-1858	Pliers	1
C	9S-9152	Bearing Puller	1

Start By:

a. Remove the fan drive pump. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic Fan) - Remove”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Be sure that the outside of the piston pump is thoroughly clean prior to disassembly.

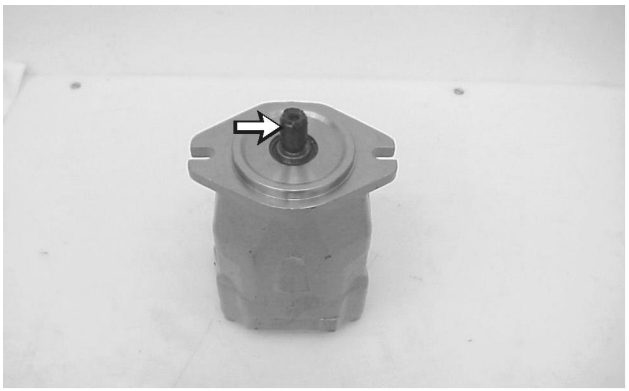


Illustration 525 g00670363

2. In order to protect the shaft seal, use an adhesive tape to cover the drive shaft.

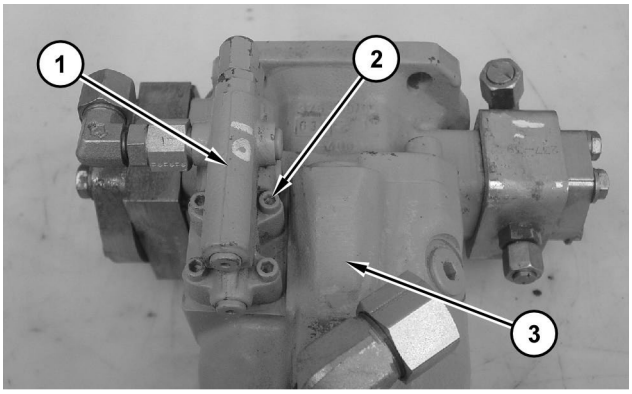


Illustration 526 g01238162

3. Remove bolts (2) and pressure and flow compensator valve (1) from fan drive pump (3).

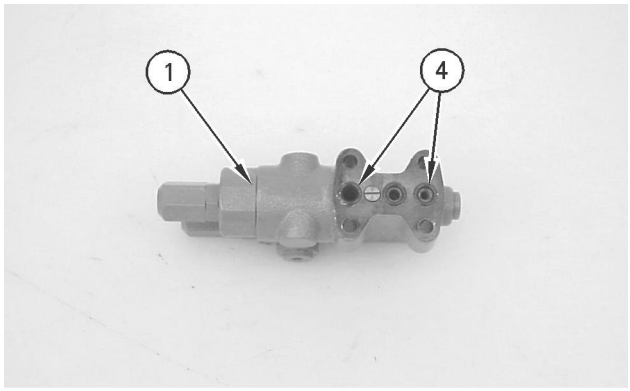


Illustration 527 g00670188

4. Remove three O-ring seals (4) from compensator valve (1).

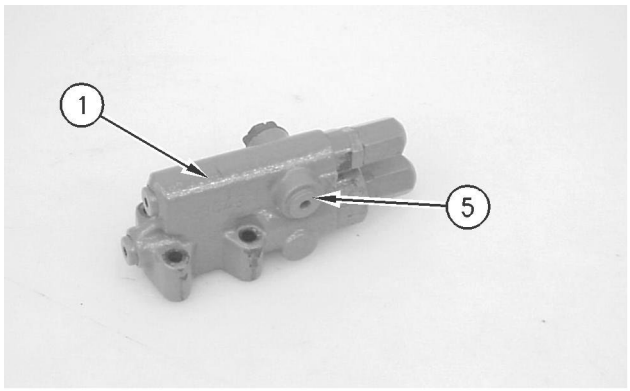


Illustration 528 g00670190

5. Remove plug (5) from compensator valve (1). Repeat for opposite side.

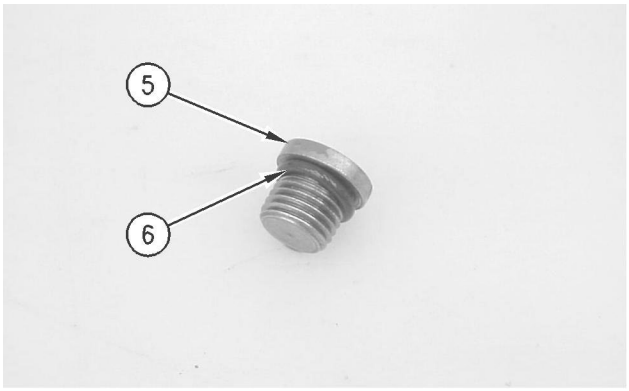


Illustration 529 g00670191

6. Remove O-ring seal (6) from plug (5).

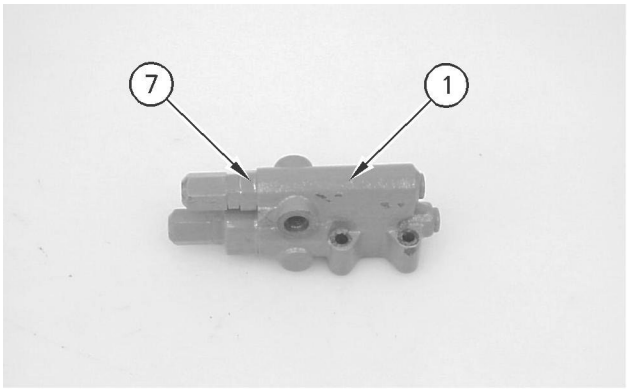


Illustration 530 g00670192

7. Remove plug (7) from compensator valve (1).

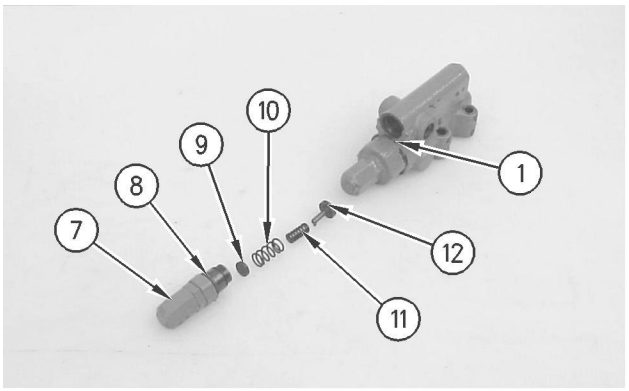


Illustration 531 g00670195

8. Remove O-ring seal (8) from plug (7). Remove plate (9), spring (10), spring (11), and guide (12) from compensator valve (1).

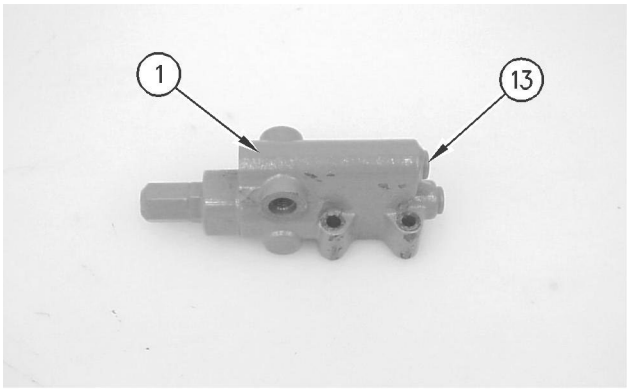


Illustration 532 g00670197

9. Remove plug (13) from compensator valve (1).

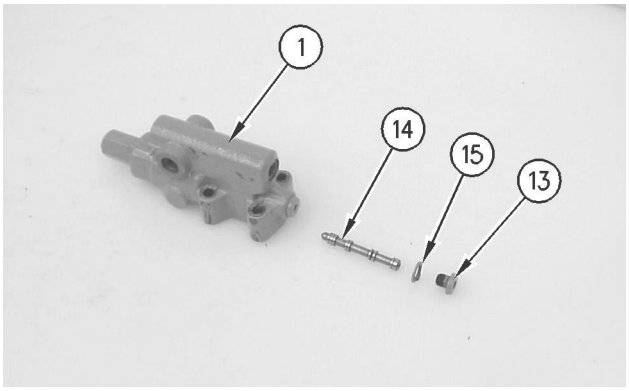


Illustration 533 g00670198

10. Remove spool (14) from compensator valve (1). Remove spacer (15) from plug (13).

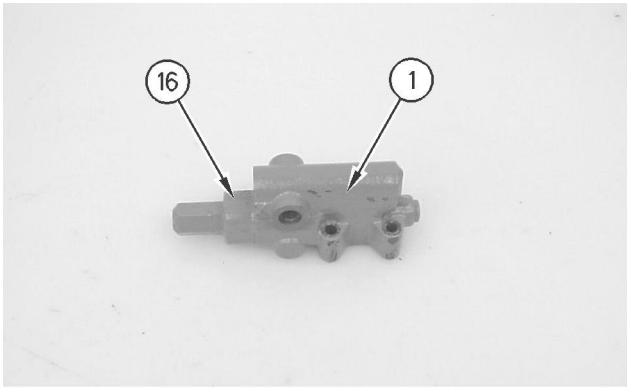


Illustration 534 g00670199

11. Remove plug (16) from compensator valve (1).

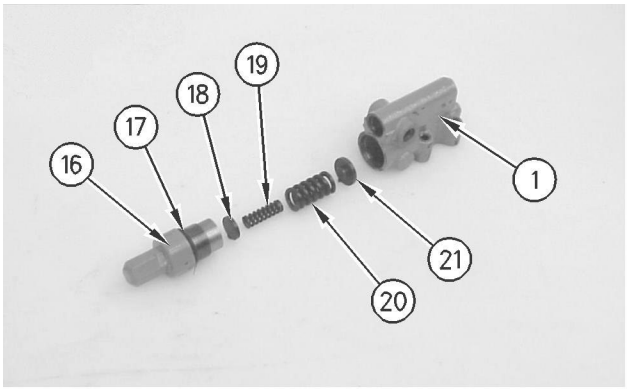


Illustration 535 g00670201

12. Remove O-ring seal (17) from plug (16). Remove plate (18), spring (19), spring (20), and guide (21) from compensator valve (1).

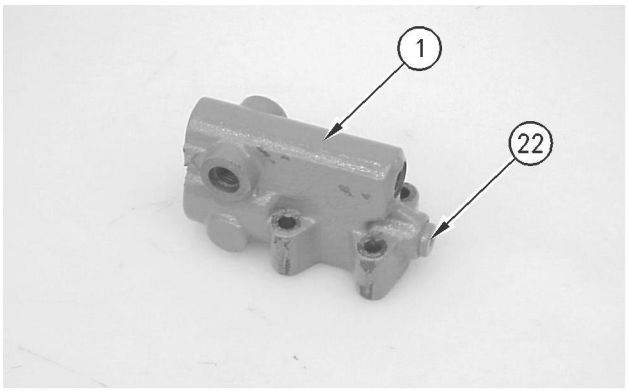


Illustration 536 g00670202

13. Remove plug (22) from compensator valve (1).

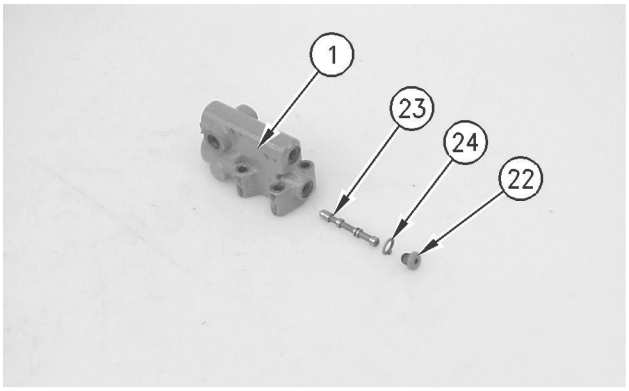


Illustration 537 g00670203

14. Remove spool (23) from compensator valve (1). Remove spacer (24) from plug (22).

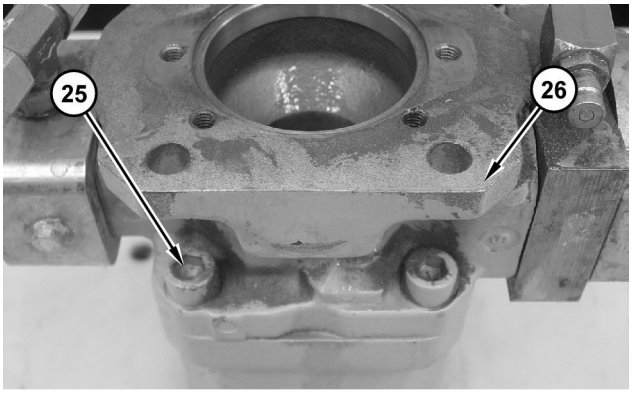


Illustration 538 g01238164

15. Remove bolts (25) from head assembly (26).

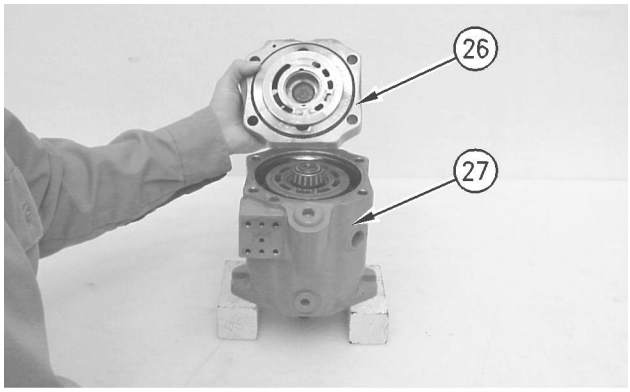


Illustration 539 g00669723

16. Remove head assembly (26) from pump body (27).

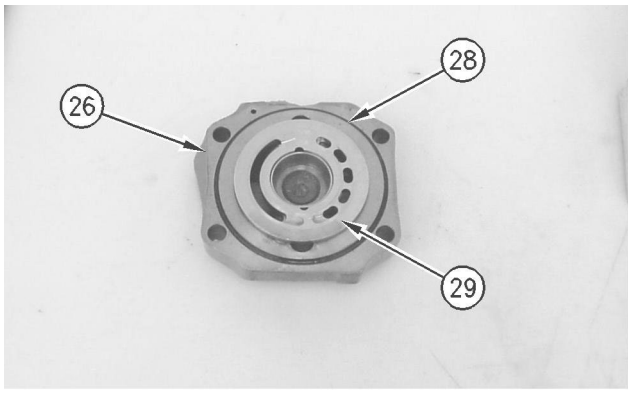


Illustration 540 g00669727

17. Remove O-ring seal (28) and port plate (29) from head assembly (26).

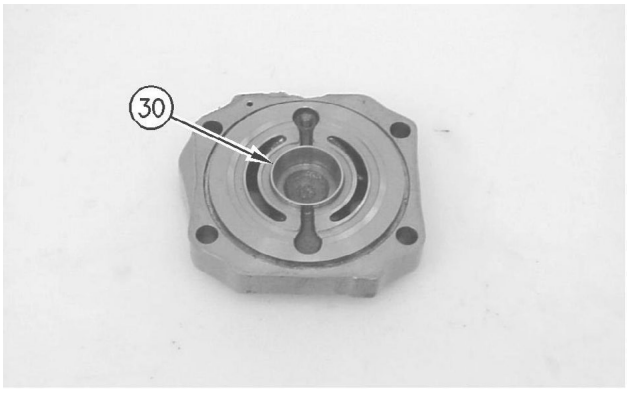


Illustration 541 g00669728

18. Remove bearing cup (30).

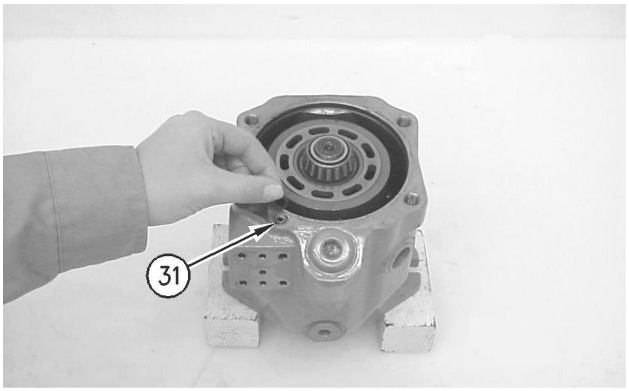


Illustration 542 g00669729

19. Remove O-ring seal (31).

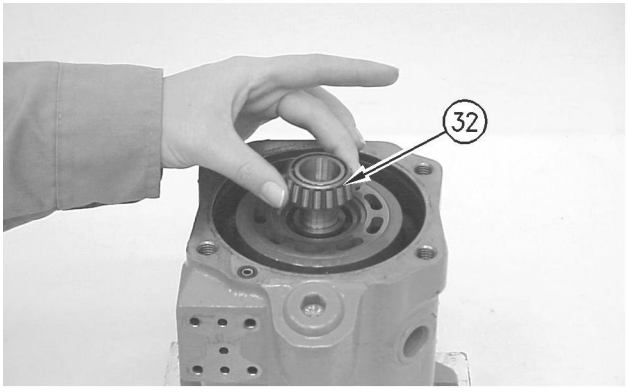


Illustration 543 g00669730

20. Remove bearing cone (32) from the shaft.

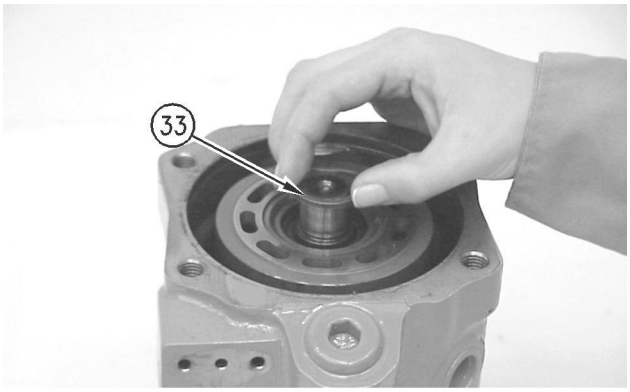


Illustration 544 g00669731

21. Remove adjustment shim (33).

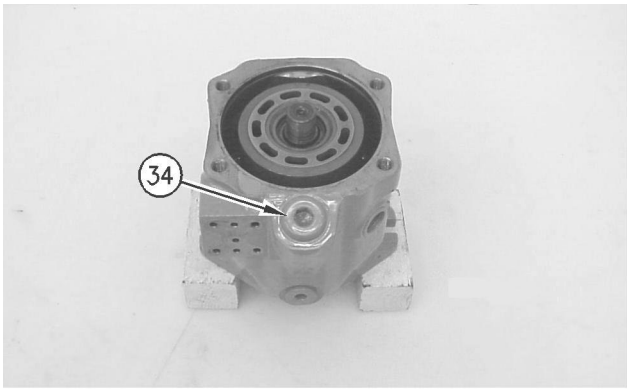


Illustration 545 g00669732

22. Remove plug (34).

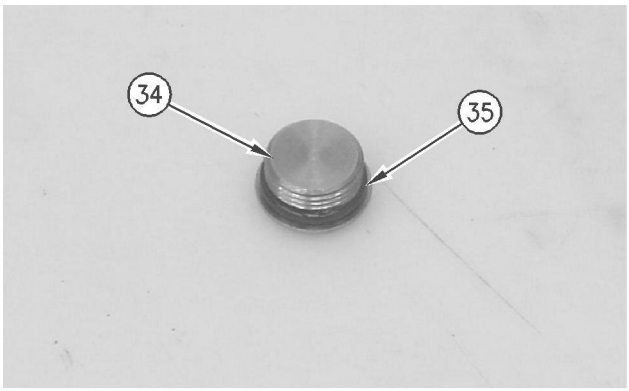


Illustration 546 g00669738

23. Remove O-ring seal (35) from plug (34).

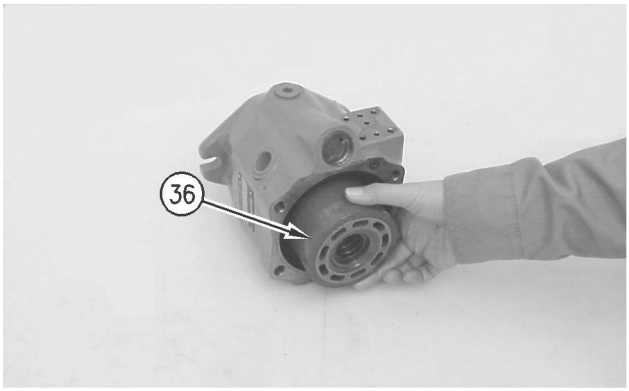


Illustration 547 g00669742

24. Carefully place the pump in a horizontal position.

25. Remove rotary group (36).

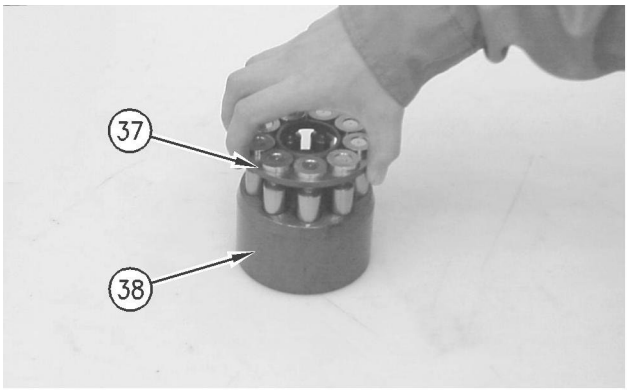


Illustration 548 g00669741

26. Remove piston assembly (37) from barrel assembly (38).

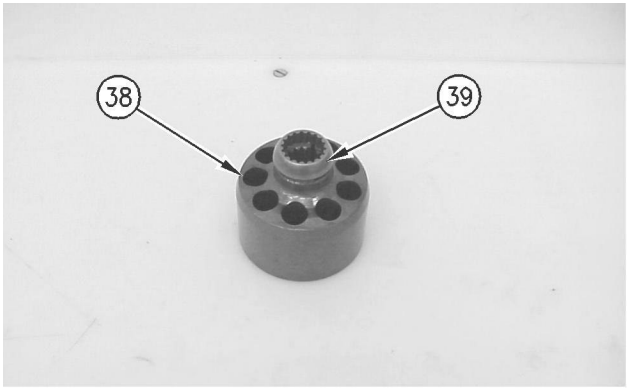


Illustration 549 g00669743

27. Remove retaining ball (39) from barrel assembly (38).

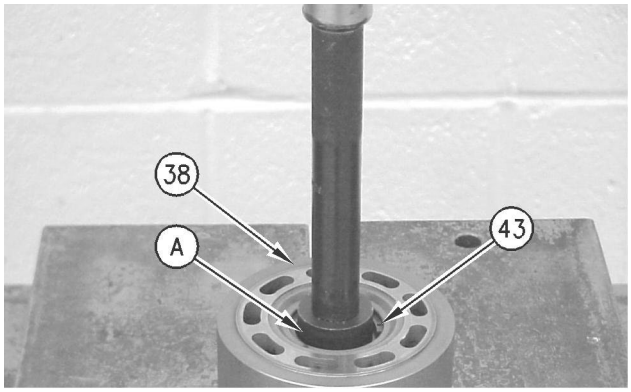


Illustration 550 g00669744

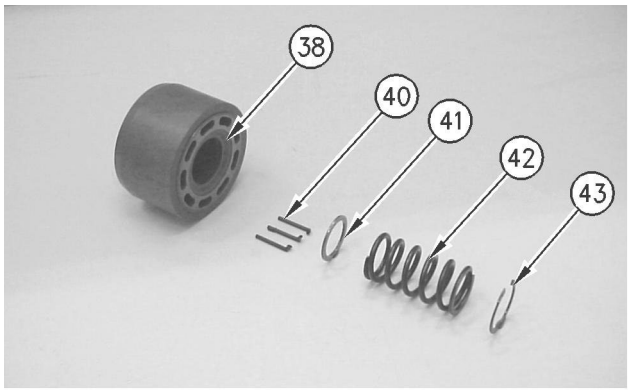


Illustration 551 g00669745

⚠ WARNING

Sudden release of spring force can cause injury.

To prevent the possibility of injury, follow the procedure to relieve the spring pressure.

Note: There is spring force against retaining ring (43). When retaining ring (43) is removed, the spring force will be released. Removal of the internal components in barrel assembly (38) should be performed in a press. This is done in order to retain spring (42) and retaining ring (43).

28. Use a suitable press and Tooling (A) to compress the spring in barrel assembly (38).

29. Use Tooling (B) to remove retaining ring (43) from the barrel assembly (38).

30. Remove retaining ring (43), spring (42), guide (41), and pins (40) from the barrel.

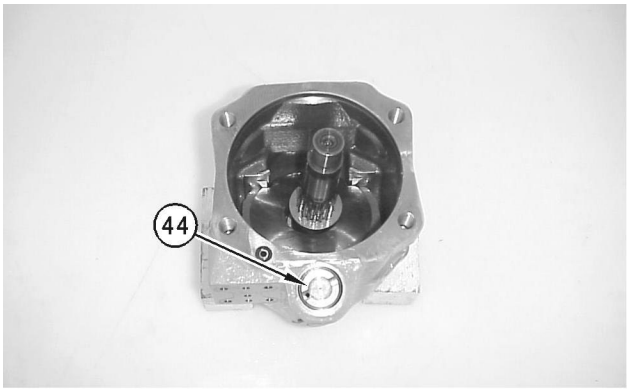


Illustration 552 g00670204

31. Move the swashplate up and down in order to remove control piston (44).

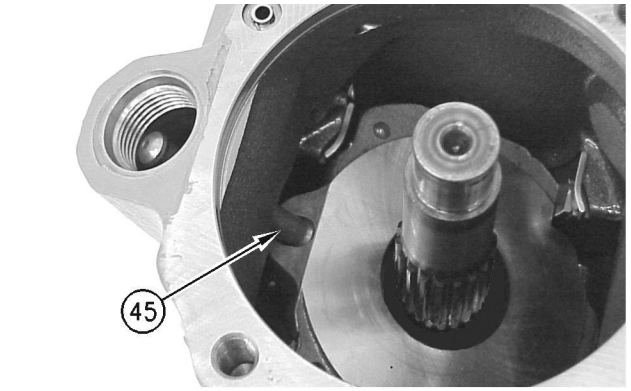


Illustration 553 g00670205

Note: In order to release the piston rod (45) from the swashplate, lift the swashplate a little and move the piston rod sideways.

32. Remove piston rod (45).

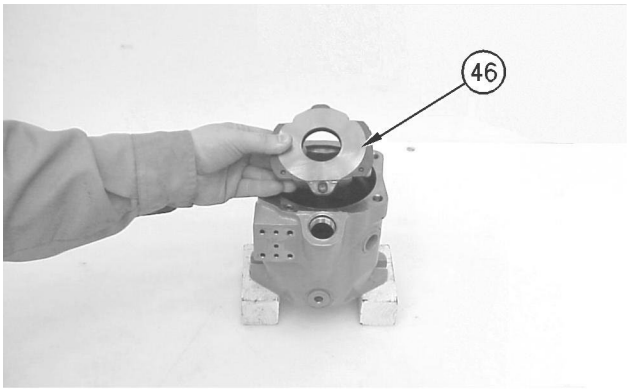


Illustration 554 g00670206

33. Remove swashplate (46).

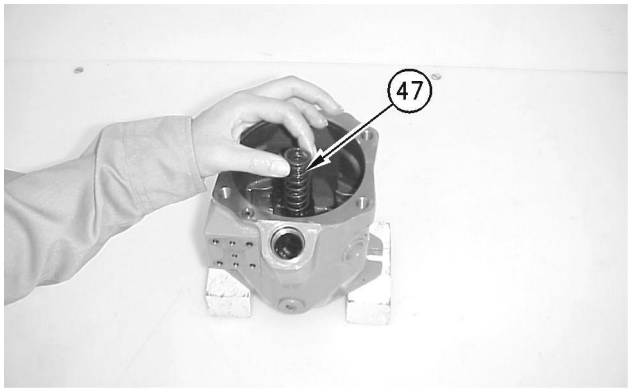


Illustration 555 g00670207

34. Remove spring (47).

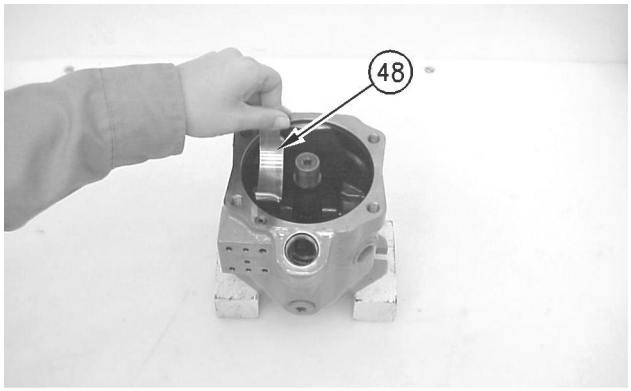


Illustration 556 g00670223

35. Remove two swashplate bearings (48).

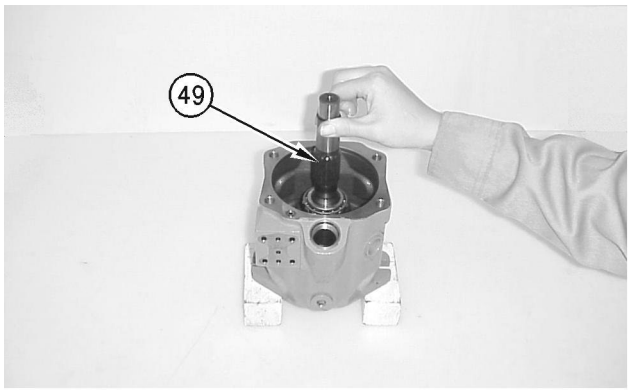


Illustration 557 g00670298

36. Remove shaft assembly (49).

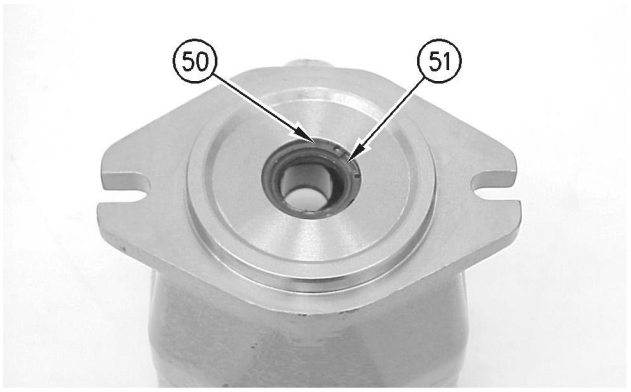


Illustration 558 g00670301

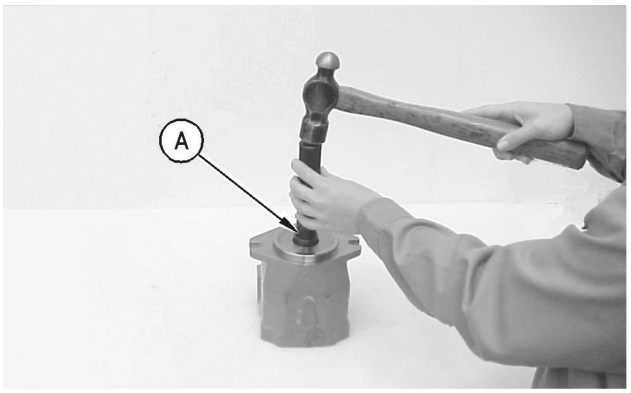


Illustration 559 g00670302

37. Remove retaining ring (50).

38. Use Tooling (A) to remove seal (51).

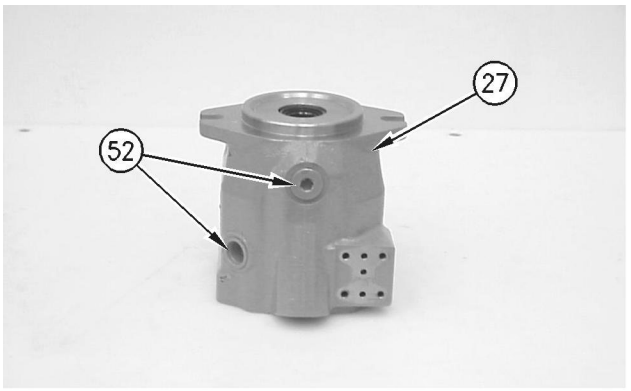


Illustration 560 g00670360

39. Remove plugs (52) from pump body (27). Inspect the O-ring seals on the plugs. Replace the O-ring seals, if necessary.

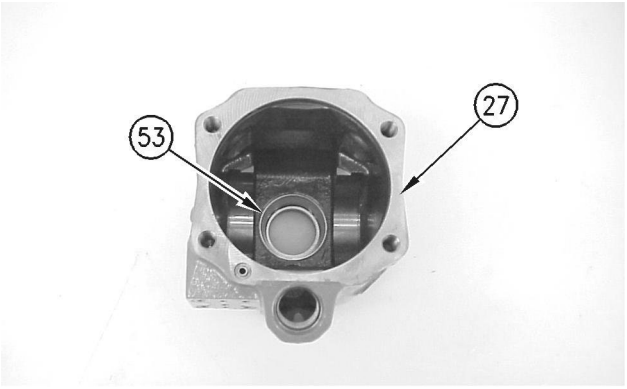


Illustration 561 g00670361

40. Remove bearing cup (53) from pump body (27).

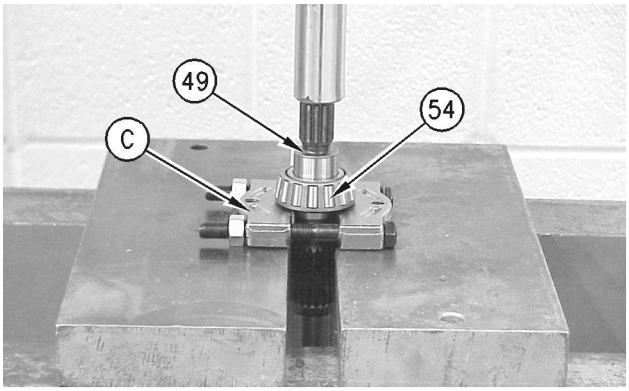


Illustration 562 g00670362

41. Use Tooling (C) and a suitable press to remove bearing cone (54) from shaft assembly (49).

i02478974

Piston Pump (Hydraulic Fan) - Assemble

SMCS Code: 1387-016-QP; 5070-016-HFN

Assembly Procedure

Table 27

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Group	1
B	1P-1858	Pliers	1
D	8T-5096	Indicator	1
E	1S-0256	Pliers	1
F	1U-7978	Screwdriver	1
G	8H-8581	Feeler Gauge	1

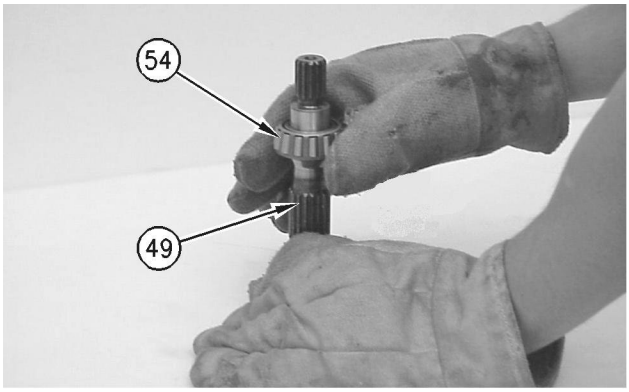


Illustration 563 g00670525

1. Use the proper equipment to handle bearing cone (54). Raise the temperature of bearing cone (54). Install bearing cone (54) onto the shaft (49).

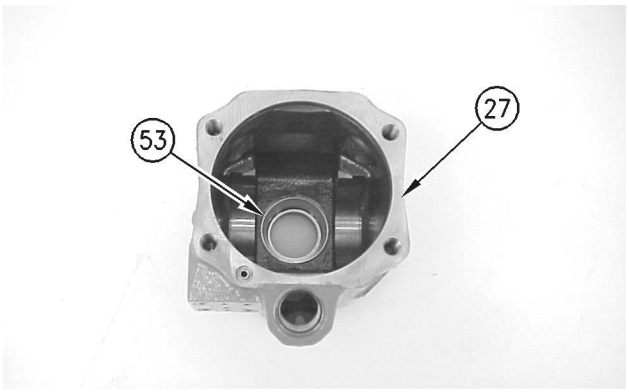


Illustration 564 g00670361

2. Use the proper equipment to handle the bearing cup. Lower the temperature of bearing cup (53) and install the bearing cup in pump body (27).

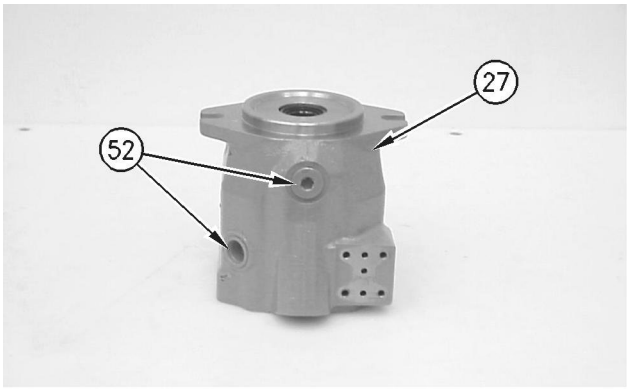


Illustration 565 g00670360

3. Inspect the O-ring seals on plugs (52). Replace the O-ring seals, if necessary. Install two plugs (52) in pump body (27).

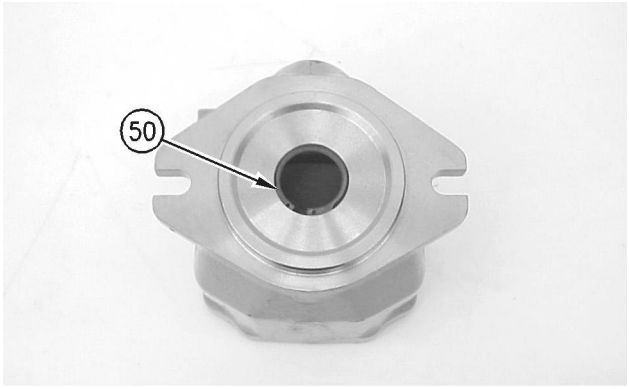


Illustration 566 g00670531

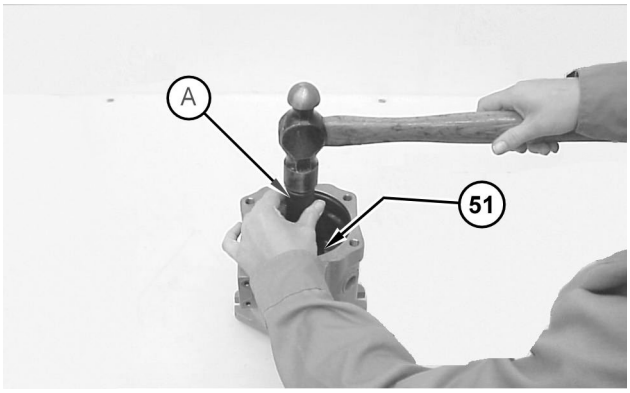


Illustration 567 g01246397

4. Install retaining ring (50). Use Tooling (A) to install seal (51).

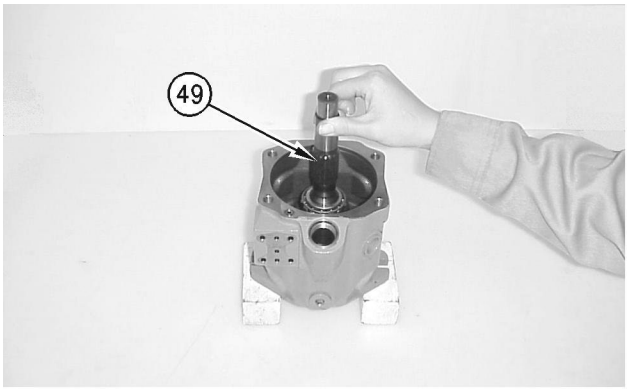


Illustration 568 g00670298

5. Install shaft assembly (49).

6. Use the following steps to determine the proper preload on the bearings of the pump assembly.

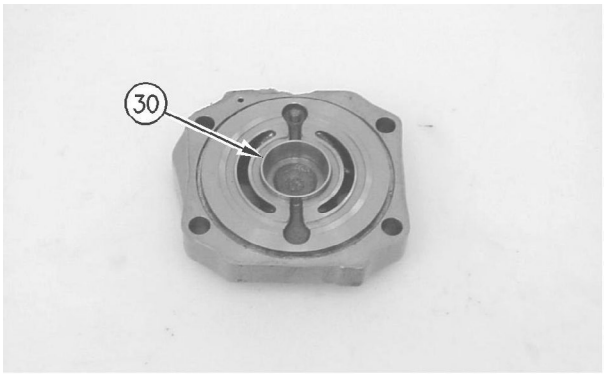


Illustration 569 g00669728

a. Use the proper equipment to handle the bearing cup. Lower the temperature of bearing cup (30) and install the bearing cup.

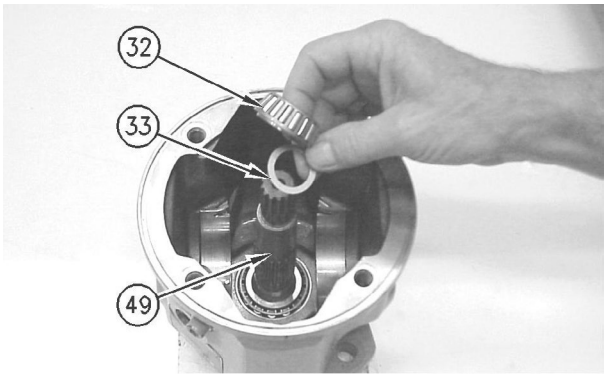


Illustration 570 g00670604
Typical Example

b. Install adjustment shim (33) and bearing cone (32) onto shaft assembly (49).

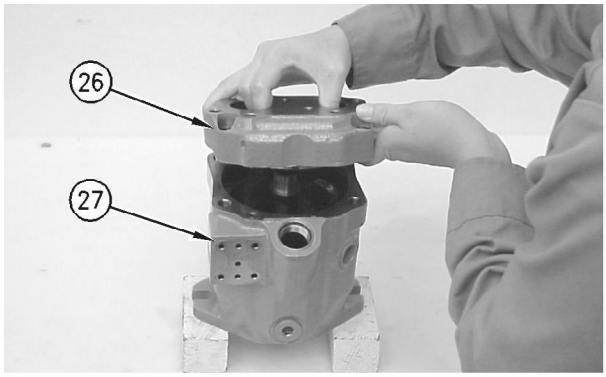


Illustration 571 g00670605
Typical Example

c. Position head assembly (26) onto pump body (27).

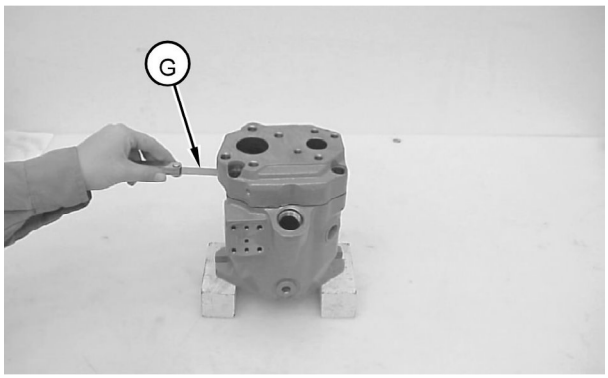


Illustration 572 g01246403
Typical Example

d. Use Tooling (G) to measure the distance between the head and the pump housing.

e. Take measurements at three equal intervals on the surface between the head and the pump housing.

f. The average of the three dimensions should be between zero and 0.05 mm (0.002 inch).

g. If necessary, grind adjustment shim (33) in order to obtain the correct dimension between the head and the pump housing. It may be necessary to replace the shim with a new part.

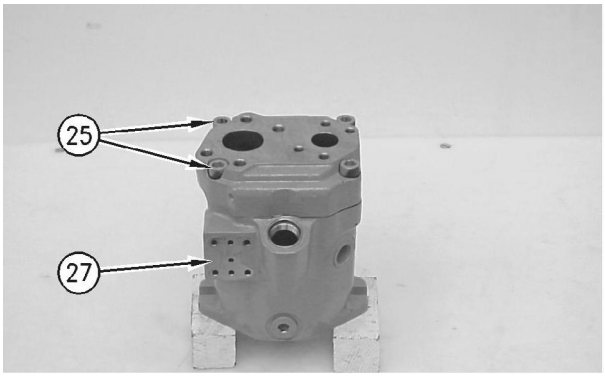


Illustration 573 g00670625

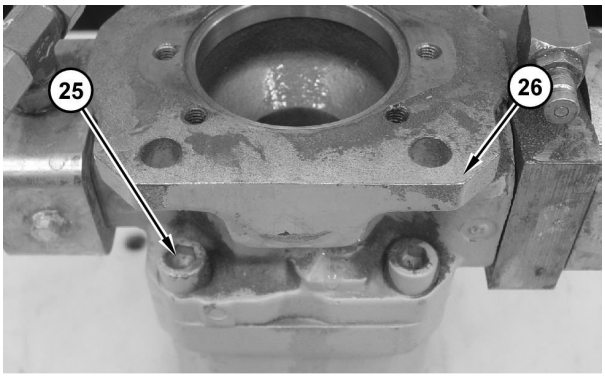


Illustration 574 g01238164

h. Install bolts (25) into head assembly (26). Tighten bolts (25) to a torque of 100 ± 20 N·m (75 ± 15 lb ft).

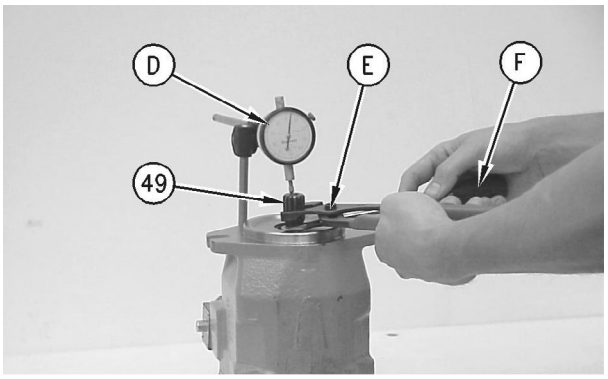


Illustration 575 g00670626

i. Use Tooling (D), (E), and (F) to check end play in shaft (49). If end play exists in the shaft assembly, repeat Step 6 until the correct dimension between the head and the pump housing is reached.

j. Remove bolts (25) and head assembly (26) from pump body (27). Remove bearing (32) and adjustment shim (33) from shaft (49).

k. Proceed with the assembly of the fan drive pump.

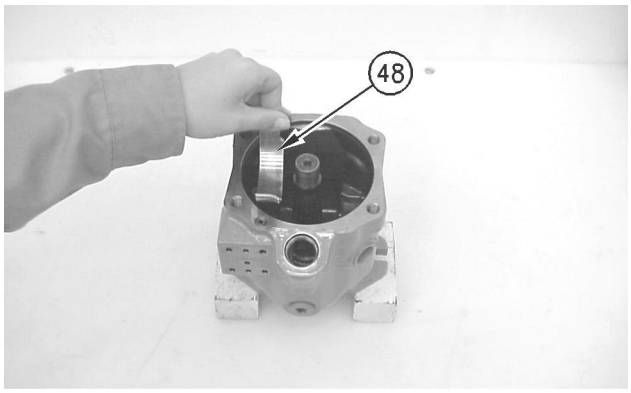


Illustration 576 g00670223

7. Install two swashplate bearings (48).

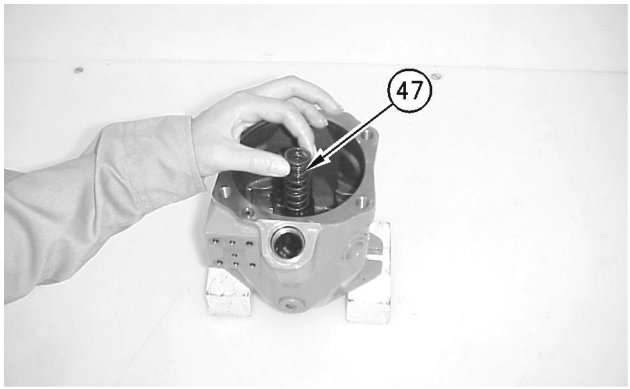


Illustration 577 g00670207

8. Install spring (47).

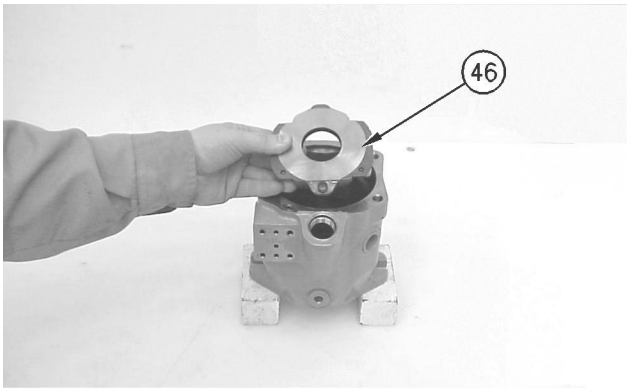


Illustration 578 g00670206

9. Install swashplate (46).

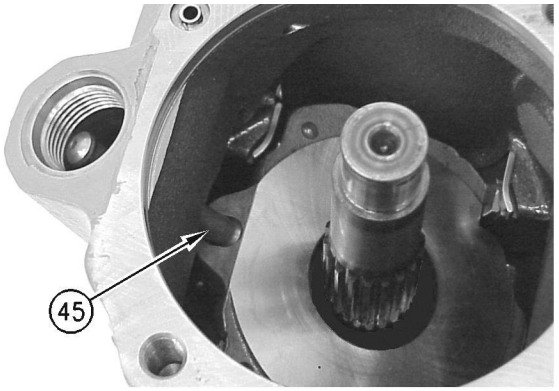


Illustration 579 g00670205

Note: Note that there is a correct connection of the piston rod and the swashplate.

10. Install piston rod (45).

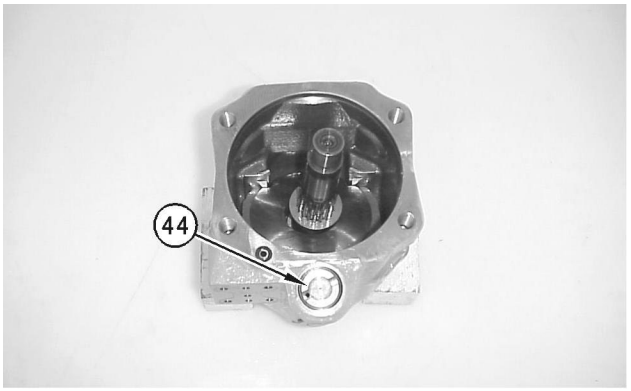


Illustration 580 g00670204

11. Install control piston (44).

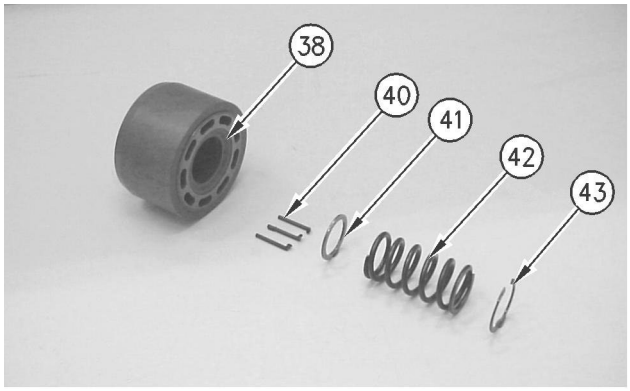


Illustration 581 g00669745

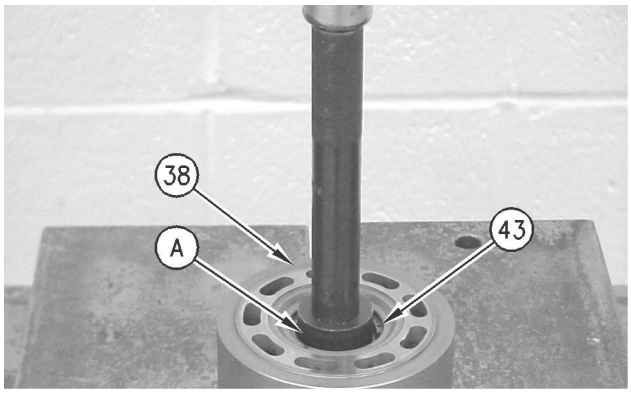


Illustration 582 g00669744

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

12. Install pins (40), guide (41) and spring (42) in barrel (38).

13. Use a suitable press and Tooling (A) to compress the spring (42) in barrel assembly (38).

14. Use Tooling (B) to install retaining ring (43).

15. Slowly release compression on spring (42). Make sure that the retaining ring (43) is seated properly.

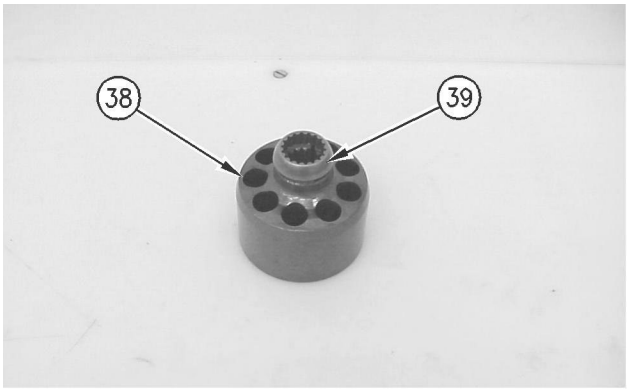


Illustration 583 g00669743

16. Install retaining ball (39) on barrel assembly (38).

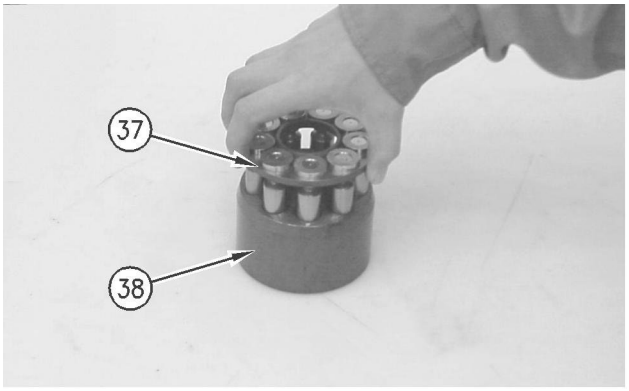


Illustration 584 g00669741

17. Install piston assembly (37) in barrel assembly (38).

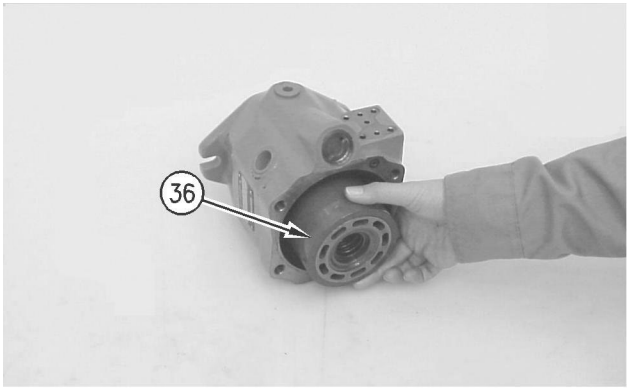


Illustration 585 g00669742

18. Install rotary group (36) onto the shaft. Make sure that the splines are aligned properly.

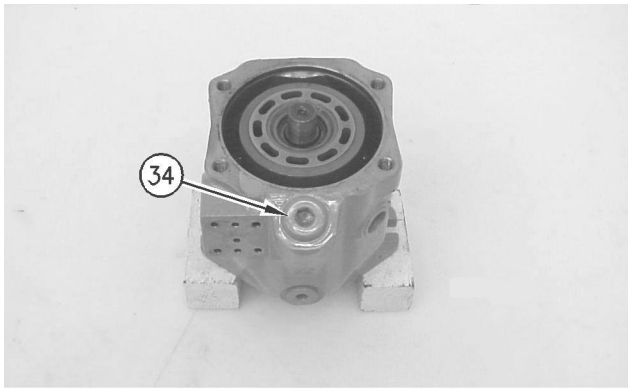


Illustration 586 g00669732

19. Inspect the O-ring seal on plug (34). Replace the O-ring seal, if necessary. Install plug (34).

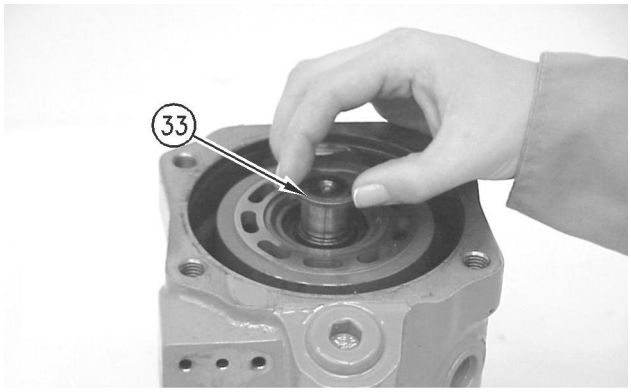


Illustration 587 g00669731

20. Install adjustment shim (33).

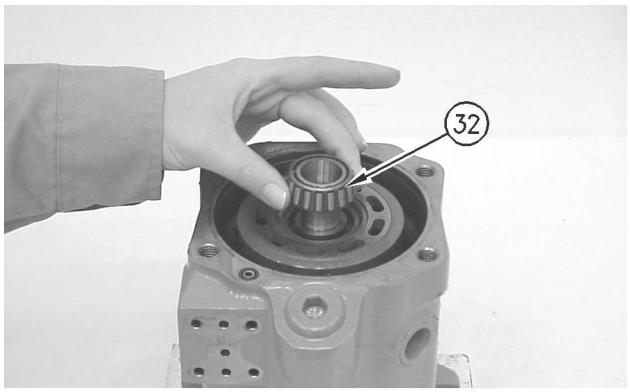


Illustration 588 g00669730

21. Install bearing cone (32) on the shaft.

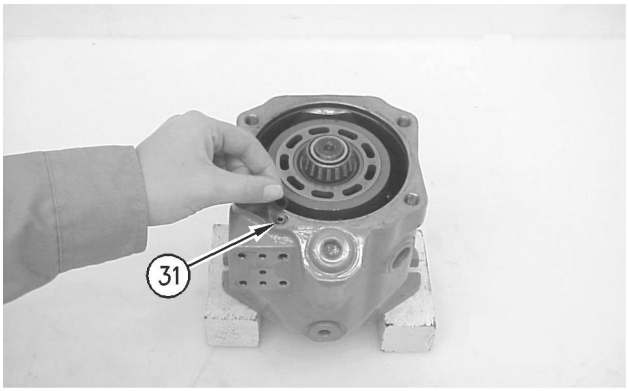


Illustration 589 g00669729

22. Install O-ring seal (31).

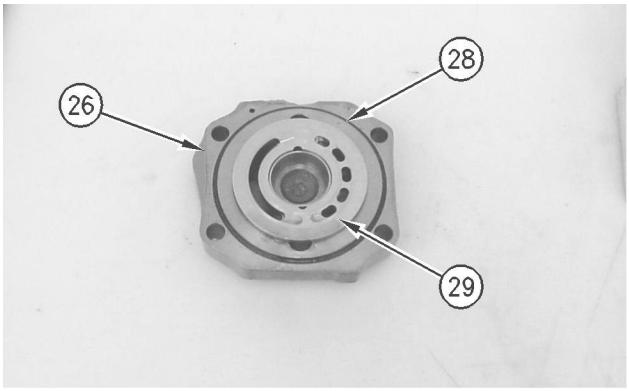


Illustration 590 g00669727

23. Install O-ring seal (28) and port plate (29) on head assembly (26).

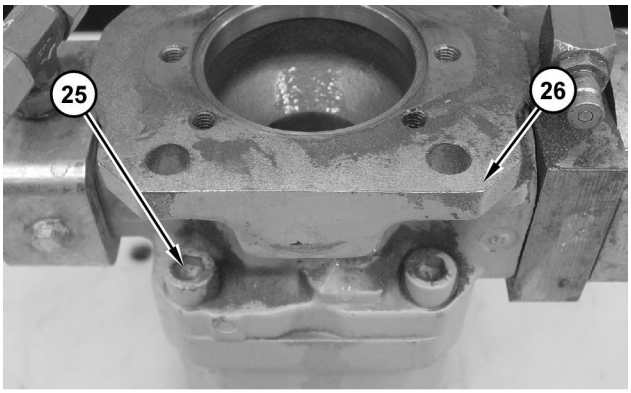


Illustration 591 g01238164

24. Install head assembly (26) and bolts (25). The torque for bolts (25) is 100 ± 20 N·m (75 ± 15 lb ft).

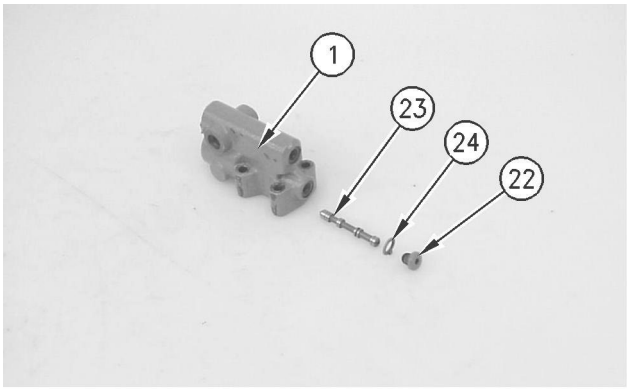


Illustration 592 g00670203

25. Install spool (23) in compensator valve (1). Install spacer (24) onto plug (22).

26. Install plug (22) in compensator valve (1). The torque for plug (22) is 31 ± 2 N·m (23 ± 1 lb ft).

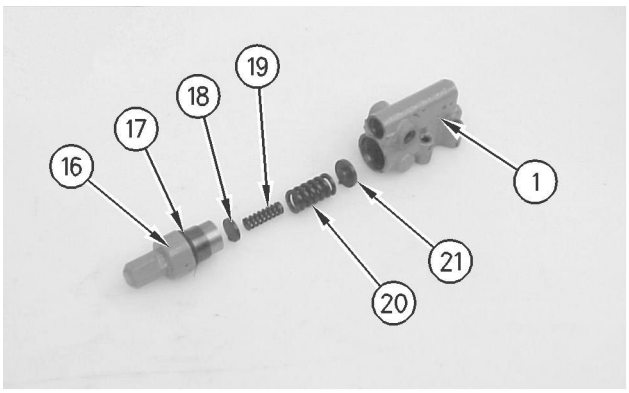


Illustration 593 g00670201

27. Install O-ring seal (17) to plug (16). Install plate (18), spring (19), spring (20), and guide (21) in compensator valve (1).

28. Install plug (16) in compensator valve (1). The torque for plug (16) is 100 ± 5 N·m (75 ± 3 lb ft).

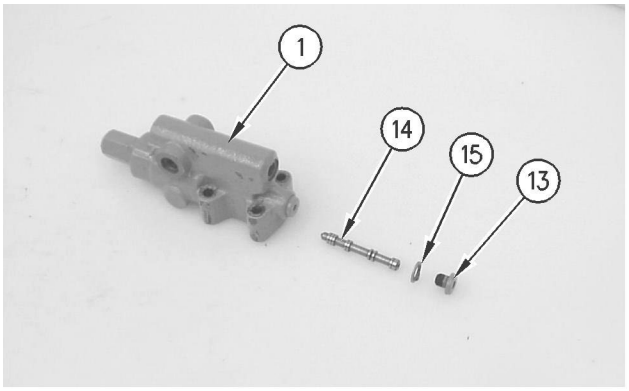


Illustration 594 g00670198

29. Install spool (14) in compensator valve (1). Install spacer (15) on plug (13).

30. Install plug (13) in compensator valve (1). The torque for plug (13) is 31 ± 2 N·m (23 ± 1 lb ft).

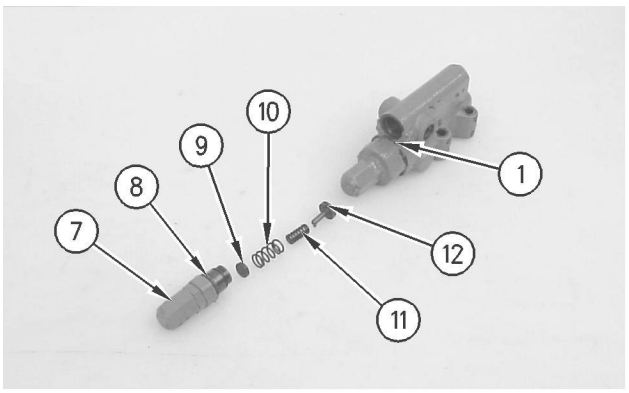


Illustration 595 g00670195

31. Install O-ring seal (8) to plug (7). Install plate (9), spring (10), spring (11), and guide (12) in compensator valve (1).

32. Install plug (7) in compensator valve (1). The torque for plug (7) is 80 ± 5 N·m (58 ± 3 lb ft).

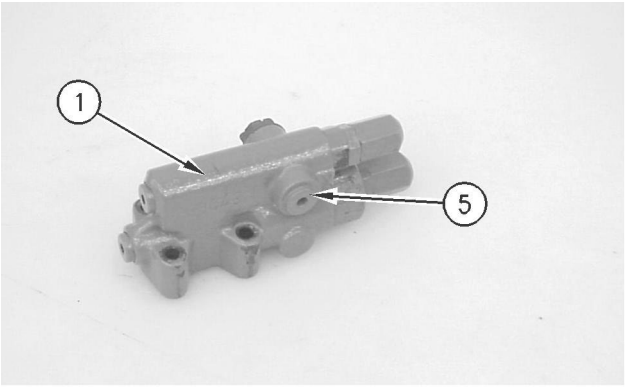


Illustration 596 g00670190

33. Inspect the O-ring seals on plugs (5). Replace the O-ring seals, if necessary. Install plugs (5) in compensator valve (1).

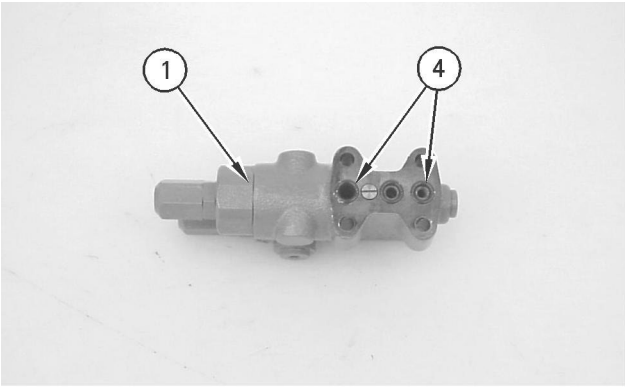


Illustration 597 g00670188

34. Inspect O-ring seals (4) and replace the O-ring seals, if necessary. Install three O-ring seals (4) on compensator valve (1).

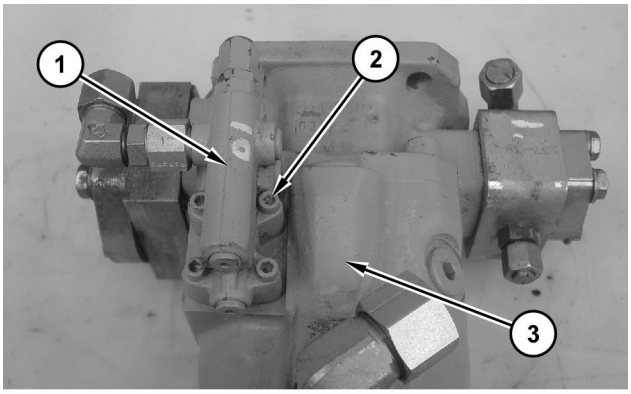


Illustration 598 g01238162

35. Install pressure and flow compensator valve (1) and bolts (2) to fan drive pump (3). The torque for bolts (2) is 34 ± 3 N·m (25 ± 2 lb ft).

End By:

a. Install the fan drive pump. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic Fan) - Install”.

i02473966

Piston Pump (Hydraulic Fan) - Install

SMCS Code: 1387-012-QP; 5070-012-HFN

Installation Procedure

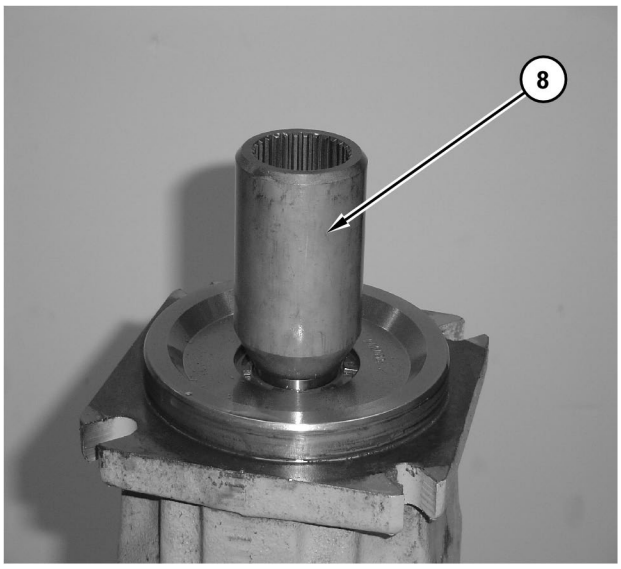


Illustration 599 g01234348

1. Install coupling (8).

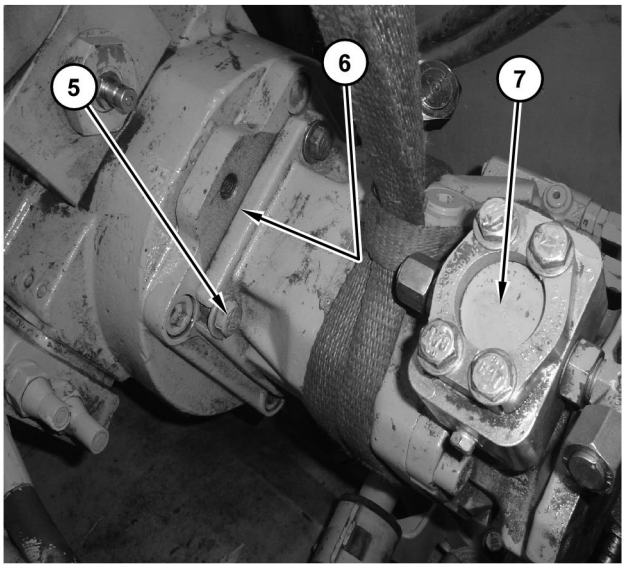


Illustration 600 g01234345

2. Install O-ring seal (6). Attach a suitable lifting device to pump assembly (7). Install pump assembly (7). The weight of pump assembly (7) is approximately 39 kg (85 lb). Install bolts (5).

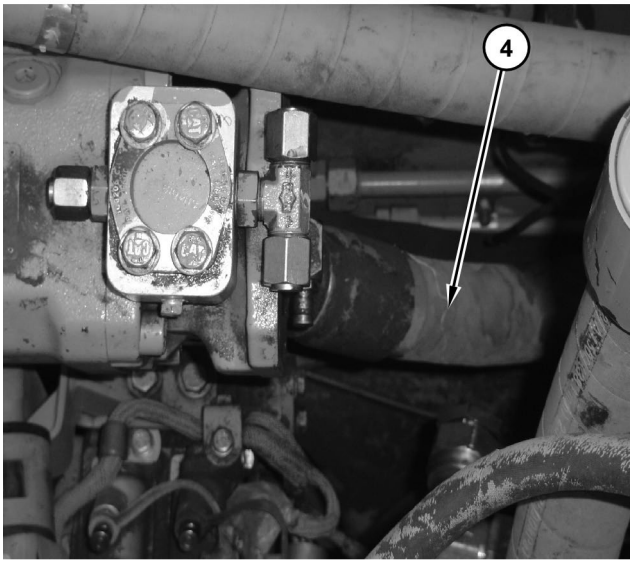


Illustration 601 g01234344

3. Connect hose assembly (4).

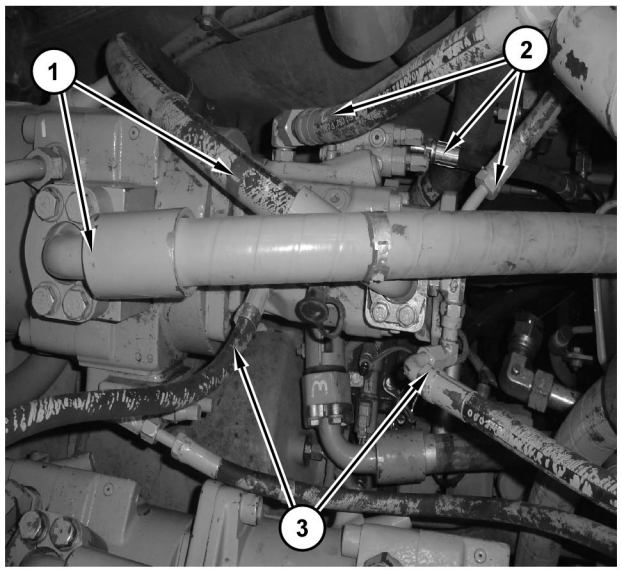


Illustration 602 g01234342

4. Connect hose assemblies (3), (2), and (1).

End By:

a. Install the gear pump (pilot brake). Refer to Disassembly and Assembly Manual, “Gear Pump (Pilot Brake) - Install”.

i02480113

Demand Fan Valve - Remove

SMCS Code: 5264-011-HFN; 5479-011-HFN

Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

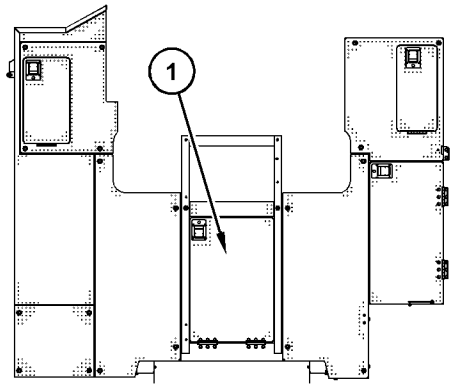


Illustration 603 g01238752

1. Open access door assembly (1).

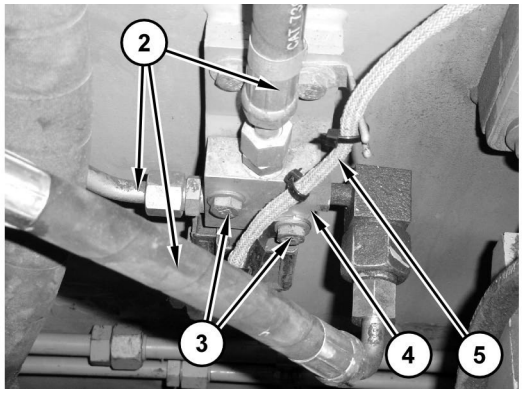


Illustration 604 g01238661

Note: The demand fan valve is located on the inside of the left frame rail.

2. Disconnect hose assemblies (2) and harness assemblies (5). Remove bolts (3) and demand fan valve assembly (4).

i02480123

Demand Fan Valve - Install

SMCS Code: 5264-012-HFN; 5479-012-HFN

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

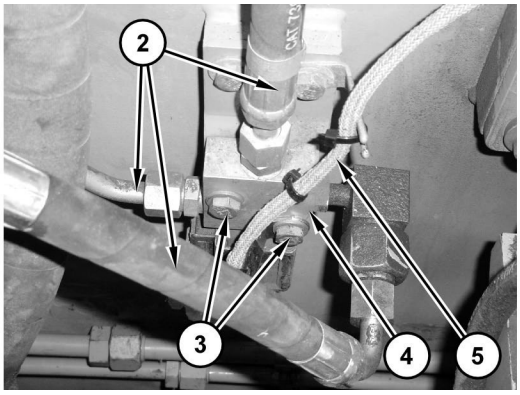


Illustration 605 g01238661

1. Position demand fan valve assembly (4) and install bolts (3). Connect harness assemblies (5) and hose assemblies (2).

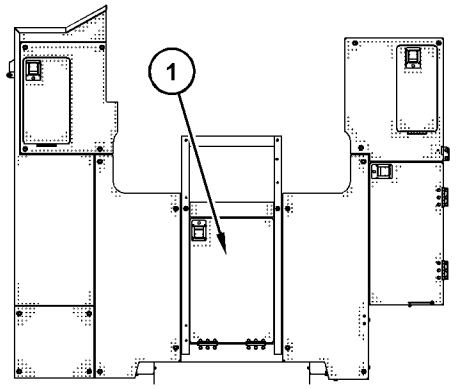


Illustration 606 g01238752

2. Close access door assembly (1).

i02476021

Fan and Piston Motor (Hydraulic Fan) - Remove

SMCS Code: 1356-011-MW; 1386-011-QP; 5058-011-HFN

Removal Procedure

Table 28

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	140-7742	Sleeve	2

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "System Pressure - Release".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

At operating temperature the implement hydraulic oil tank is hot and under pressure. Hot oil can cause burns.

To prevent possible injury, release the pressure in the implement hydraulic system before hydraulic lines or components are disconnected or removed.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

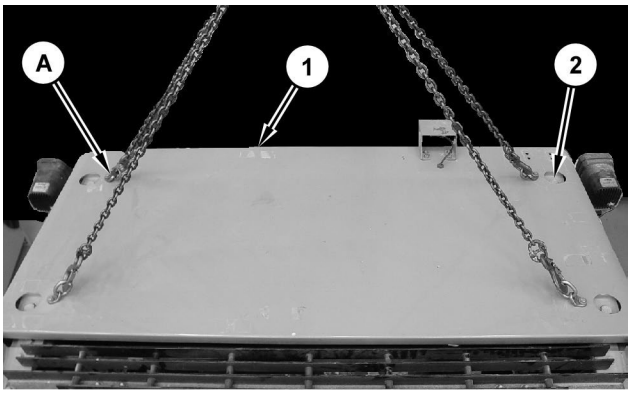


Illustration 607 g01236127

1. Attach Tooling (A) and a suitable lifting device onto panel assembly (1). The weight of panel assembly is approximately 66 kg (145 lb).

2. Remove bolts (2) and raise panel assembly (1) slightly.

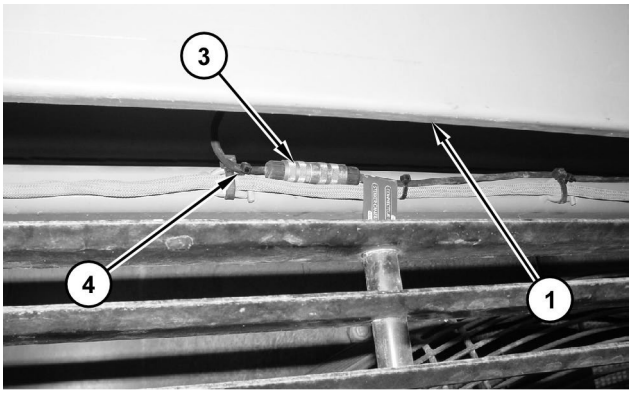


Illustration 608 g01239507

3. Disconnect harness assembly (3). Remove cable strap (4).

4. Remove panel assembly (1).

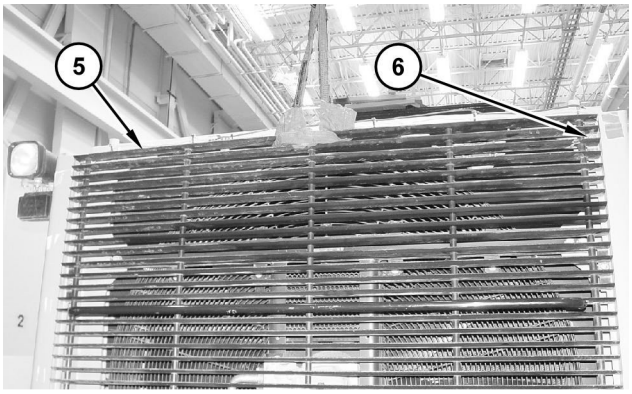


Illustration 609 g01236006

5. Attach a suitable lifting device and Tooling (B) onto grill assembly (5). The weight of grill assembly (5) is approximately 61 kg (135 lb).

6. Remove bolts (6). Remove grill assembly (5).

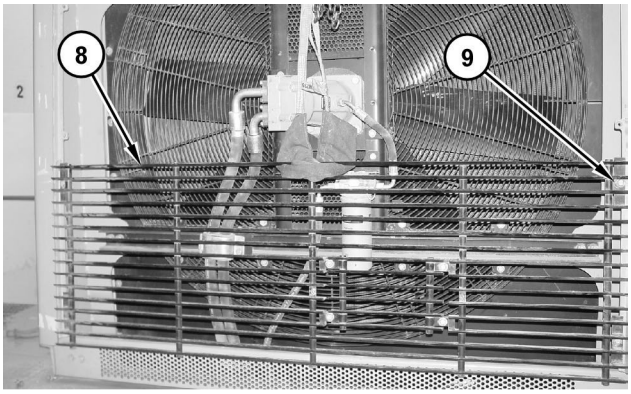


Illustration 610 g01236015

7. Attach a suitable lifting device and Tooling (B) onto grill assembly (8). The weight of grill assembly (8) is approximately 36 kg (80 lb).

8. Remove bolts (9). Remove grill assembly (8).

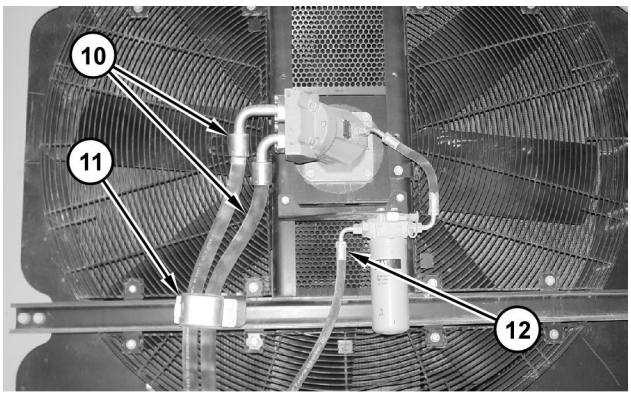


Illustration 611 g01236018

9. Disconnect hose assemblies (10). Remove clip (11). Disconnect hose assembly (12).

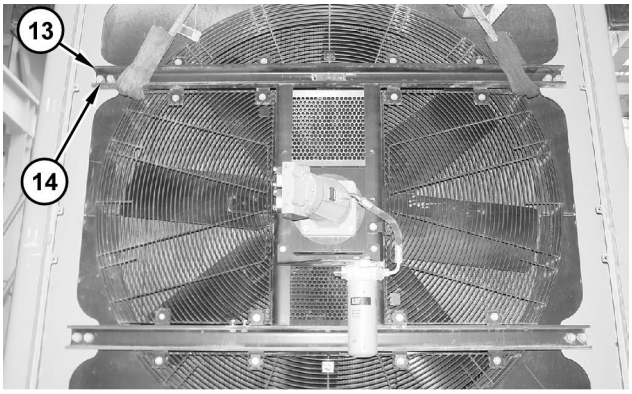


Illustration 612 g01236025

10. Attach a suitable lifting device and Tooling (B) onto fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 261 kg (575 lb).

11. Remove bolts (14). Remove fan and piston motor assembly (13).

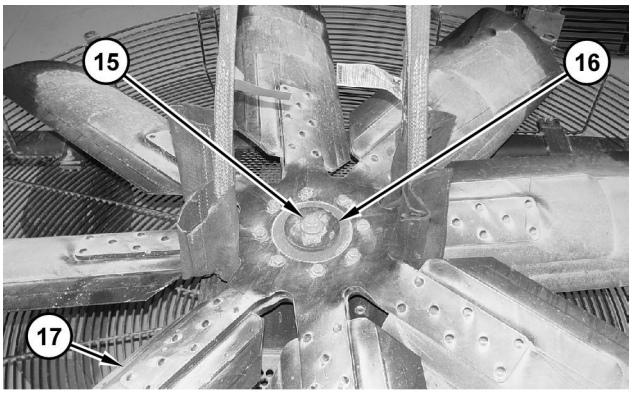


Illustration 613 g01236066

12. Position fan and piston motor assembly (13) onto suitable blocking.

13. Remove bolt (15) and washer (16). Remove fan assembly (17). The weight of fan assembly (17) is approximately 86 kg (190 lb).

14. Use a suitable lifting device in order to turn over fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 175 kg (385 lb).

Note: The fan has been removed.

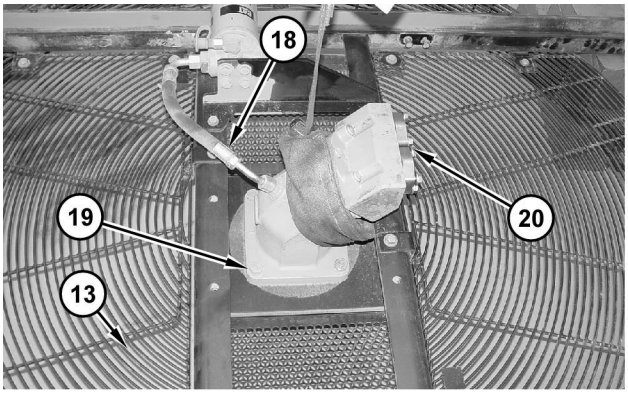


Illustration 614 g01236064

15. Attach a suitable lifting device and Tooling (B) onto piston motor (20). Disconnect hose assembly (18). Remove bolts (19). Remove piston motor (20). The weight of piston motor (20) is approximately 34 kg (75 lb).

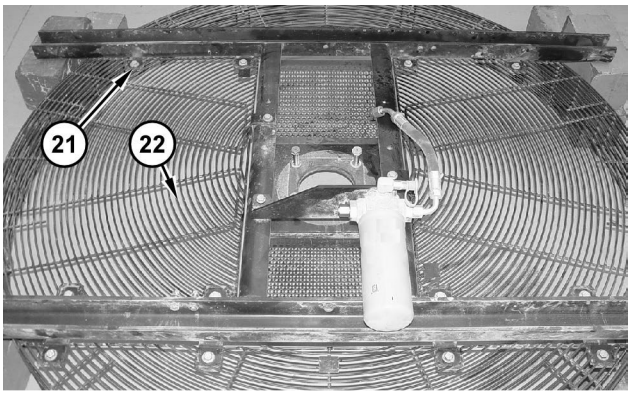


Illustration 615 g01236085

16. If necessary, Remove bolts (21) in order to remove guard assemblies (22).

i02478691

Piston Motor (Hydraulic Fan) - Disassemble

SMCS Code: 1386-015-QP; 5058-015-HFN

Disassembly Procedure

Table 29

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1861	Retaining Ring Pliers	1

(continued)

(Table 29, contd)

Required Tools			
B	4C-5656	Adapter	1
	126-7183	Crossblock	1
	126-7182	Nut	1
	126-7181	Sliding Plate	4
	126-7177	Puller Leg	2
	5P-4808	Cap	2
	1B-4430	Jam Nut	2
C	8H-0663	Bearing Puller	1
D	1P-1860	Retaining Ring Pliers	1

Start By:

a. Remove the piston motor. Refer to Disassembly and Assembly, “Piston Motor (Hydraulic Fan) - Remove”.

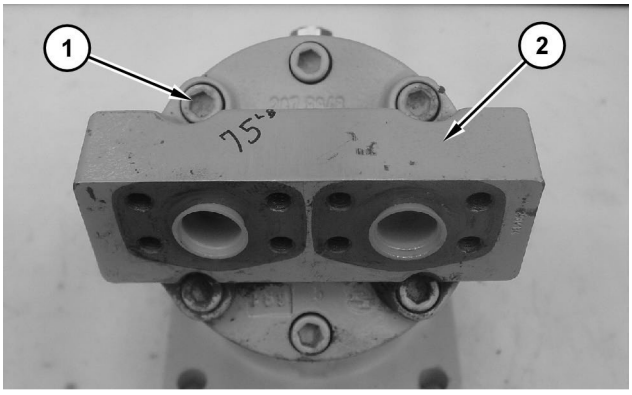


Illustration 616 g01237986

1. Remove bolts (1) and head (2).

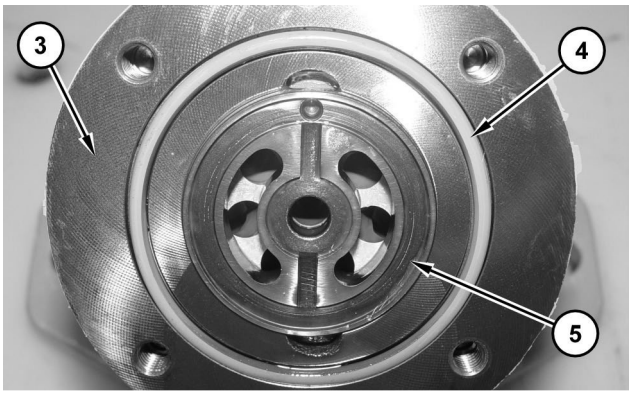


Illustration 617 g01171621

2. Remove O-ring seal (4) and port plate (5) from housing (3).

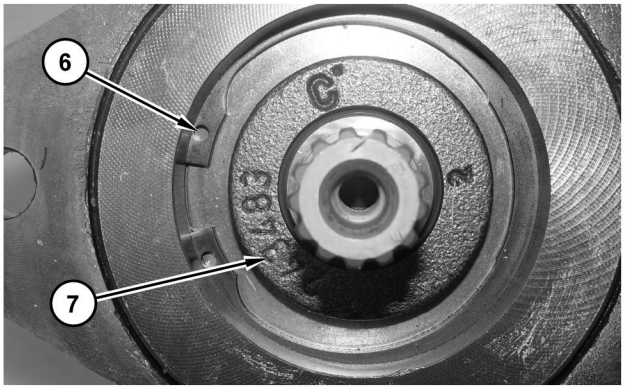


Illustration 618 g01171622

3. Use Tooling (A) in order to remove retaining ring (6).

4. Remove cover (7).

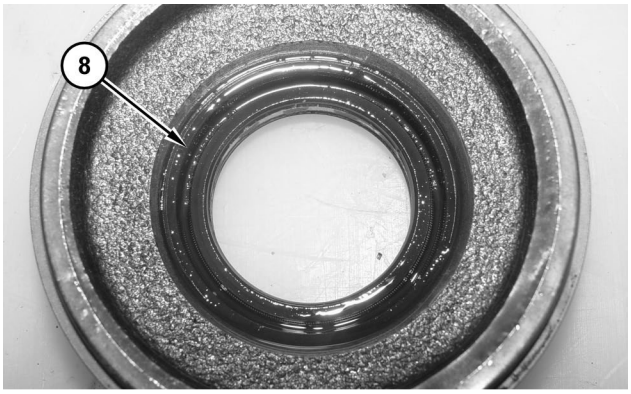


Illustration 619 g01171624

5. Remove lip seal (8).



Illustration 620 g01171625

6. Remove O-ring seal (9) and shim (10).

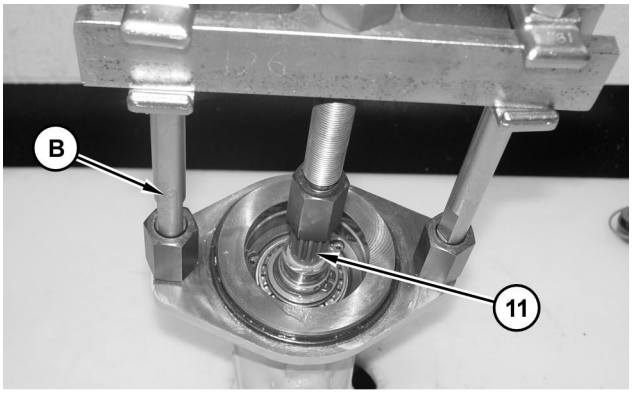


Illustration 621 g01171628

7. Use Tooling (B) in order to remove rotating group (11).

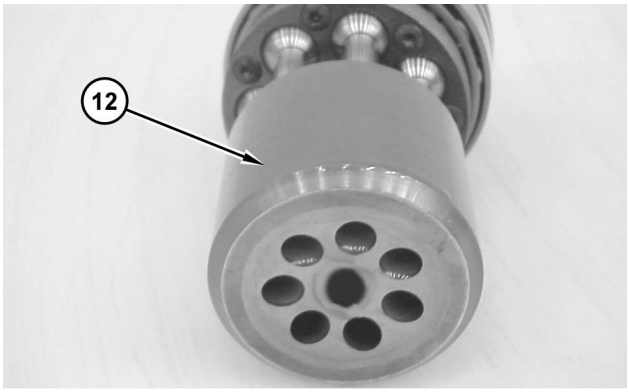


Illustration 622 g01171627

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

8. Remove barrel assembly (12).

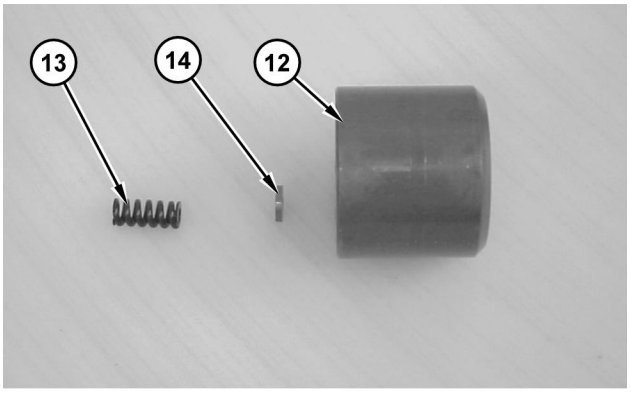


Illustration 623 g01171631

9. Remove spring (13) and washer (14) from barrel assembly (12).

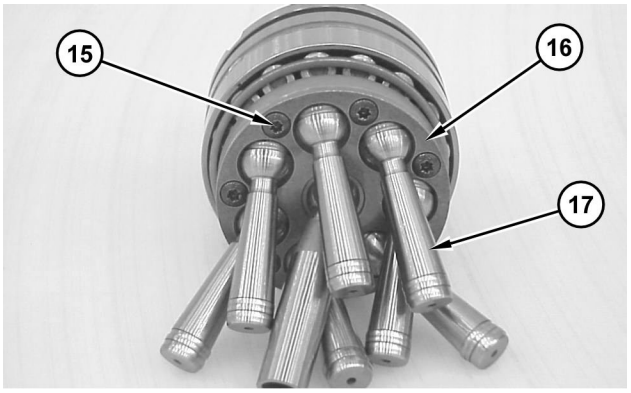


Illustration 624 g01171632

10. Remove bolts (15) and retainer (16).

11. Remove pistons (17).

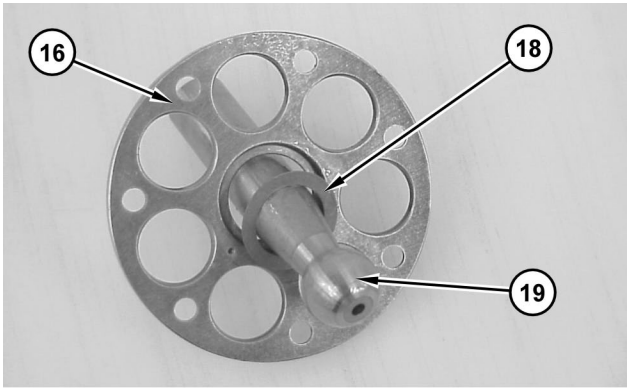


Illustration 625 g01171634

12. Remove center pin (19) and bearing (18) from retainer (16).

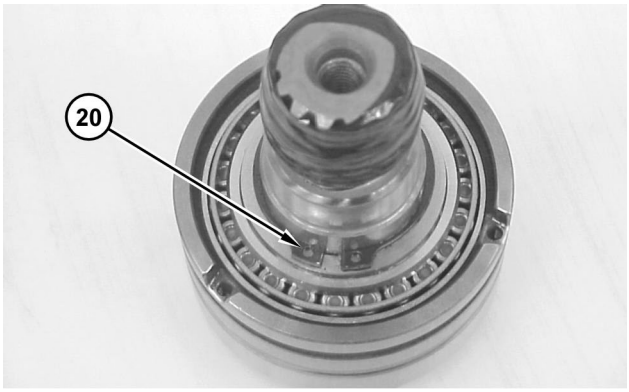


Illustration 626 g01171636

13. Use Tooling (D) in order to remove retaining ring (20).

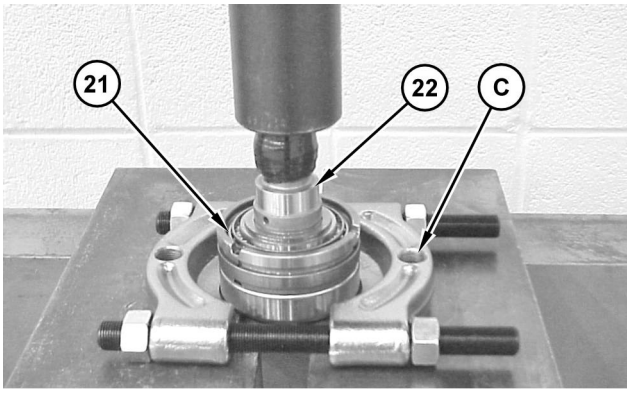


Illustration 627 g01171637

14. Use Tooling (C) and a suitable press in order to remove bearing kit (21) from shaft (22).

i02478693

Piston Motor (Hydraulic Fan) - Assemble

SMCS Code: 1386-016-QP; 5058-016-HFN

Assembly Procedure

Table 30

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1861	Retaining Ring Pliers	1
B	4C-5656	Adapter	1
	126-7183	Crossblock	1

(continued)

(Table 30, contd)

Required Tools			
	126-7182	Nut	1
	126-7181	Sliding Plate	4
	126-7177	Puller Leg	2
	5P-4808	Cap	2
	1B-4430	Jam Nut	2
D	1P-1860	Retaining Ring Pliers	1

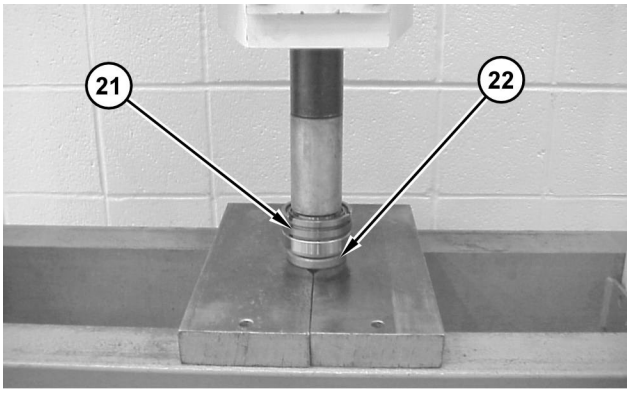


Illustration 628 g01172199

1. Use a suitable press in order to install bearing kit (21) onto shaft (22).

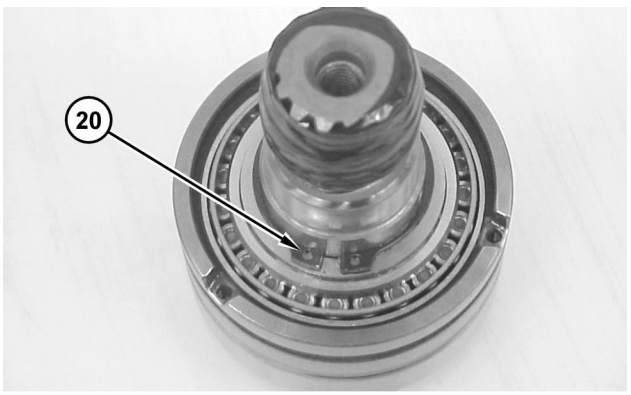


Illustration 629 g01171636

2. Use Tooling (D) in order to install retaining ring (20).

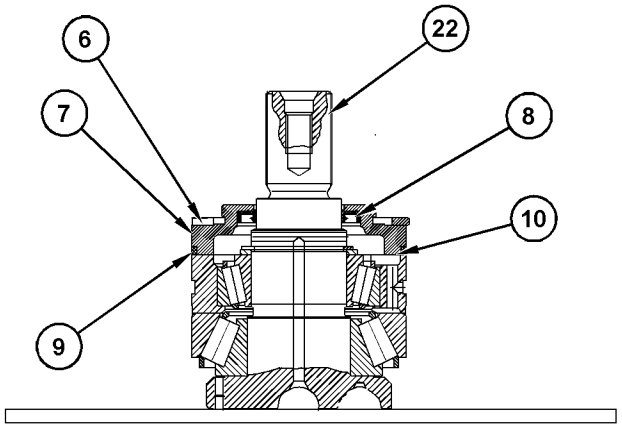


Illustration 630 g01172201

3. Install lip seal (8) into cover (7). Install shims (10), cover (7), and retaining ring (6) onto shaft (22).

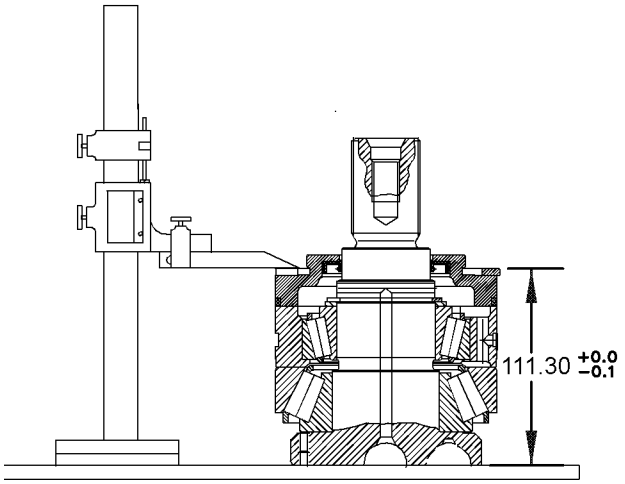


Illustration 631 g01237995

4. Use a height gauge to measure the bearing assembly. The correct dimension is 111.30 + 0.0 − 0.100 mm (4.3818 + 0.00 − 0.0039 inch). This measurement determines the correct angle of the rotating group.

5. Add shims or subtract shims (10), if necessary.

6. Once the correct dimension is achieved, install retaining ring (6), cover (7), and shims (10) from shaft (22).

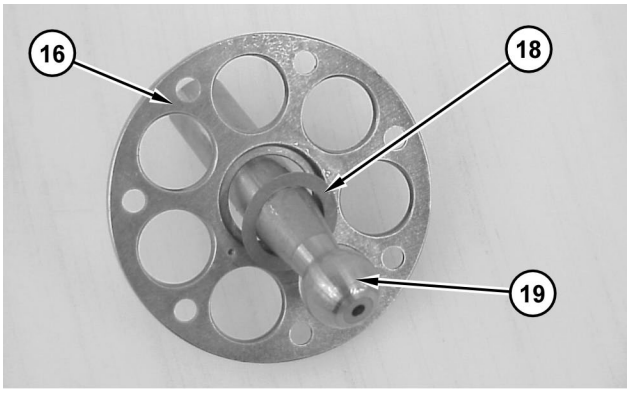


Illustration 632 g01171634

7. Install center pin (19) and bearing (18) onto retainer (16).

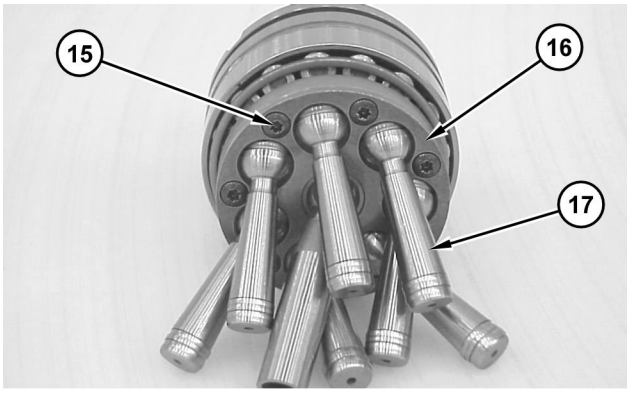


Illustration 633 g01171632

8. Install pistons (17).

9. Install retainer (16) and bolts (15).

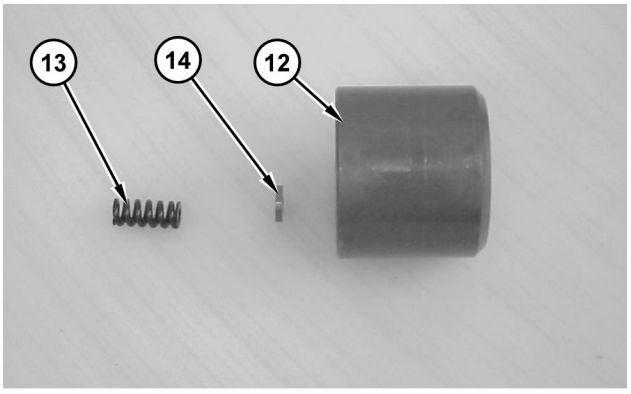


Illustration 634 g01171631

10. Install washer (14) and spring (13) into barrel assembly (12).

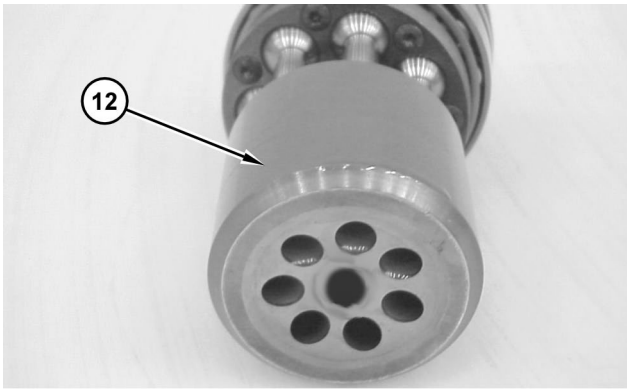


Illustration 635 g01171627

11. Install barrel assembly (12).

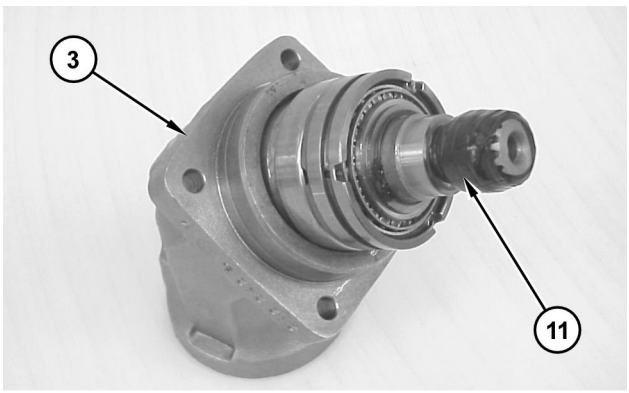


Illustration 636 g01172204

12. Raise the temperature of housing (3). Lower the temperature of rotating group (11).

13. Install rotating group (11) into housing (3). Do not allow the barrel to separate from the pistons during the installation procedure.



Illustration 637 g01171625

14. Install shims (10) and O-ring seal (9).

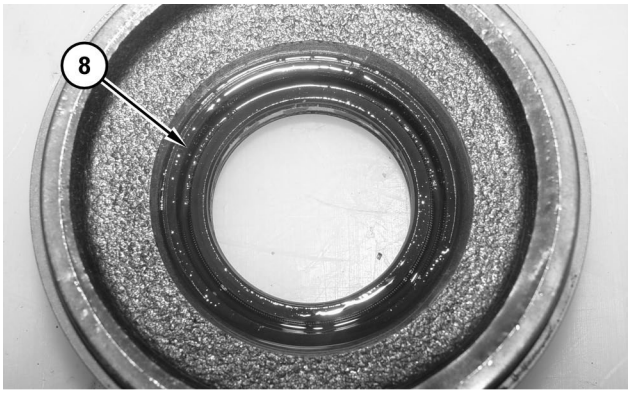


Illustration 638 g01171624

15. Install lip seal (8).

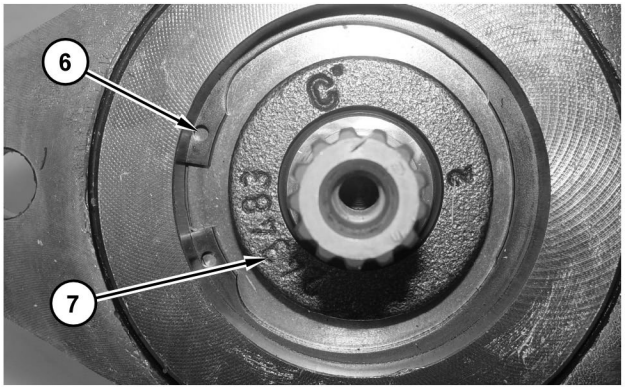


Illustration 639 g01171622

16. Install cover (7).

17. Use Tooling (A) in order to install retaining ring (6).

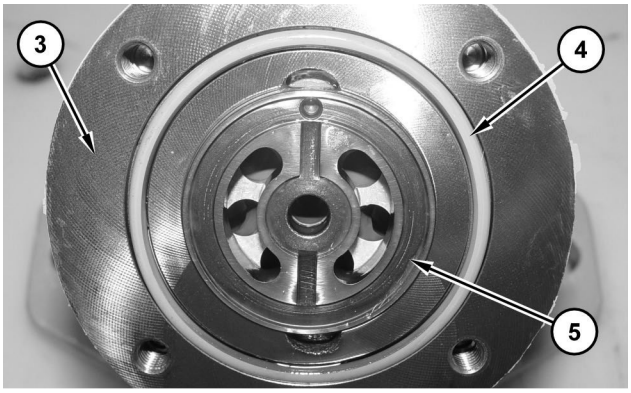


Illustration 640 g01171621

18. Install O-ring seal (4) and port plate (5) into housing (3).

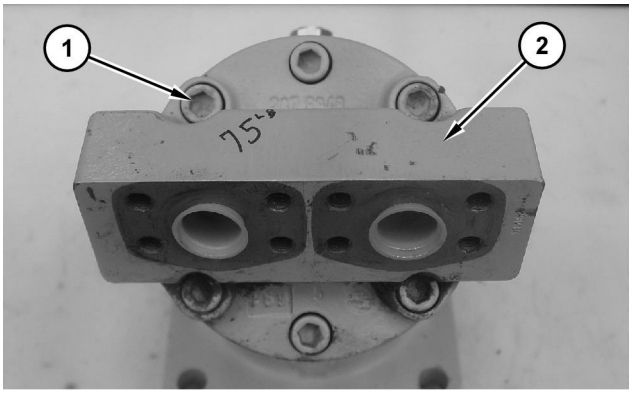


Illustration 641 g01237986

19. Install head (2) and bolts (1).

End By:

a. Install the piston motor. Refer to Disassembly and Assembly, "Piston Motor (Hydraulic Fan) - Install".

i02476023

Fan and Piston Motor (Hydraulic Fan) - Install

SMCS Code: 1356-012-MW; 1386-012-QP; 5058-012-HFN

Installation Procedure

Table 31

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	4
B	140-7742	Sleeve	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

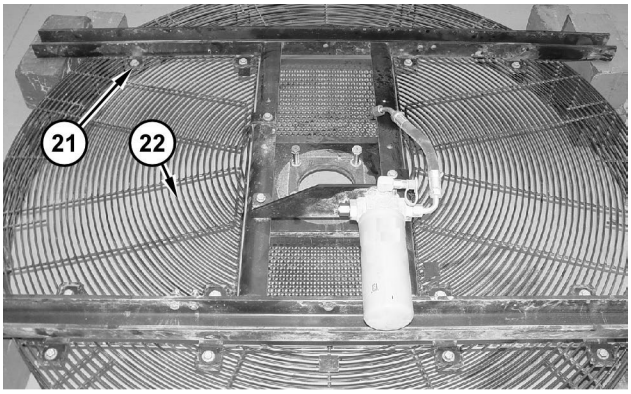


Illustration 642 g01236085

1. If the guards were removed, position guard assemblies (22) and install bolts (21).

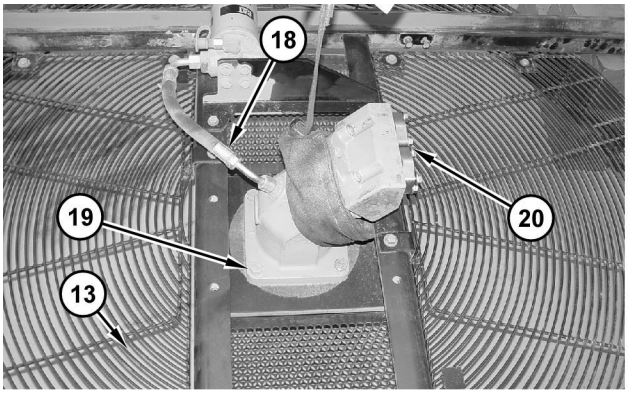


Illustration 643 g01236064

2. Attach a suitable lifting device and Tooling (B) onto piston motor (20). Install piston motor (20). The weight of piston motor (20) is approximately 34 kg (75 lb). Install bolts (19). Connect hose assembly (18).

3. Use a suitable lifting device in order to turn over fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 175 kg (385 lb).

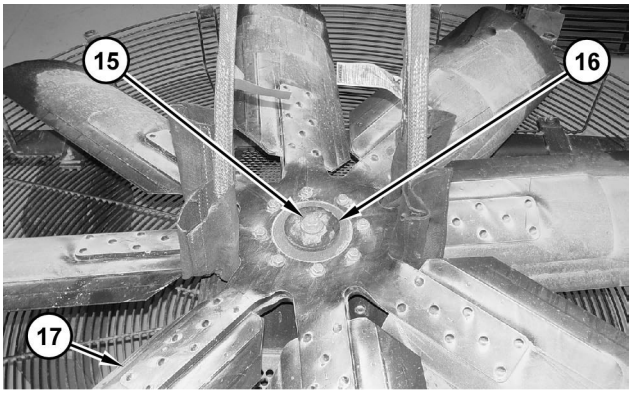


Illustration 644 g01236066

4. Install fan assembly (17). The weight of fan assembly (17) is approximately 86 kg (190 lb). Install washer (16) and install bolt (15).

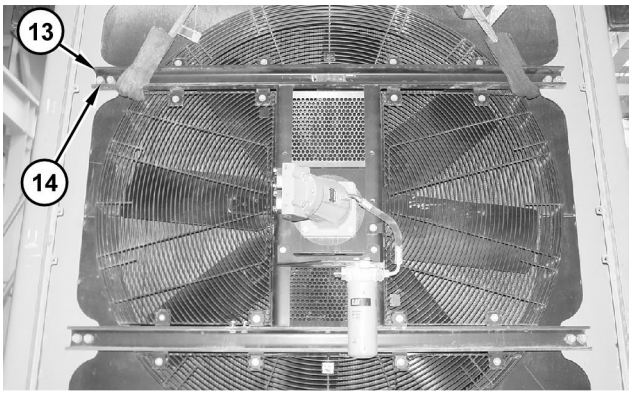


Illustration 645 g01236025

5. Attach a suitable lifting device and Tooling (B) onto fan and piston motor assembly (13). The weight of fan and piston motor assembly (13) is approximately 261 kg (575 lb).

6. Position fan and piston motor assembly (13). Install bolts (14).

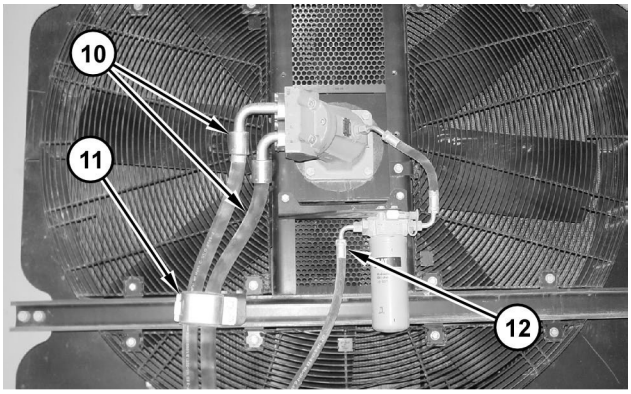


Illustration 646 g01236018

7. Connect hose assembly (12). Install clip (11). Connect hose assemblies (10).

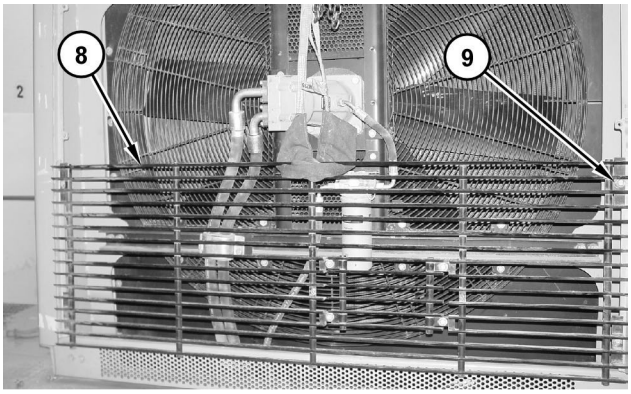


Illustration 647 g01236015

8. Attach a suitable lifting device and Tooling (B) onto grill assembly (8). The weight of grill assembly (8) is approximately 36 kg (80 lb).

9. Position grill assembly (8). Install bolts (9).

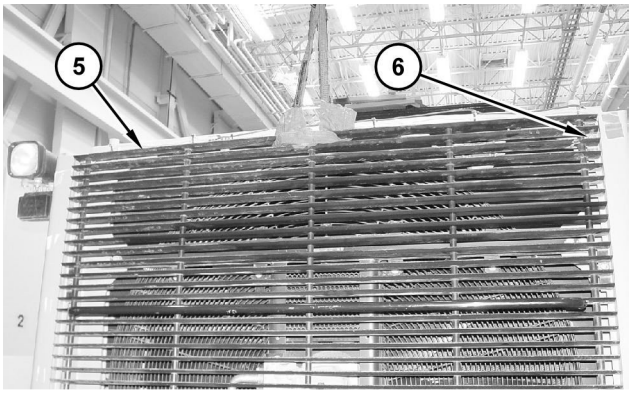


Illustration 648 g01236006

10. Attach a suitable lifting device and Tooling (B) onto grill assembly (5). The weight of grill assembly (5) is approximately 61 kg (135 lb).

11. Position grill assembly (5). Install bolts (6).

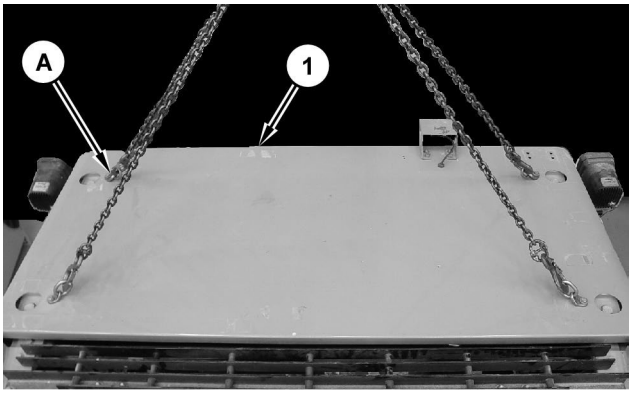


Illustration 649 g01236123

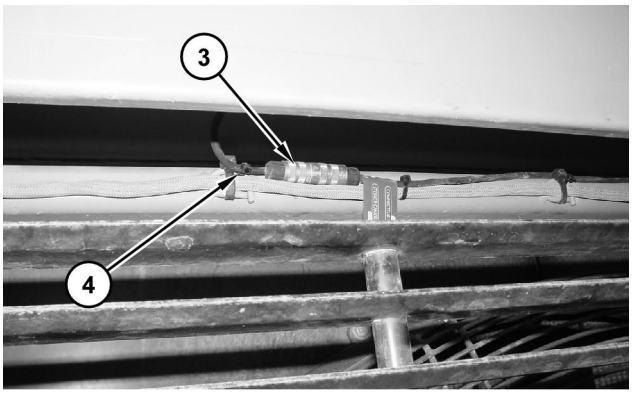


Illustration 650 g01235398

12. Attach Tooling (A) and a suitable lifting device onto panel assembly (1). The weight of panel assembly (1) is approximately 66 kg (145 lb).

13. Position panel assembly (1) in order to connect harness assembly (3). Install cable strap (4).

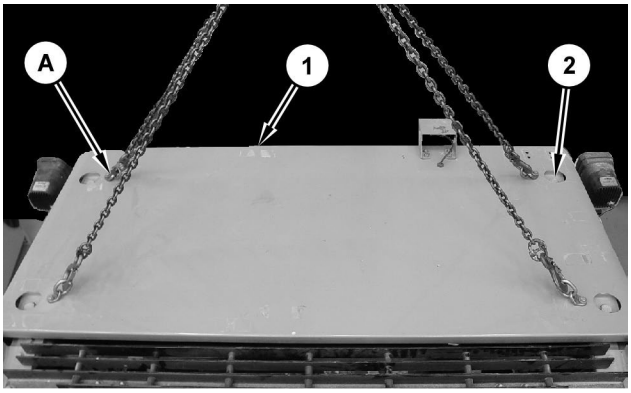


Illustration 651 g01236138

14. Lower panel assembly (1) and install bolts (2).

15. Remove Tooling (A).

i02480103

Accumulator (Pilot) - Remove and Install

SMCS Code: 5077-010-PS

Removal Procedure

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly , " Hydraulic System Pressure - Release".

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

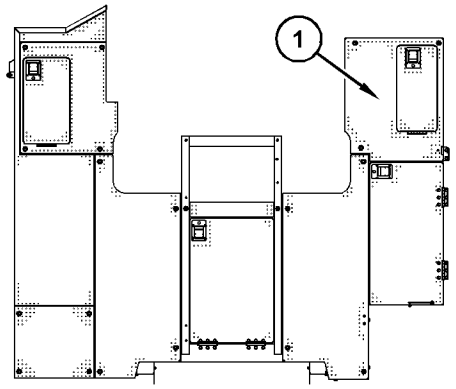


Illustration 652 g01241202

1. Use two people in order to remove panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).

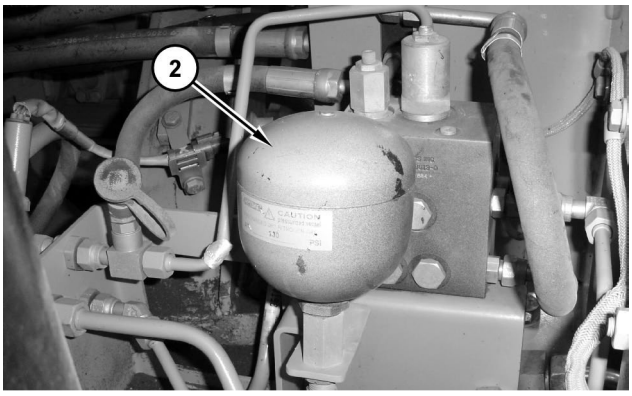


Illustration 653 g01238638

2. Remove accumulator (2).

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

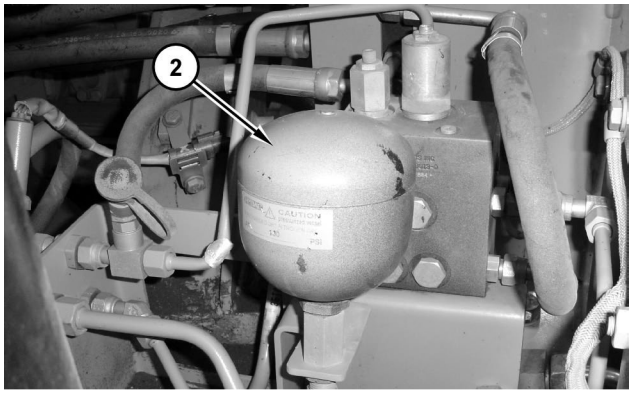


Illustration 654 g01238638

1. Install accumulator (2).

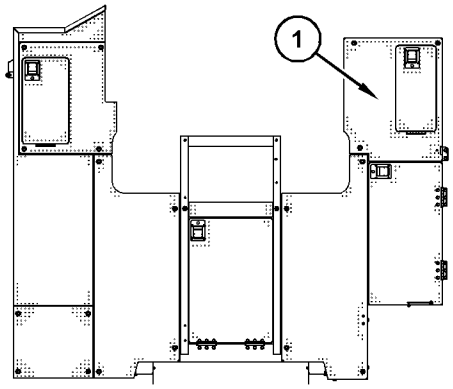


Illustration 655 g01241202

2. Use two people in order to install panel assembly (1). The weight of panel assembly (1) is approximately 27 kg (60 lb).

i02514823

Pilot Operated Hydraulic Control (Joystick) - Remove

SMCS Code: 5059-011; 5063-011; 5705-011

Removal Procedure

Start By:

a. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

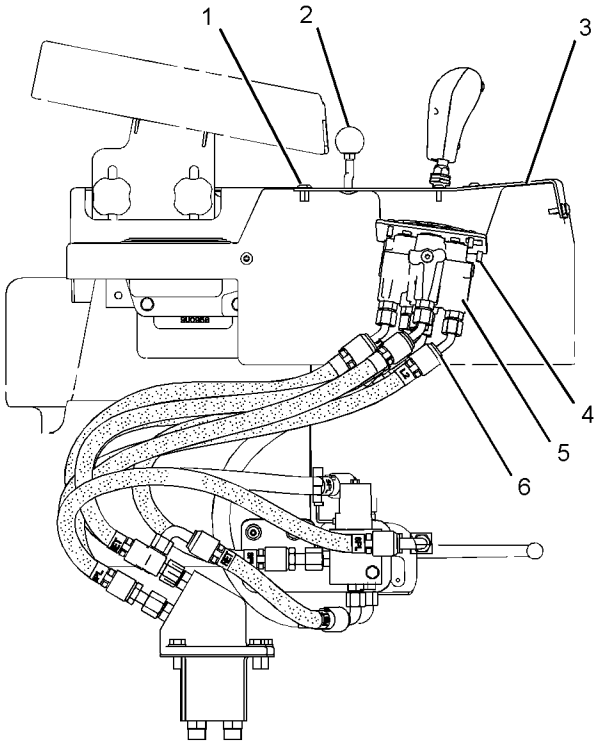


Illustration 656 g01258054

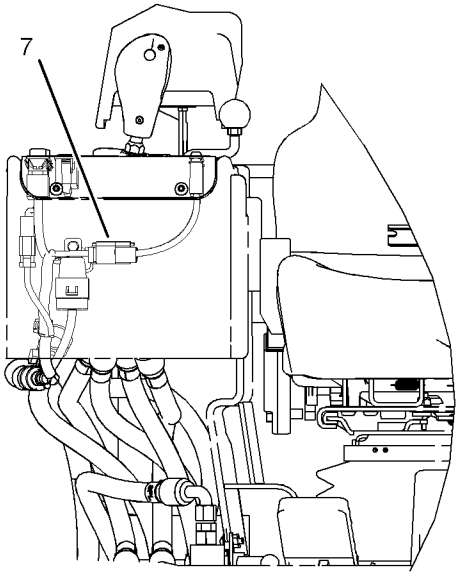


Illustration 657 g01258057

1. Disconnect harness assemblies (7) and hose assemblies (6).

2. Remove knob (2), screws (1), and cover assembly (3).

3. Remove bolts (4) and pilot operated hydraulic control (5).

i02514082

Pilot Operated Hydraulic Control (Joystick) - Disassemble

SMCS Code: 5059-015; 5063-015; 5705-015

Disassembly Procedure

Start By:

a. Remove the pilot control valve. Refer to Disassembly and Assembly, “Pilot Operated Hydraulic Control (Joystick) - Remove”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

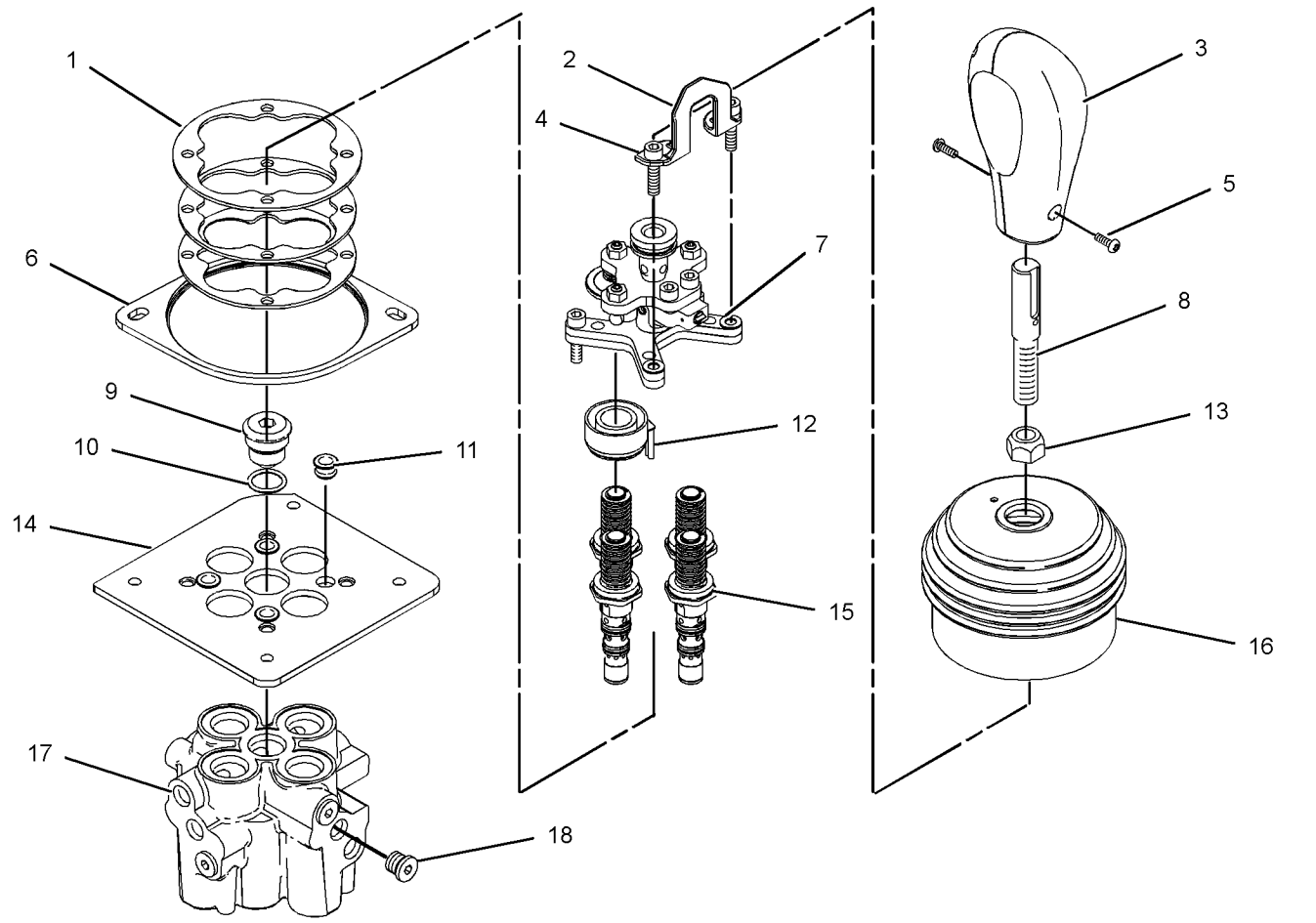


Illustration 658 g01257817

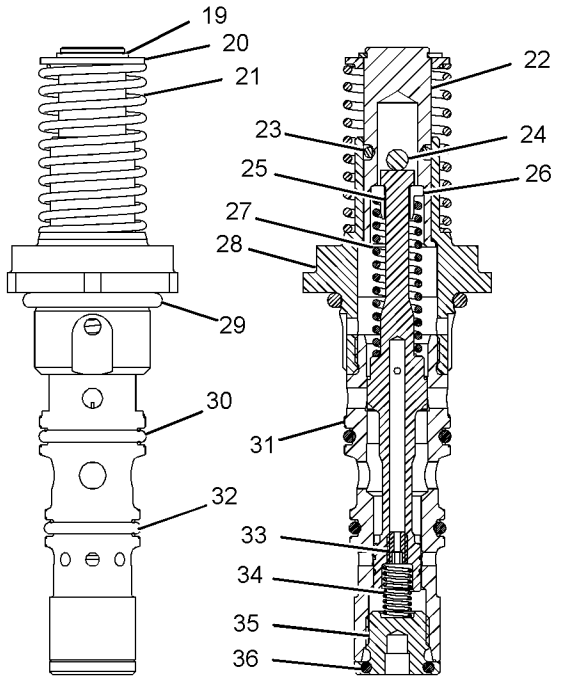


Illustration 659 g01257821

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Remove screws (5) and handle (3).

2. Remove boot (16), rod (8), and nut (13).

3. Remove bolts (4), plate (2), and lever assembly (7).

4. Remove coil assembly (12), plates (1), and shim (6).

5. Remove adapter (9), O-ring seal (10), grommets (11), and plate assembly (14) from pilot valve (17).

6. Remove cartridge assemblies (15).

7. Use the following procedure in order to disassemble cartridge assemblies (15).

a. Remove O-ring seals (29), (30), and (32).

b. Carefully compress spring (21) in order to remove retaining ring (19).

c. Remove retainer (20) and spring (21).

d. Remove stop (35), O-ring seal (36), spring (34), and orifice (33).

e. Remove adapter (28) from cage (31).

f. Remove plunger (22), O-ring seal (23), and ball (24) from adapter (28).

g. Compress spring (27) in order to remove retainers (26) from spool (25).

h. Remove spring (27) and spool (25) from cage (31).

8. Remove plugs (18) and the O-ring seals from pilot valve (17).

i02514083

Pilot Operated Hydraulic Control (Joystick) - Assemble

SMCS Code: 5059-016; 5063-016; 5705-016

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

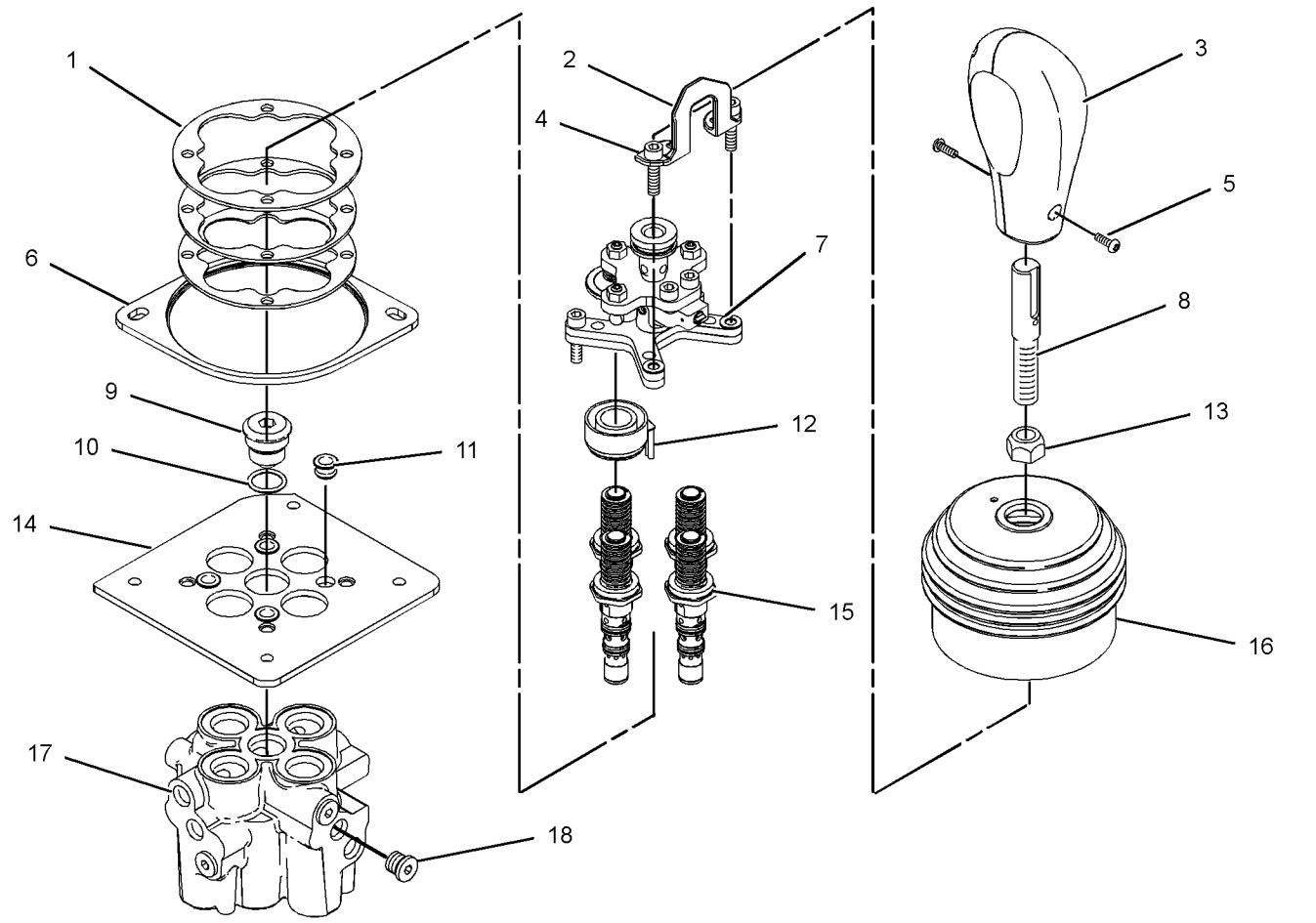


Illustration 660 g01257817

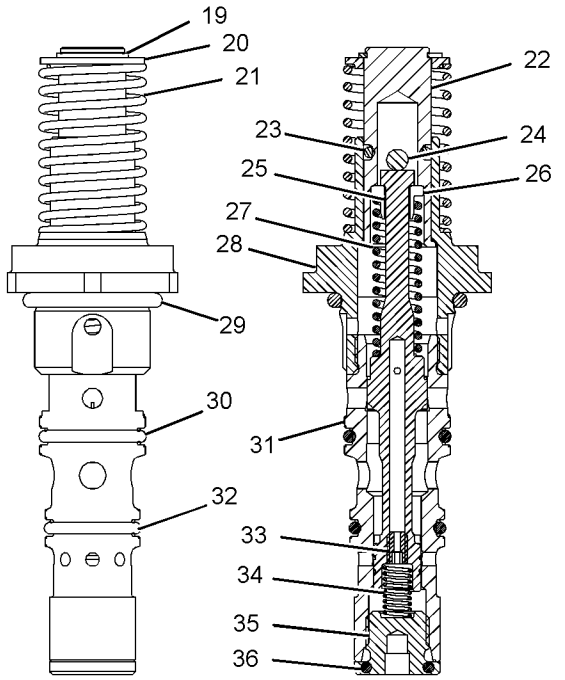


Illustration 661 g01257821

1. Install plugs (18) and the O-ring seals in pilot valve (17). Tighten plugs (18) to a torque of 12 ± 3 N·m (106 ± 27 lb in).

2. Use the following procedure to assemble cartridge assemblies (15).

a. Install orifice (33) in spool (25). Tighten orifice (33) to a torque of 2.5 ± 0.5 N·m (22 ± 4 lb in).

b. Compress spring (27) on spool (25) in order to install retainers (26).

c. Install spool (25) in cage (31).

d. Install plunger (22), O-ring seal (23), and ball (24) in adapter (28).

e. Assemble adapter (28) to cage (31). Tighten cage (31) in adapter (28) to a torque of 15 ± 2 N·m (133 ± 18 lb in).

f. Install spring (34), stop (35), and O-ring seal (36) in cage (31). Tighten stop (35) to a torque of 6 ± 1 N·m (53 ± 9 lb in).

.

3. Install cartridge assemblies (15) in pilot valve (17).

4. Install plate assembly (14), grommets (11), adapter (9), and O-ring seal (10). Tighten adapter (9) to a torque of 45 ± 5 N·m (33 ± 4 lb ft).

5. Install shim (6), plates (1), and coil assembly (12).

6. Install lever assembly (7), plate (2), and bolts (4). Tighten bolts (4) to a torque of 20 ± 3 N·m (15 ± 2 lb ft).

7. Install boot (16), rod (8), and nut (13). Tighten nut (13) to a torque of 45 ± 5 N·m (33 ± 4 lb ft).

8. Install handle (3) and screws (5).

End By:

a. Install the pilot control valve. Refer to Disassembly and Assembly, “Pilot Operated Hydraulic Control (Joystick) - Install”.

i02514824

Pilot Operated Hydraulic Control (Joystick) - Install

SMCS Code: 5059-012; 5063-012; 5705-012

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

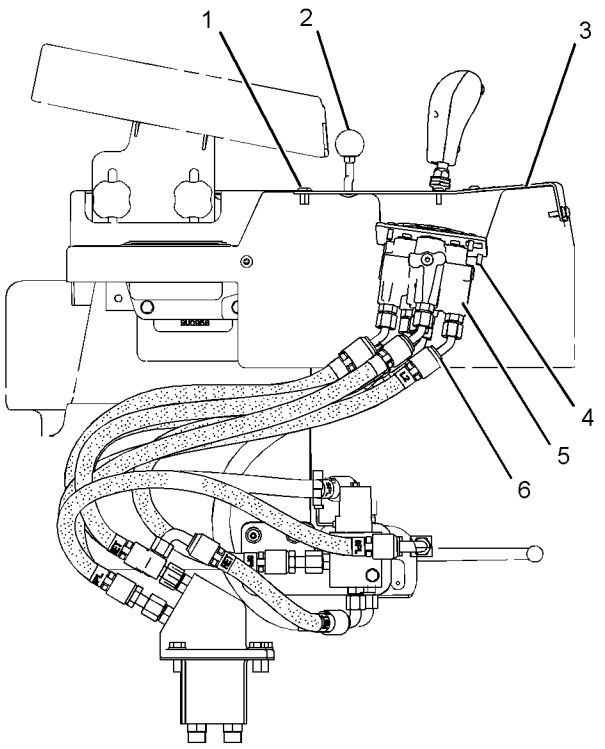


Illustration 662 g01258054

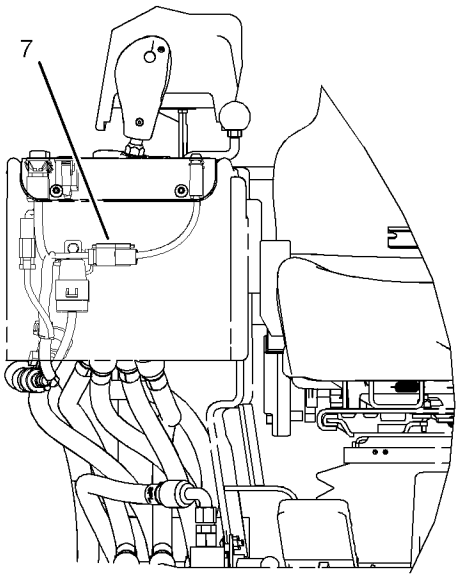


Illustration 663 g01258057

1. Install pilot operated hydraulic control (5) and bolts (4).

2. Install cover assembly (3), screws (1), and knob (2).

3. Connect hose assemblies (6) and harness assemblies (7).

i02514420

Main Control Valve - Remove

SMCS Code: 5051-011-MV

Removal Procedure

Table 32

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138 - 7575	Link Bracket	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses and on all wires for installation purposes. Plug all lines and all hoses. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the oil from the hydraulic tank for the implement and the braking system into a suitable container for storage or disposal.

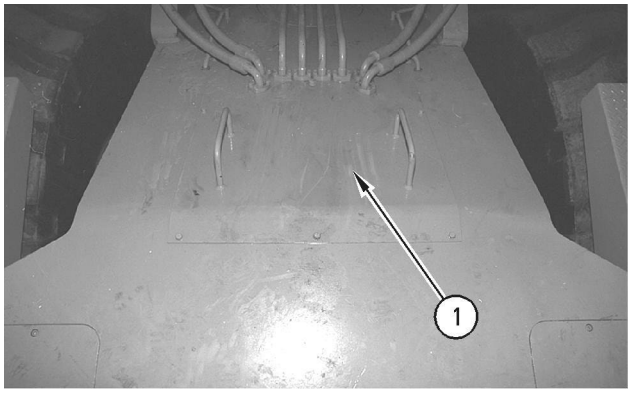


Illustration 664 g00883233

2. Remove cover assembly (1).

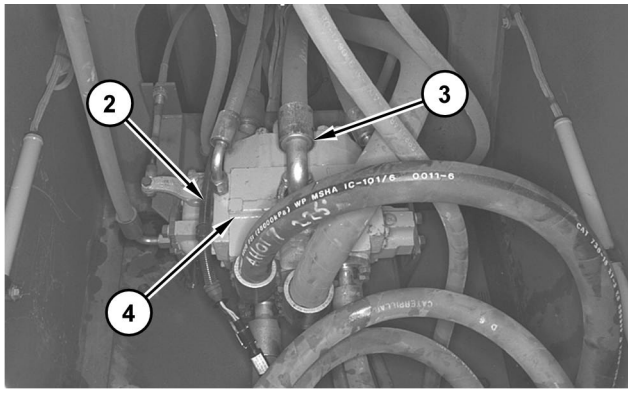


Illustration 665 g01257964

3. Disconnect harness assembly (2) and hose assemblies (3) from main control valve (4).

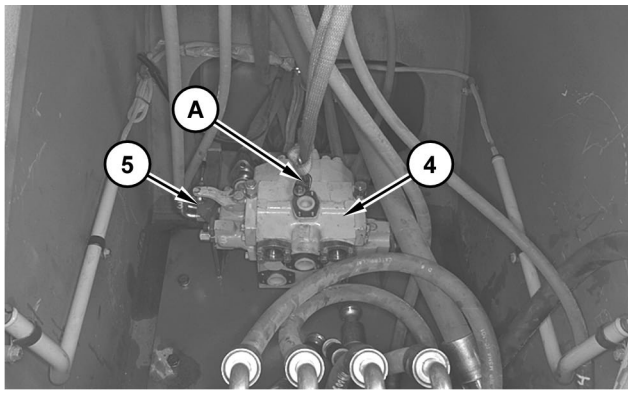


Illustration 666 g01257954

4. Attach Tooling (A) and a suitable lifting device to main control valve (4). The weight of main control valve (4) is approximately 77 kg (170 lb).

5. Remove mounting bolts (5) from each side of main control valve (4) and remove main control valve (4).

i02514385

Main Control Valve - Disassemble

SMCS Code: 5051-015-MV

Disassembly Procedure

Start By:

a. Remove the main control valve. See Disassembly and Assembly, "Main Control Valve - Remove".

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

1. Drain the hydraulic oil into a suitable container for storage or for disposal.

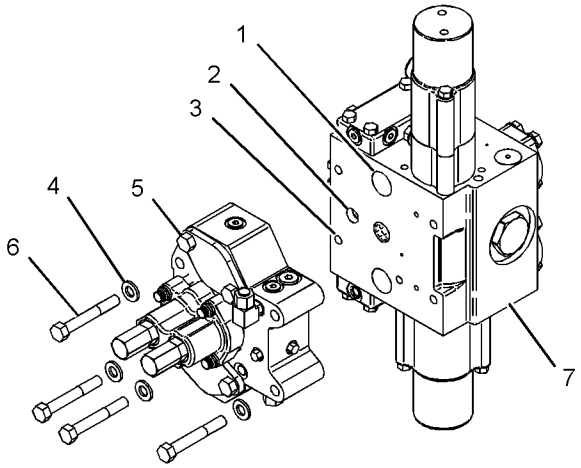


Illustration 667 g01257934

2. Remove bolts (6) and washers (4). Separate control valve (5) from valve body (7).

3. Remove O-ring seals (1), (2), and (3).

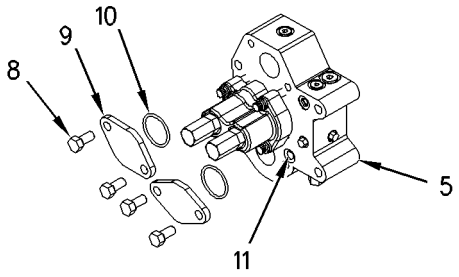


Illustration 668 g00805919

4. Remove the following components from control valve (5) : bolts (8), covers (9) and O-ring seals (10).

5. Remove bolt (11) from control valve (5).

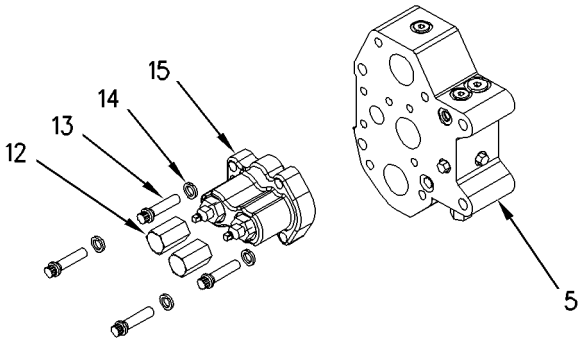


Illustration 669 g00805695

6. Remove two nuts (12).

7. Remove bolts (13) and washers (14). Separate housing (15) from control valve (5).

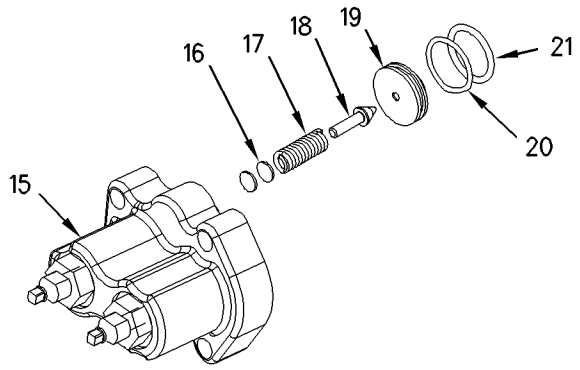


Illustration 670 g00805671

8. Remove the following components from housing (15) : O-ring seal (21), O-ring seal (20), seat (19), poppet valve (18), spring (17) and shims (16).

Note: Take care not to lose any of the shims that are located under the poppet valves.

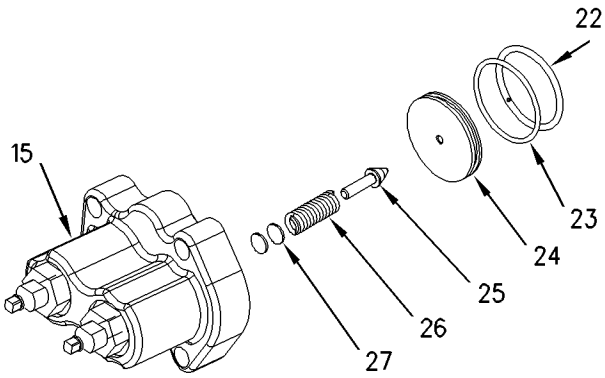


Illustration 671 g00805649

9. Remove the following components from housing (15) : O-ring seal (22), O-ring seal (23), seat (24), poppet valve (25), spring (26) and shims (27).

Note: Take care not to lose any of the shims that are located under the poppet valves.

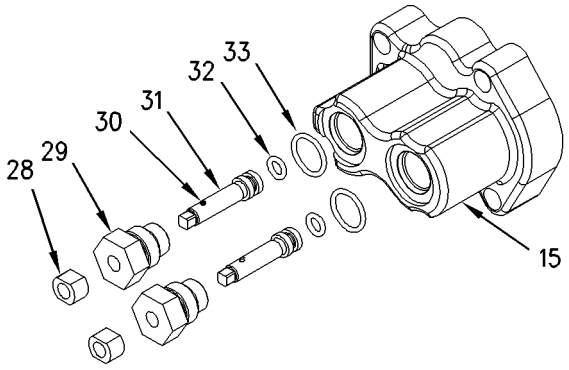


Illustration 672 g00805368

10. Remove the following components from housing (15) : nuts (28), plugs (29), adjustment screws (31) and O-ring seals (33).

11. Remove O-ring seals (32) from adjustment screws (31).

12. Remove spring pins (30) from adjustment screws (31).

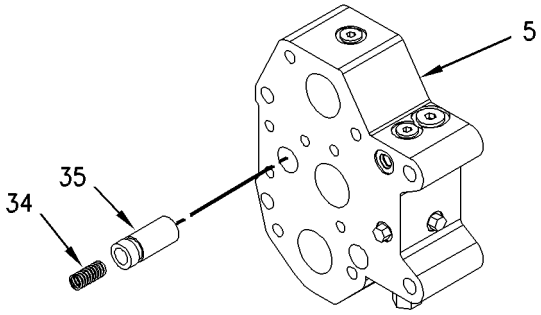


Illustration 673 g00805366

13. Remove valve (35) and spring (34) from control valve (5).

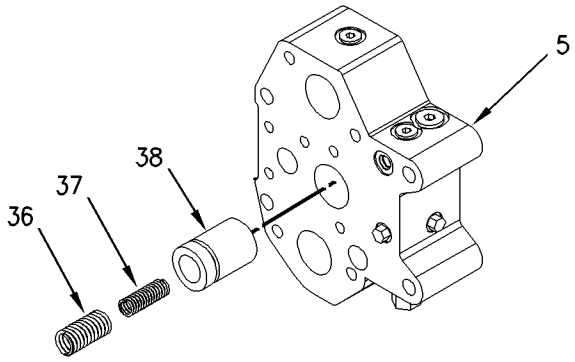


Illustration 674 g00805362

14. Remove the following components from control valve (5) : spring (36), spring (37) and valve (38).

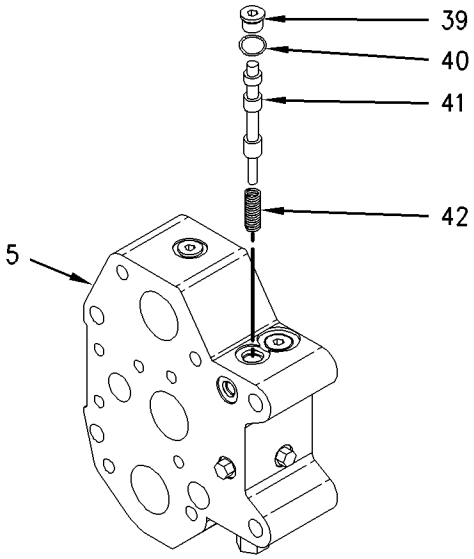


Illustration 675 g00805344

15. Remove the following components from control valve (5) : plug (39), O-ring seal (40), spool (41) and spring (42).

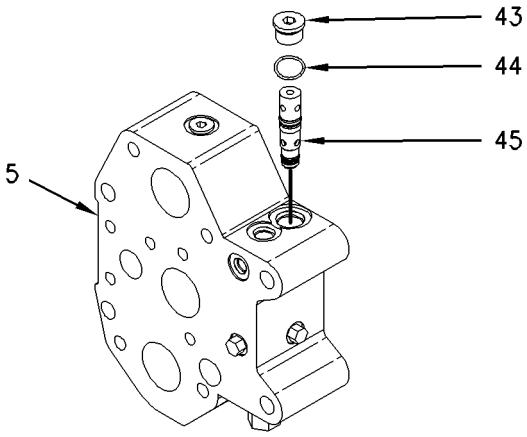


Illustration 676 g00805336

16. Remove the following components from control valve (5) : plug (43), O-ring seal (44) and valve cartridge (45).

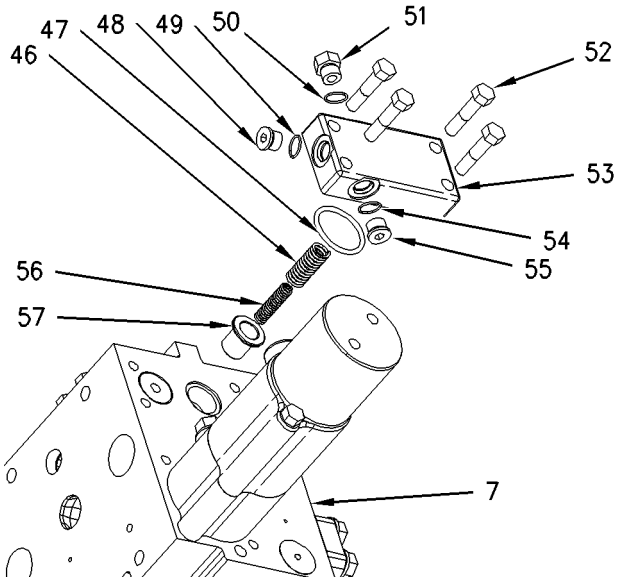


Illustration 677 g00805296

17. Remove plug (51). Remove O-ring seal (50) from plug (51).

18. Remove plug (48). Remove O-ring seal (49) from plug (48).

19. Remove plug (55). Remove O-ring seal (54) from plug (55).

20. Remove four bolts (52) and cover (53).

21. Remove the following components from valve body (7) : O-ring seal (47), spring (46), spring (56) and retainer (57)

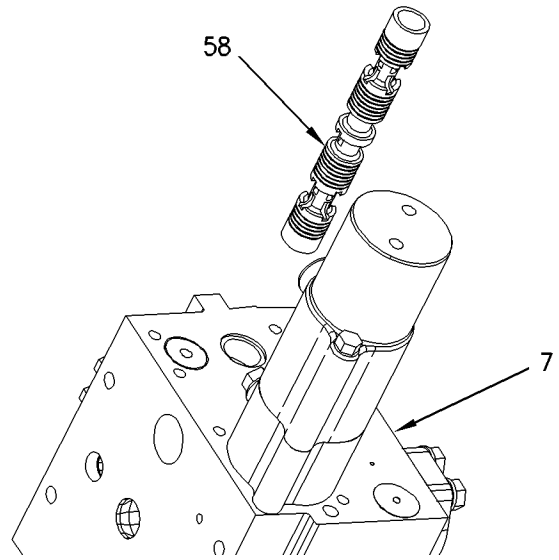


Illustration 678 g00805534

22. Remove spool (58) from valve body (7).

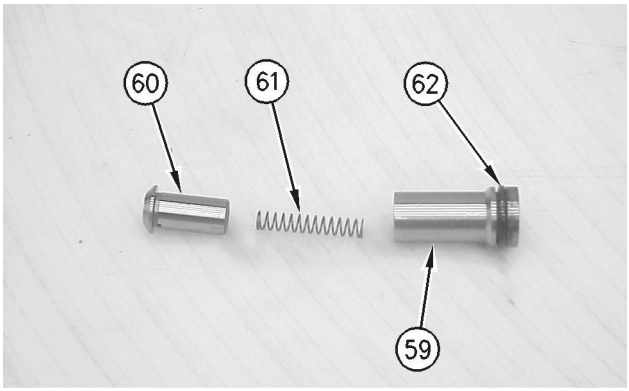


Illustration 679 g00805501

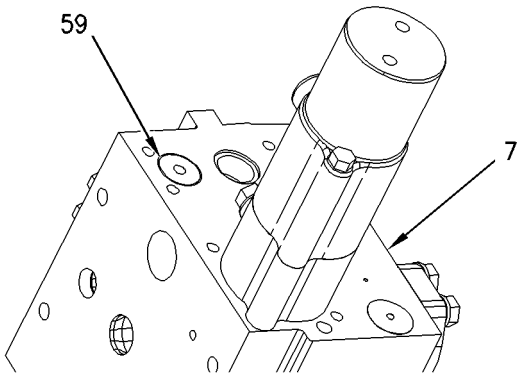


Illustration 680 g00805503

23. Remove plug assembly (59) from valve body (7).

24. Remove spring (61) and valve (60) from plug (59).

25. Remove O-ring seal (62) from plug (59).

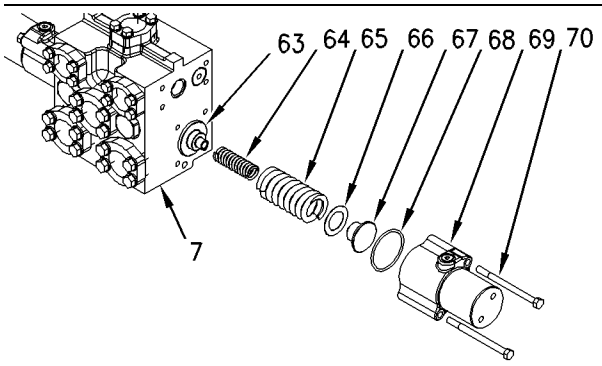


Illustration 681 g00805469

26. Remove bolts (70). Separate housing (69) from valve body (7).

27. Remove the following components from housing (69) : retainer (63), spring (64), spring (65), shim (66), retainer (67) and O-ring seal (68).

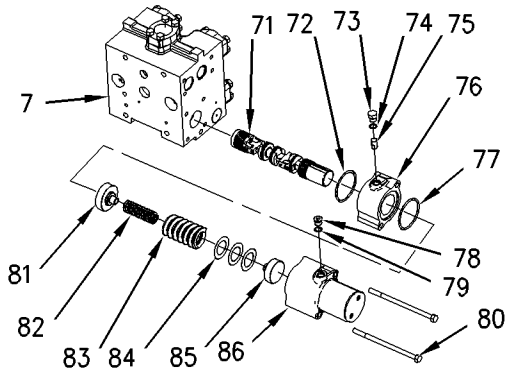


Illustration 682 g00827440

28. Remove plug (78). Remove O-ring seal (79) from plug (78).

29. Remove bolts (80) and housing (86) from valve body (7).

30. Remove spool (71) from housing (7).

31. Remove the following components from housing (76) : plug (73), O-ring seal (74) and pin (75).

32. Remove the following components from housing (86) : O-ring seal (72), housing (76), O-ring seal (77), retainer (81), spring (82), spring (83), shim (84) and retainer (85).

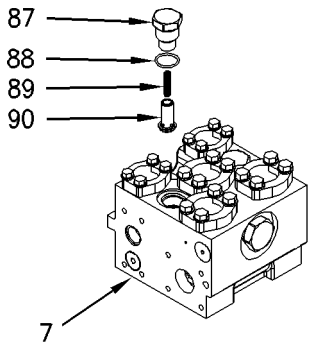


Illustration 683 g00805428

33. Remove the following components from valve body (7) : plug (87), O-ring seal (88), spring (89) and valve (90).

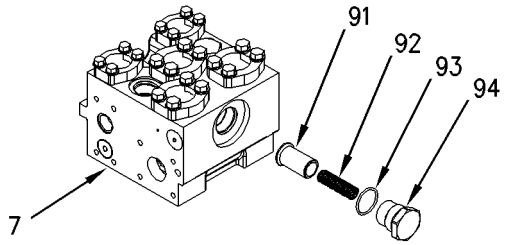


Illustration 684 g00805419

34. Remove the following components from valve body (7) : plug (94), O-ring seal (93), spring (92) and valve (91).

i02514387

Main Control Valve - Assemble

SMCS Code: 5051-016-MV

Assembly Procedure

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement. Dirt and other contaminants can damage the precision components of the valve. All assembly procedures must be performed on a clean work surface and in a clean hydraulic area. Keep cleaned parts covered and protected at all times.

Note: Check the O-ring seals and the seals for wear or for damage. Replace the components, if necessary.

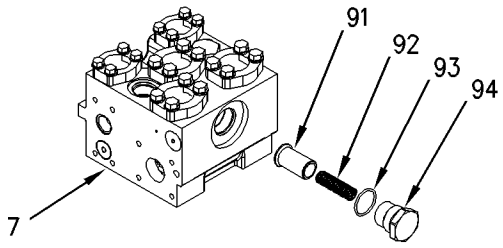


Illustration 685 g00805419

1. Install the following components into valve body (7) : valve (91), spring (92), O-ring seal (93) and plug (94).

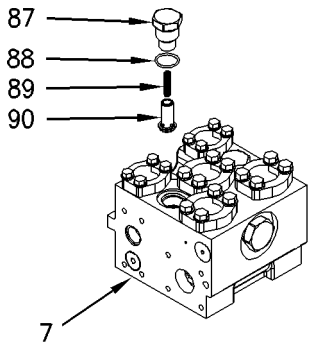


Illustration 686 g00805428

2. Install the following components into valve body (7) : valve (90), spring (89), O-ring seal (88) and plug (87).

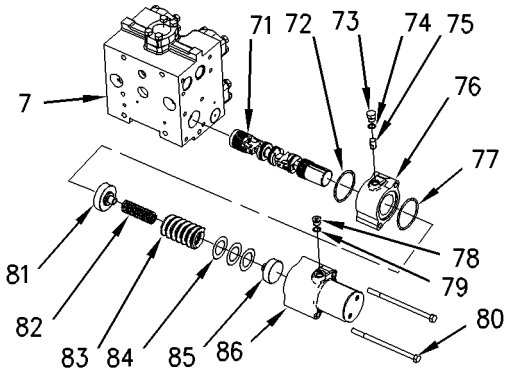


Illustration 687 g00827440

3. Install the following components on housing (86) : O-ring seal (77), retainer (85), shim (84), spring (83), spring (82), retainer (81), housing (76) and O-ring seal (72).

4. Install the following components into housing (76) : pin (75), O-ring seal (74) and plug (76).

5. Install spool (71) into housing (7).

6. Use bolts (80) in order to install housing (86) to valve body (7) . Line up the groove on spool (71) with pin (75).

7. Install O-ring seal (79) and plug (78).

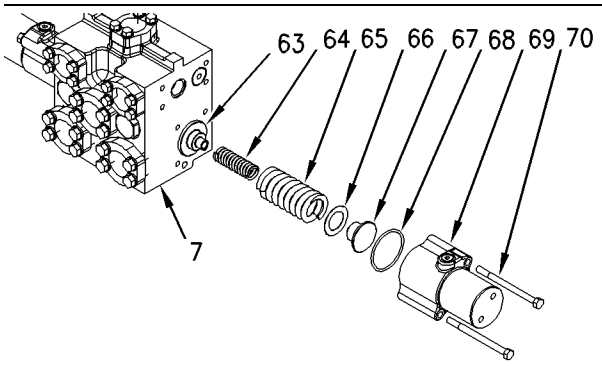


Illustration 688 g00805469

8. Install the following components into housing (69) : O-ring seal (68), retainer (67), shim (66), spring (65), spring (64) and retainer (63).

9. Install housing (69) to valve body (7) with bolts (70).

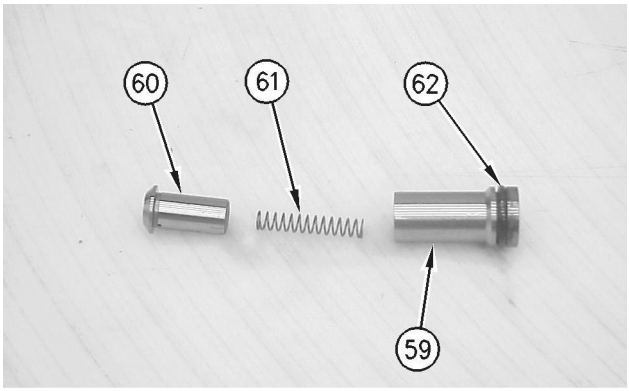


Illustration 689 g00805501

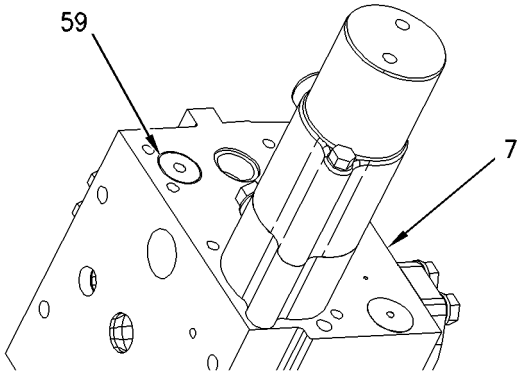


Illustration 690 g00805503

10. Install O-ring seal (62) onto plug (59).

11. Install spring (61) and valve (60) into plug (56).

12. Install plug (59) into valve body (7).

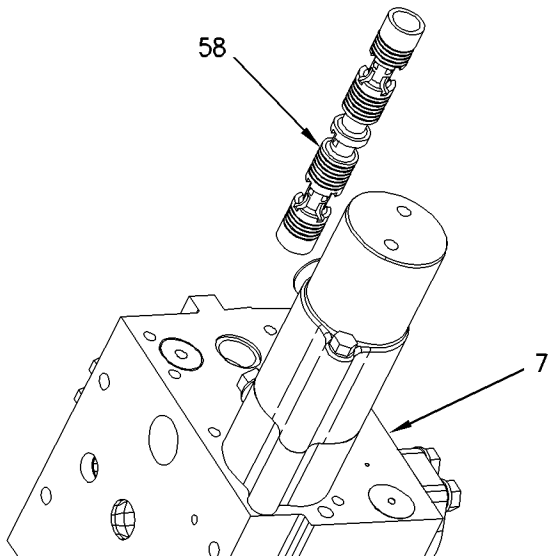


Illustration 691 g00805534

13. Install spool (58) into valve body (7).

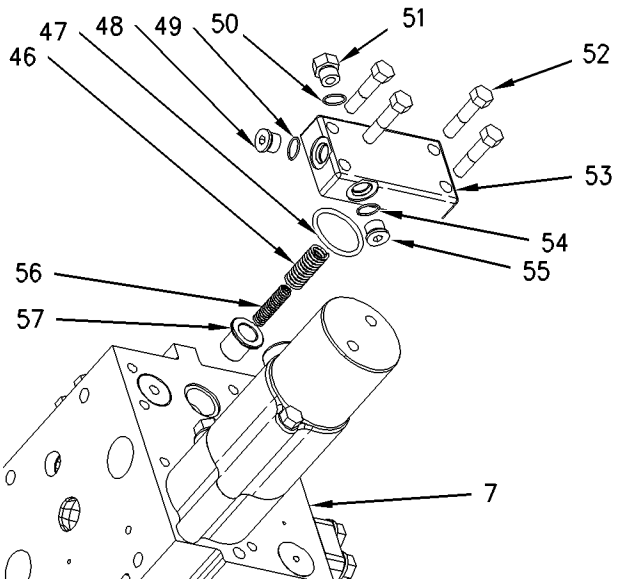


Illustration 692 g00805296

14. Install the following components into valve body (7) : retainer (57), spring (56), spring (46) and O-ring seal (47).

15. Position cover (53) on top of valve body (7). Install four bolts (52) to cover (53).

16. Install O-ring seal (54) and plug (55).

17. Install O-ring seal (49) and plug (48).

18. Install O-ring seal (50) and plug (51).

19. Repeat Step 14 through Step 18 for the other side of the valve body.

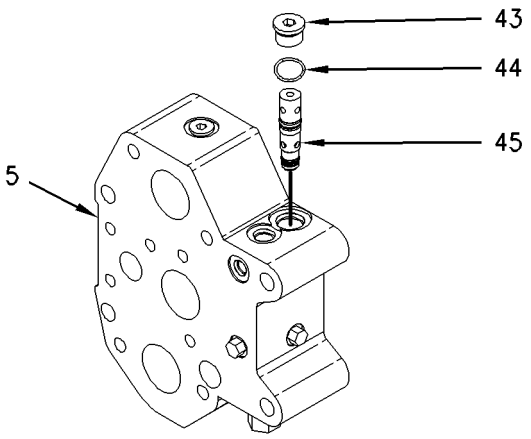


Illustration 693 g00805336

20. Install the following components into control valve (5) : valve cartridge (45), O-ring seal (44) and plug (43).

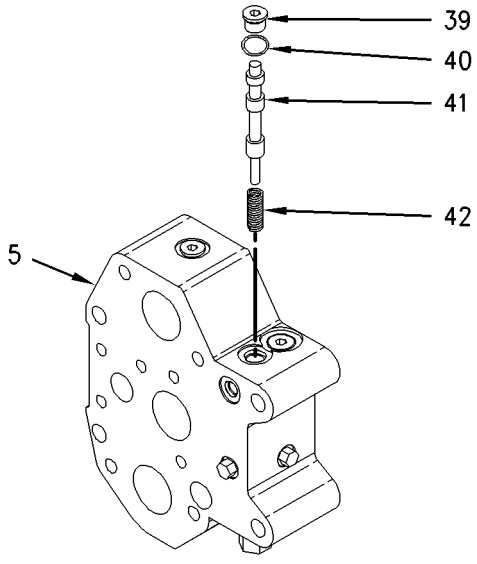


Illustration 694 g00805344

21. Install the following components into control valve (5) : spring (42), spool (41), O-ring seal (40) and plug (39).

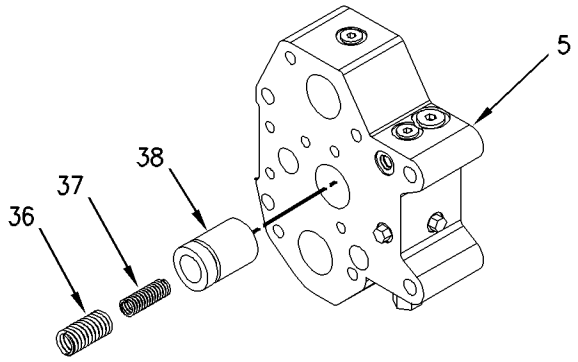


Illustration 695 g00805362

22. Install the following components into control valve (5) : valve (38), spring (37) and spring (36).

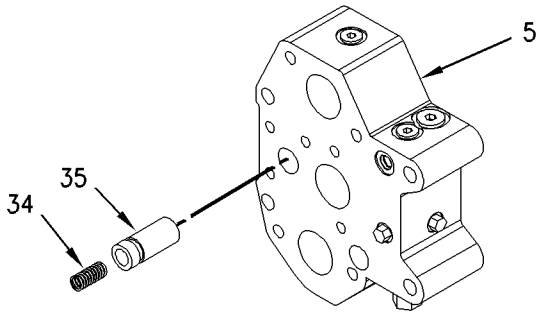


Illustration 696 g00805366

23. Install valve (35) and spring (34) into control valve (5).

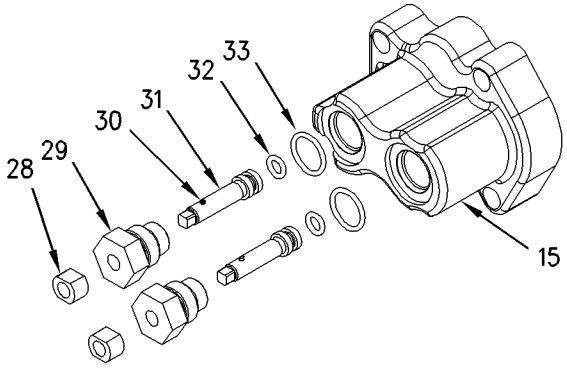


Illustration 697 g00805368

24. Install spring pins (30) into adjustment screws (31).

25. Install O-ring seals (32) onto adjustment screws (31).

26. Install the following components into housing (15) : O-ring seals (33), adjustment screws (31), plugs (29) and nuts (28). Tighten the nuts to a torque of 35 ± 6 N·m (26 ± 4 lb ft).

Note: Test the valve in order to determine the final position of the adjustment screws.

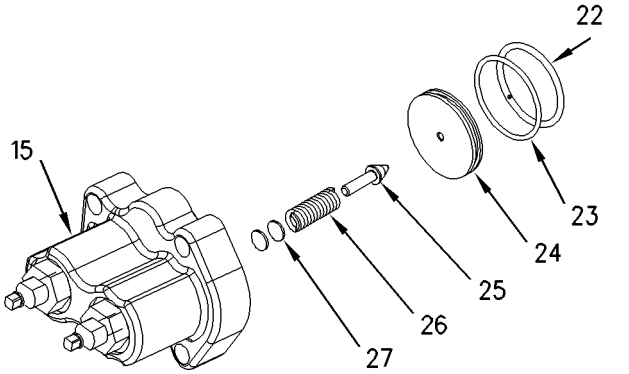


Illustration 698 g00805649

27. Install the following components into housing (15) : shims (27), spring (26), poppet valve (25), seat (24), O-ring seal (23) and O-ring seal (22).

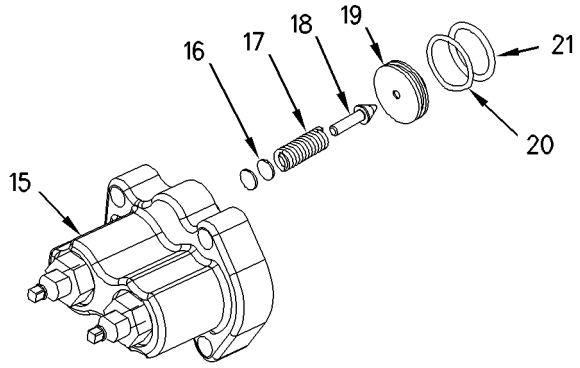


Illustration 699 g00805671

28. Install the following components into housing (15) : shims (16), spring (17), poppet valve (18), seat (19), O-ring seal (20) and O-ring seal (21).

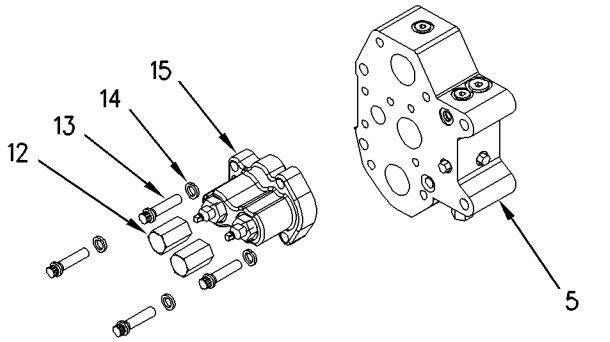


Illustration 700 g00805695

29. Position housing (15) onto control valve (5).

30. Install housing (15) with washers (14) and bolts (13). Tighten bolts (14) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

31. Tighten nuts (12) to a torque of 20 ± 6 N·m (15 ± 4 lb ft).

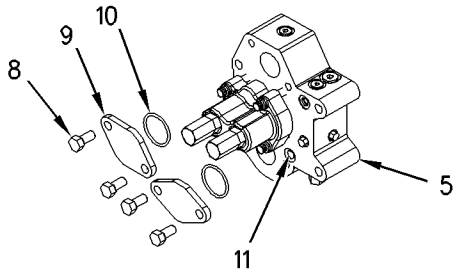


Illustration 701 g00805919

32. Install bolt (11) into control valve (5).

33. Install the following components onto control valve (5) : O-ring seals (10), covers (9) and bolts (8).

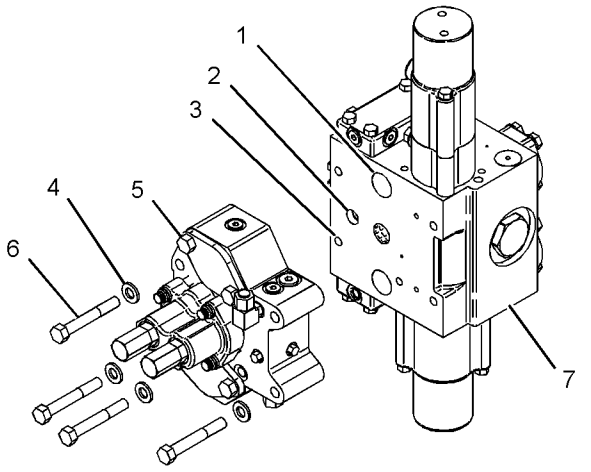


Illustration 702 g01257934

34. Install O-ring seals (1), (2), and (3). Position control valve (5) onto valve body (7).

35. Install washers (4) and bolts (6).

End By:

a. Install the main control valve. Refer to Disassembly and Assembly, “Main Control Valve - Install”.

i02514423

Main Control Valve - Install

SMCS Code: 5051-012-MV

Installation Procedure

Table 33

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1

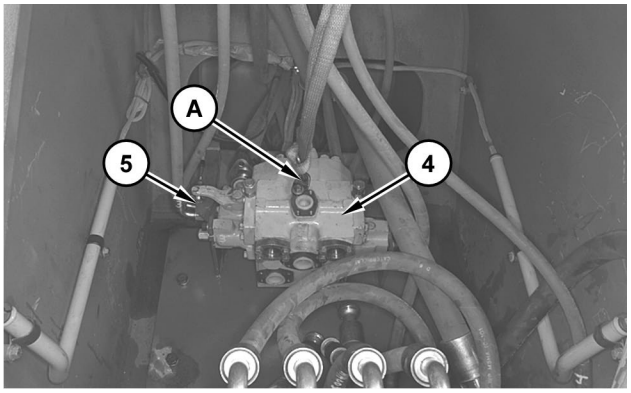


Illustration 703 g01257954

1. Use Tooling (A) and a suitable lifting device to position main control valve (4) on the machine. The weight of main control valve (4) is approximately 77 kg (170 lb).

2. Install mounting bolts (5) on both sides of main control valve (4).

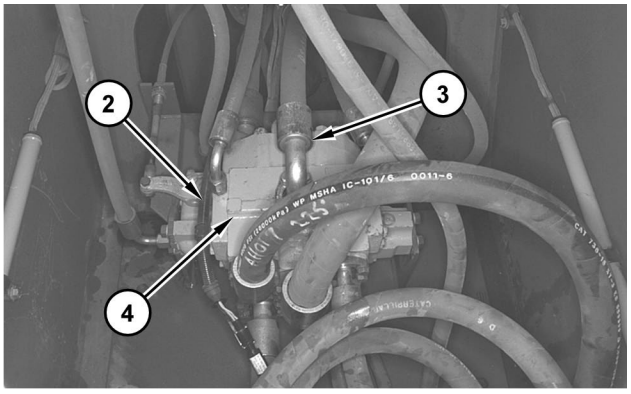


Illustration 704 g01257964

3. Connect hose assemblies (3) and harness assembly (2).

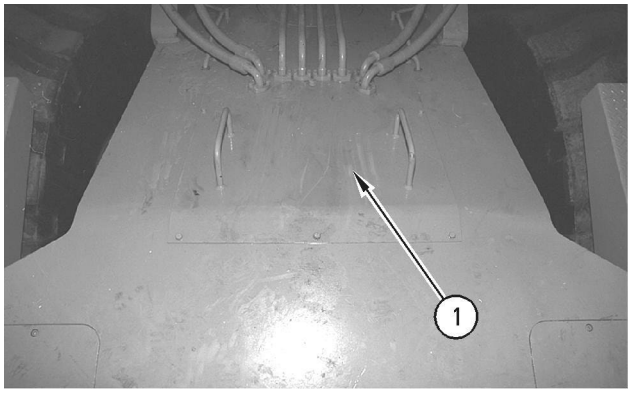


Illustration 705 g00883233

4. Install cover assembly (1).

5. Fill the hydraulic tank for the implement and the braking system to the correct level. Refer to Operation and Maintenance Manual, “Refill Capacities”.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02514049

Tilt Control Valve (Dual) - Remove

SMCS Code: 5051-011-T2

Removal Procedure

Table 34

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138 - 7575	Link Bracket	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

b. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses and on all wires for installation purposes. Plug all lines and all hoses. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the oil from the hydraulic tank for the implement and the braking system into a suitable container for storage or disposal.

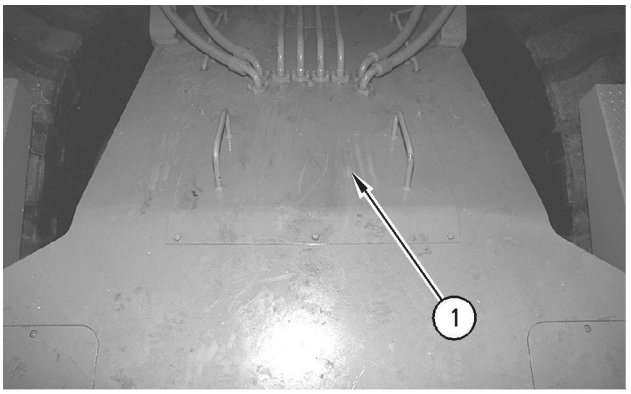


Illustration 706 g00883233

2. Remove cover assembly (1).

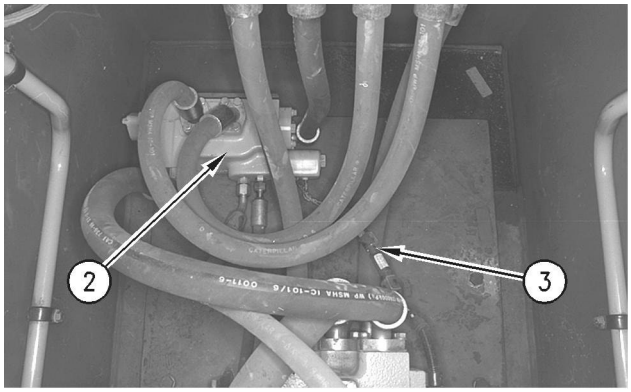


Illustration 707 g00884246

3. Disconnect the hose assemblies from tilt control valve (2).

4. Disconnect harness assembly (3).

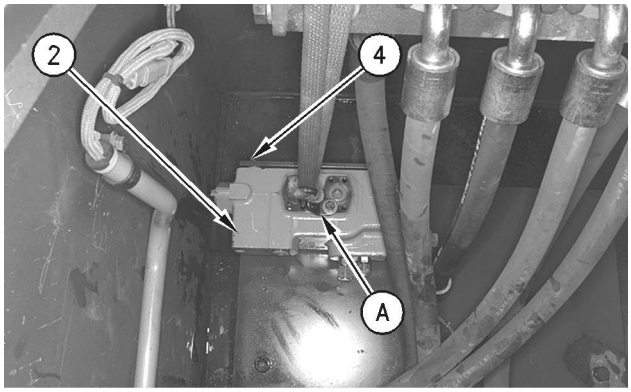


Illustration 708 g00884247

5. Attach Tooling (A) and a suitable lifting device to tilt control valve (2). The weight of tilt control valve (2) is approximately 30 kg (66 lb).

6. Remove mounting bolts (4) and tilt control valve (2).

i01719734

Tilt Control Valve (Dual) - Disassemble

SMCS Code: 5051-015-T2

Disassembly Procedure

Start By:

a. Remove the tilt control valve. Refer to Disassembly and Assembly, “Tilt Conttrol Valve (Dual) - Remove” for the machine that is being serviced.

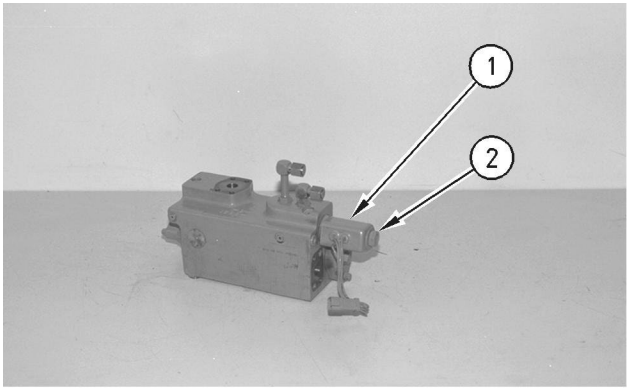


Illustration 709 g00884281

1. Remove nut (2) and remove coil assembly (1).

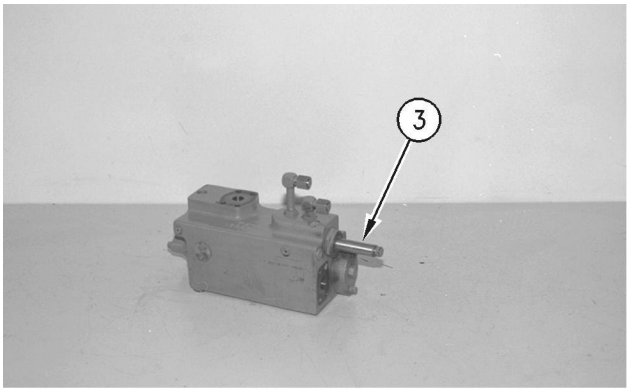


Illustration 710 g00884283

2. Remove cartridge assembly (3).

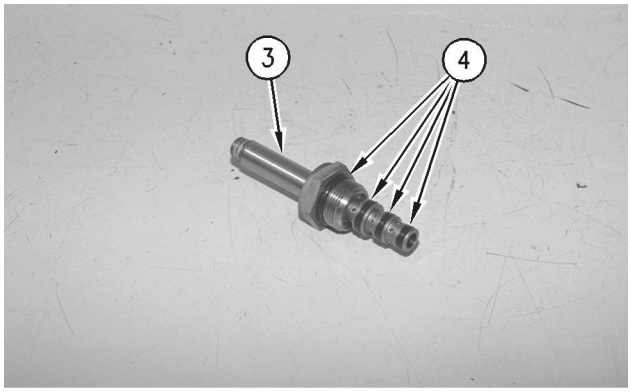


Illustration 711 g00884284

3. Remove seals (4) from cartridge assembly (3).

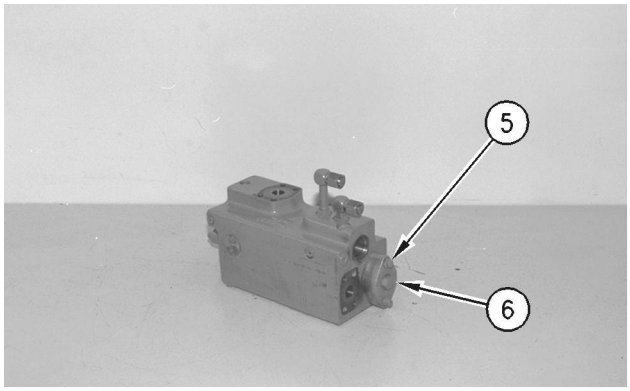


Illustration 712 g00884285

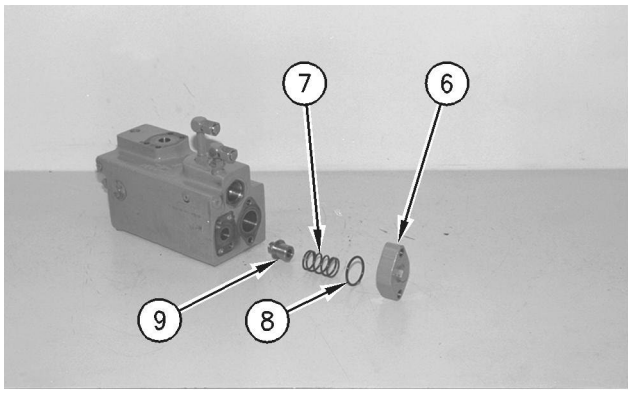


Illustration 713 g00884288

4. Remove bolts (5) from cover (6).

5. Remove cover (6), seal (8), spring (7) and retainer (9).

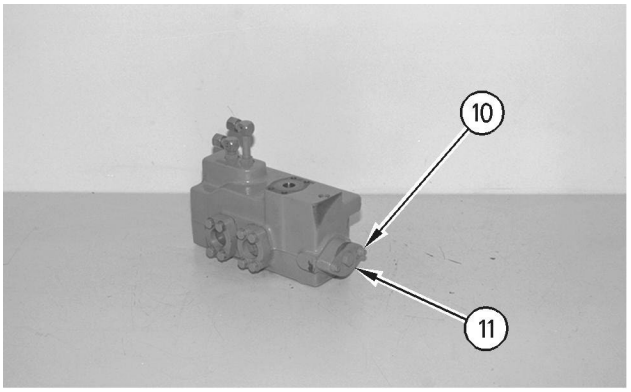


Illustration 714 g00884289

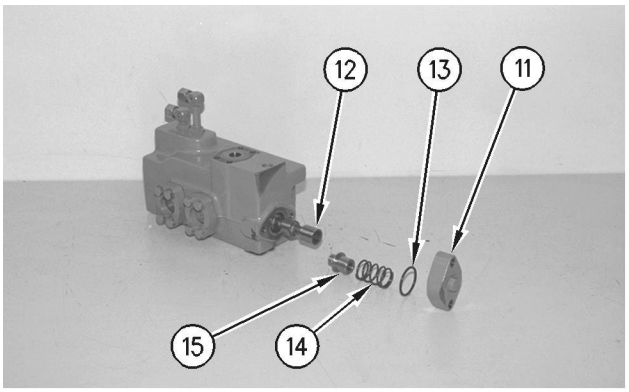


Illustration 715 g00884290

6. Remove bolts (10) from cover (11).

Note: For installation purposes, mark stem (12) before removal.

7. Remove cover (11), seal (13), spring (14), retainer (15), and stem (12).

i01719898

Tilt Control Valve (Dual) - Assemble

SMCS Code: 5051-016-T2

Assembly Procedure

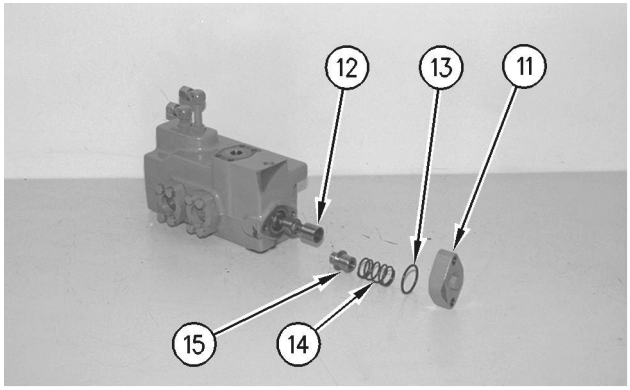


Illustration 716 g00884290

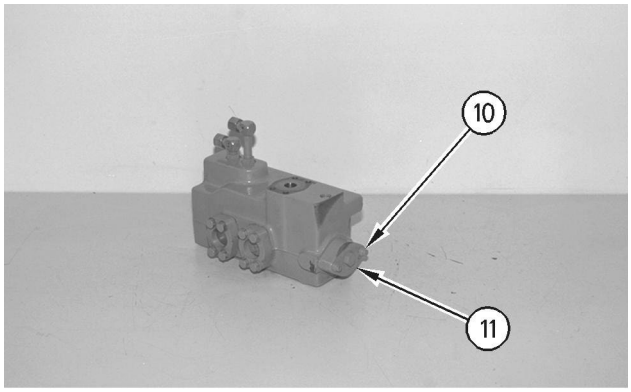


Illustration 717 g00884289

Note: Install stem (11) into the original position in the valve.

1. Install stem (12), retainer (15), spring (14), seal (13), and cover (11).

2. Install bolts (10) in cover (11).

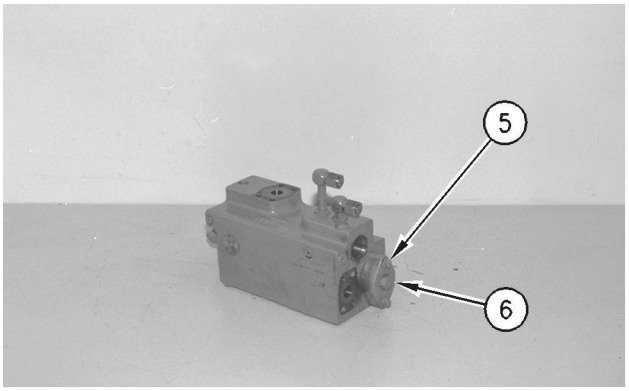


Illustration 718 g00884285

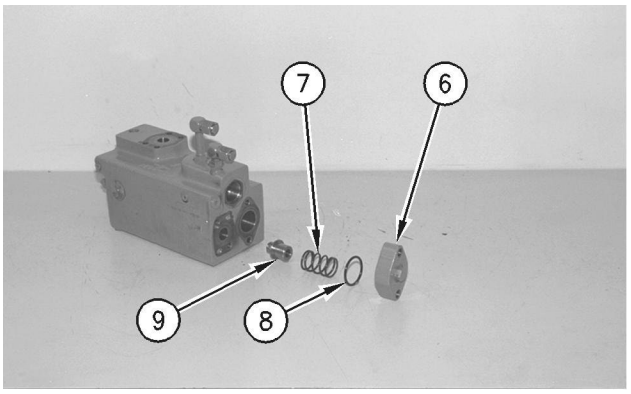


Illustration 719 g00884288

3. Install retainer (9), spring (7), seal (8), and cover (6).

4. Install bolts (5) in cover (6).

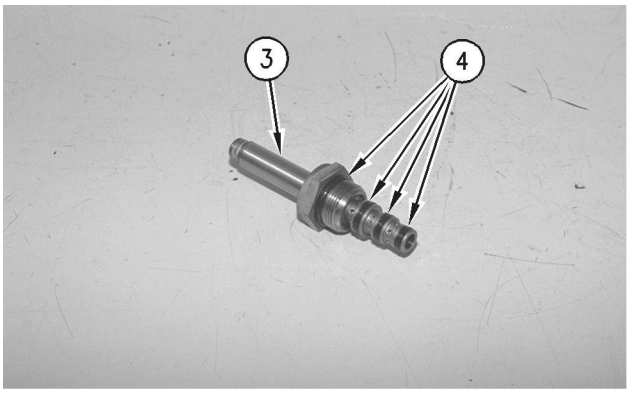


Illustration 720 g00884284

5. Install seals (4) on cartridge assembly (3).

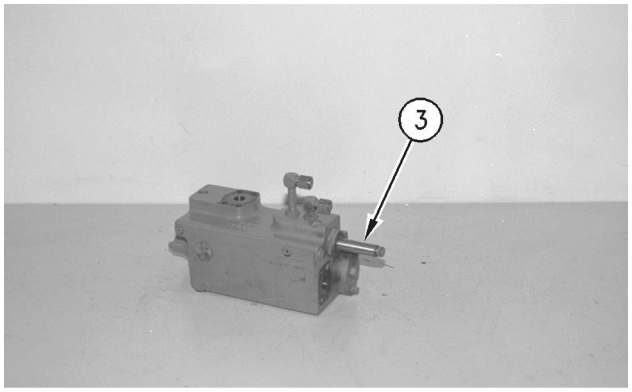


Illustration 721 g00884283

6. Install cartridge assembly (3). Tighten the cartridge assembly to a torque of 30 ± 4 N·m (22 ± 3 lb ft).

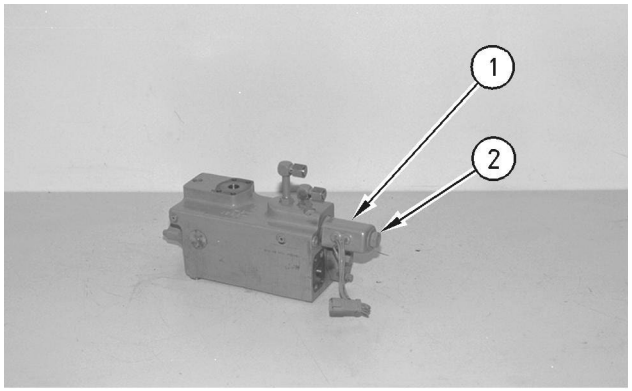


Illustration 722 g00884281

7. Install coil assembly (1).

8. Put 4C-4030 Thread Lock Compound on the threads.

9. Install nut (2) and tighten to a torque of 14 ± 3 N·m (10 ± 2 lb ft).

End By:

a. Install the tilt control valve. Refer to Disassembly and Assembly, “Tilt Conttrol Valve (Dual) - Install” for the machine that is being serviced.

i02514051

Tilt Control Valve (Dual) - Install

SMCS Code: 5051-012-T2

Installation Procedure

Table 35

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1

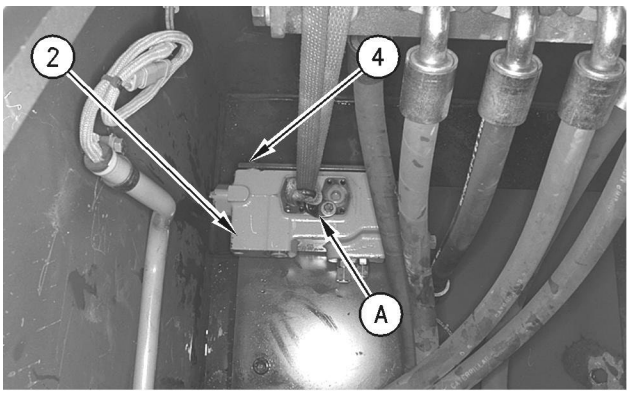


Illustration 723 g00884247

1. Use Tooling (A) and a suitable lifting device to position tilt control valve (2) on the machine. The weight of tilt control valve (2) is approximately 30 kg (66 lb).

2. Install mounting bolts (4).

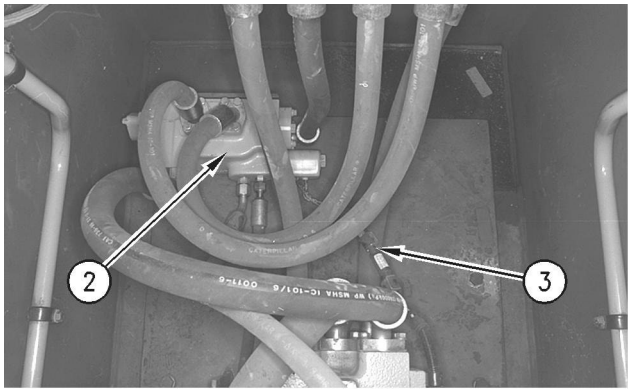


Illustration 724 g00884246

3. Connect the hose assemblies to tilt control valve (2).

4. Connect harness assembly (3).

5. Fill the hydraulic tank for the implement and the braking to the correct level. Refer to Operation and Maintenance Manual, “Refill Capacities”.

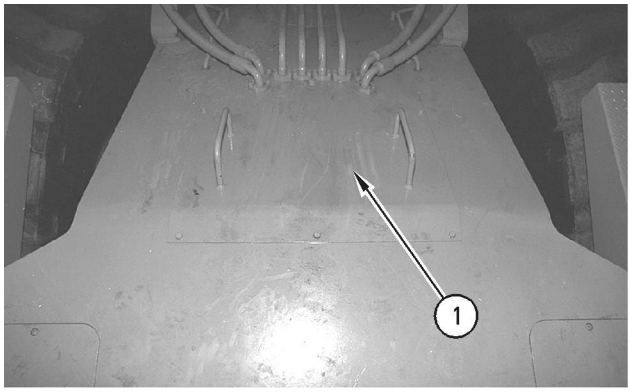


Illustration 725 g00883233

6. Install cover assembly (1).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02513717

Push Arms and Blade - Remove

SMCS Code: 6060-011; 6061-011

Removal Procedure

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all lines, on all hoses and on all wires for installation purposes. Plug all lines and all hoses. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

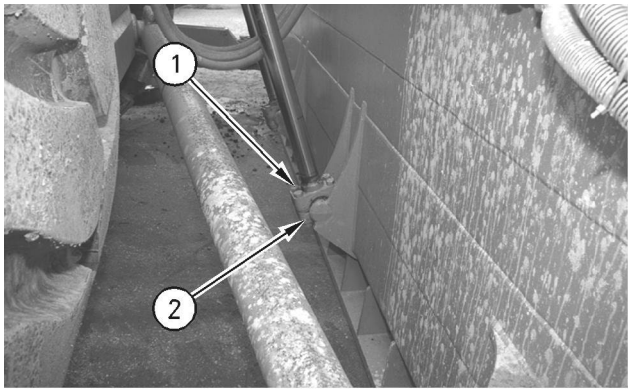


Illustration 726 g00884392

1. Remove bolts (1), caps (2), and the shims from each lift cylinder rod. Note the quantity and the location of the shims for assembly purposes.

2. Start the machine.

3. Retract the lift cylinder rods.

4. Stop the machine.

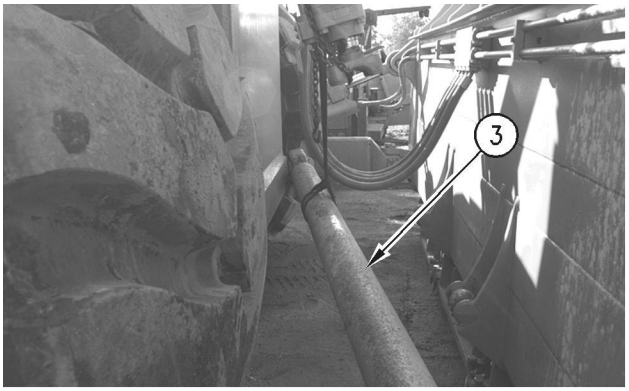


Illustration 727 g00884393

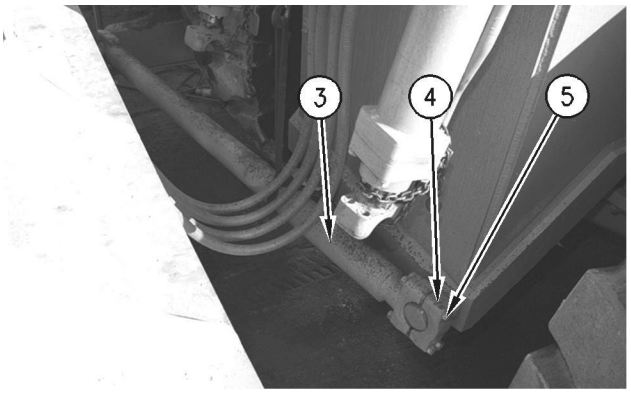


Illustration 728 g00884395

5. Attach a suitable lifting device to stabilizer link (3). The weight of stabilizer link (3) is approximately 120 kg (265 lb).

6. Remove bolts (5), cap (4), and the shims.

7. Start the machine.

8. Carefully turn the machine to the left until stabilizer link (3) is disengaged from the front trunnion.

9. Stop the machine.

10. Lower the disconnected end of stabilizer link (3) to the ground.

11. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

12. Drain the oil from the hydraulic tank for the steering system and for the hydraulic fan into a suitable container for storage or disposal.

13. Drain the oil from the hydraulic tank for the implement and the braking system into a suitable container for storage or disposal.

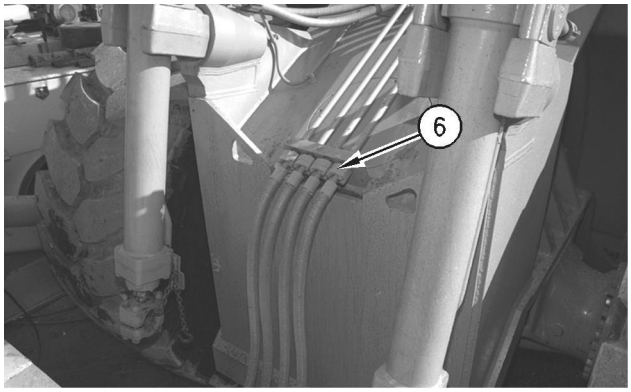


Illustration 729 g00884396

14. Disconnect hose assemblies (6).

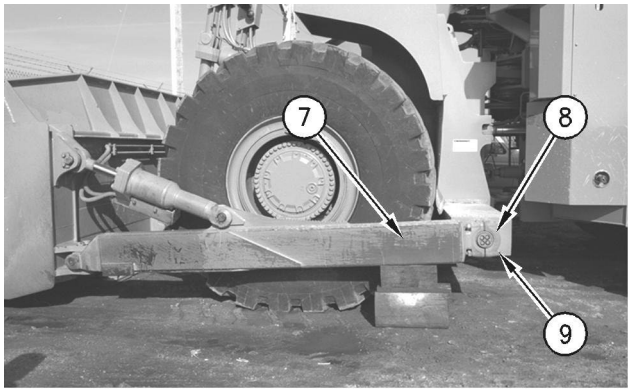


Illustration 730 g00884397

15. Position suitable blocking under push arm (7), as shown.

16. Remove bolts (9), bearing cap (8), and the shims from push arm (7). Note the quantity and the location of the shims for assembly purposes.

17. Repeat Steps 15 and 16 for the opposite machine side.

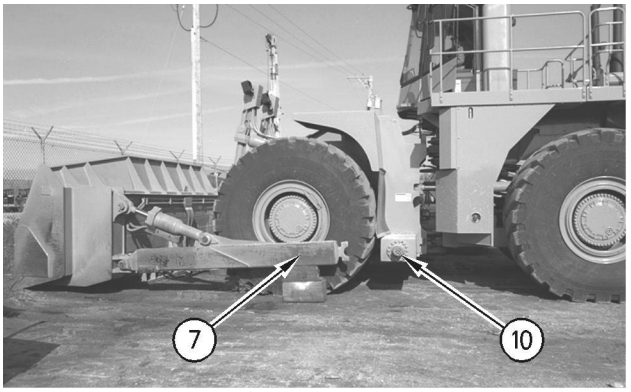


Illustration 731 g00884398



Illustration 732 g00884400

18. Move the machine away from the push arm assembly.

i02513718

Push Arms and Blade - Install

SMCS Code: 6060-012; 6061-012

Installation Procedure

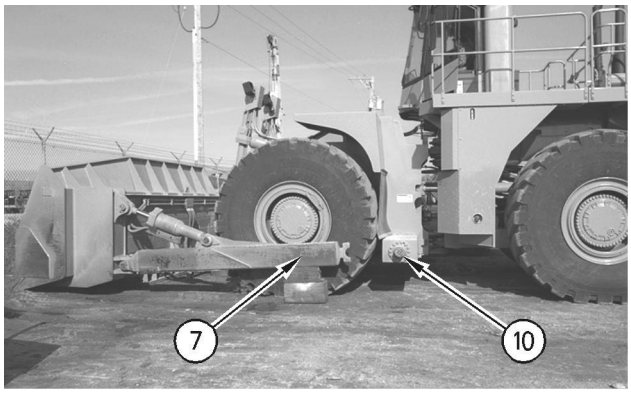


Illustration 733 g00884398

1. Move the machine in position between the push arms and the blade assembly.

2. Move the machine ahead until push arms (7) engage with trunnion (10).

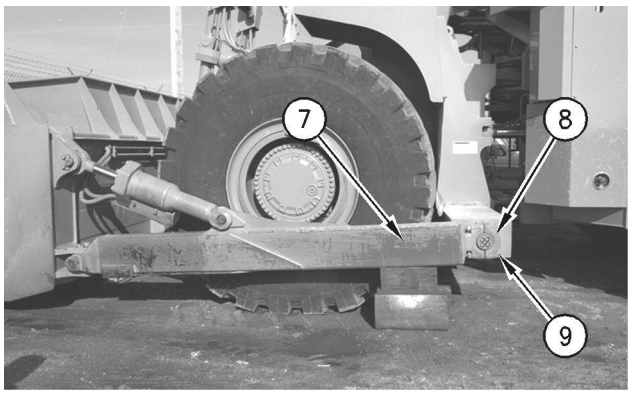


Illustration 734 g00884397

3. Install bolts (9) and cap (8) without the shims.

4. Tighten bolts (9) evenly.

5. Insert an equal amount of shims between the cap and the push arm assembly, as needed.

6. Add one additional shim to each of the spaces. The specified clearance between the trunnion and the push arm assembly is 0.50 ± 0.25 mm (0.02 ± 0.001 inch).

7. Tighten bolts (9) to a torque of 1800 ± 200 N·m (1327 ± 148 lb ft).

8. Repeat Steps 3 through 7 for the opposite machine side.

9. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

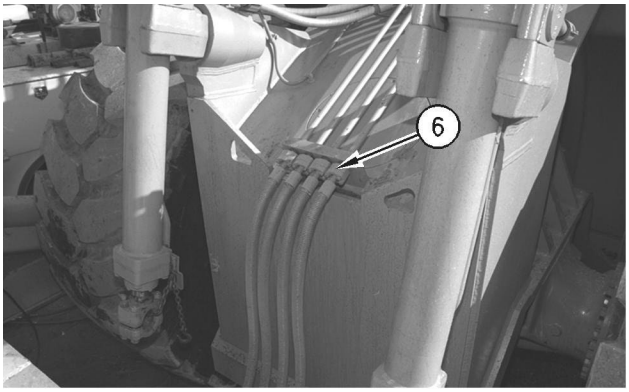


Illustration 735 g00884396

10. Connect hose assemblies (6).

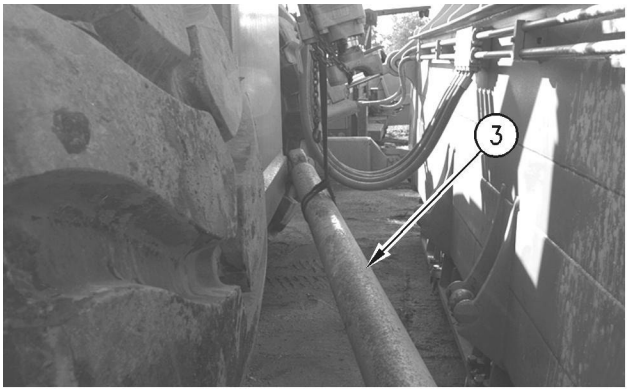


Illustration 736 g00884393

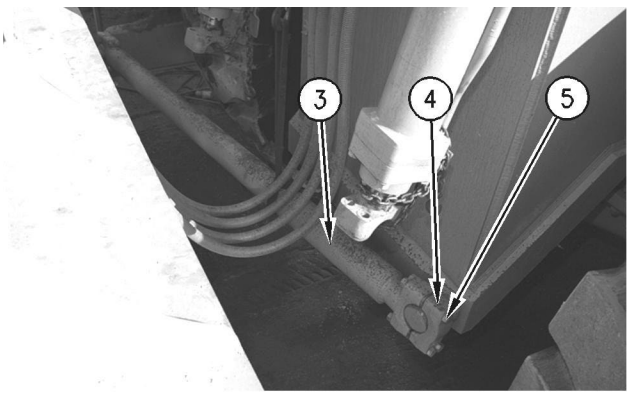


Illustration 737 g00884395

11. Attach a suitable lifting device to stabilizer link (3). The weight of stabilizer link (3) is approximately 120 kg (265 lb).

12. Raise the end of stabilizer link (3) to the front trunnion.

13. Start the machine.

14. Carefully turn the machine to the right until stabilizer link (3) is engaged with the front trunnion.

15. Stop the machine.

16. Install bolts (5) and cap (4) without shims.

17. Tighten bolts (5) evenly on both sides of the cap.

18. Insert an equal amount of shims between the cap and the stabilizer link, as needed.

19. Add one additional shim to each of the spaces. The specified clearance between the trunnion and the stabilizer link is 0.50 ± 0.25 mm (0.020 ± 0.010 inch).

20. Tighten bolts (5) to a torque of 620 ± 80 N·m (460 ± 60 lb ft).

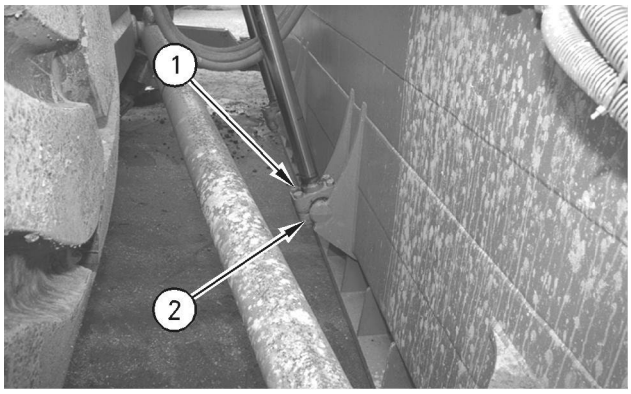


Illustration 738 g00884392

21. Start the machine.

22. Extend the lift cylinder rods to the trunnions.

23. Stop the machine.

24. Install bolts (1) and cap (2) without the shims.

25. Tighten bolts (1) evenly on both sides of the cap.

26. Insert an equal amount of shims in the spaces between the bearing cap and the lift cylinder, as needed.

27. Add one additional shim to each of the spaces. The specified clearance between the trunnion and the rod assembly is 0.50 ± 0.25 mm (0.020 ± 0.010 inch).

28. Tighten bolts (1) to a torque of 620 ± 80 N·m (460 ± 60 lb ft).

29. Repeat Steps 16 through 23 for the remaining lift cylinder.

i02513769

Stabilizer Link - Remove and Install

SMCS Code: 6071-010

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

1. Lower the blade to the ground.

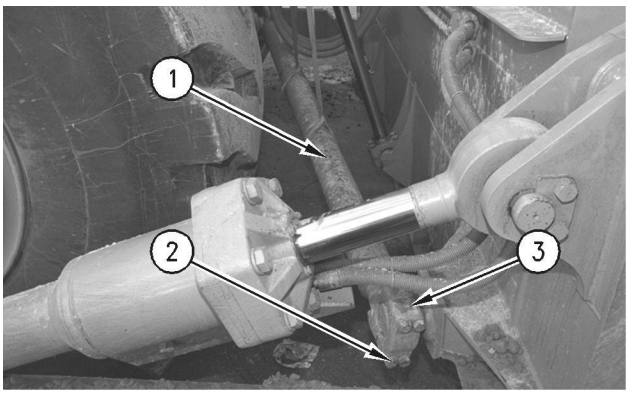


Illustration 739 g00884677

2. Attach a suitable lifting device to stabilizer link (1). The weight of stabilizer link (1) is approximately 120 kg (265 lb).

3. Remove bolts (2), cap (3), and the shims from each end of stabilizer link (1).

4. Start the machine.

5. Turn the machine to the left until stabilizer link (1) is disengaged from the trunnion and the front trunnion.

6. Stop the machine.

7. Remove stabilizer link (1).

Installation Procedure

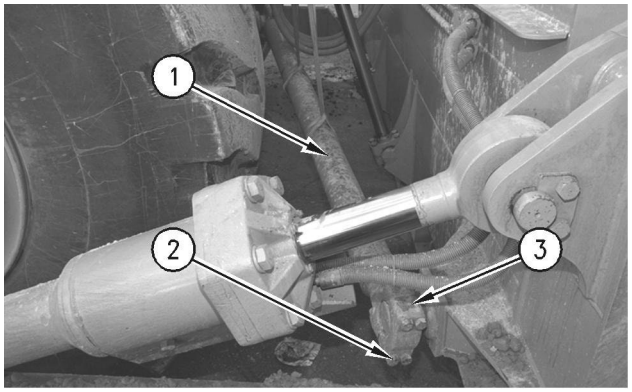


Illustration 740 g00884677

1. Use a suitable lifting device to position stabilizer link (1) between the blade and the front trunnions. The weight of stabilizer link (1) is approximately 120 kg (265 lb).
2. Start the machine.
3. Carefully turn the machine to the right until stabilizer link (1) is engaged with the trunnion and the front trunnion.
4. Stop the machine.
5. Install bolts (2) and cap (3) without the shims.
6. Tighten bolts (2) evenly on both sides of the cap.
7. Insert an equal amount of shims in the spaces between the cap and the stabilizer link, as needed.
8. Add one additional shim to each of the spaces. The specified clearance between the trunnion and the stabilizer link is 0.50 ± 0.25 mm (0.020 ± 0.010 inch).
9. Tighten bolts (2) to a torque of 620 ± 80 N·m (460 ± 60 lb ft).
10. Repeat Steps 5 through 9 in order to install the opposite end of the stabilizer link.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i01720681

Bulldozer Trunnion - Remove

SMCS Code: 6069-011

Removal Procedure

Table 36

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-6405	Puller Group	1

Start By:

a. Remove the push arms and the blade. Refer to Disassembly and Assembly, “Push Arms and Blade - Remove” for the machine that is being serviced.

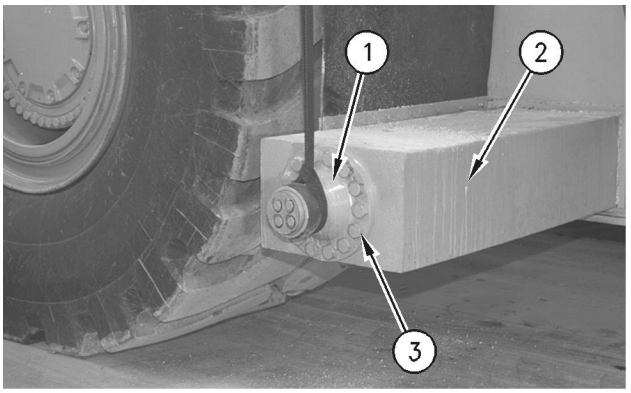


Illustration 741 g00884762

1. Attach a suitable hoist and a suitable lifting sling to trunnion (1).
2. Remove 14 bolts (3) from trunnion (1).

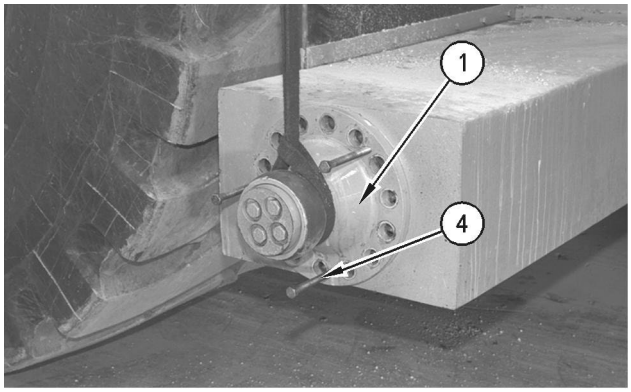


Illustration 742 g00884763

3. Install three 1/2 in NC-13 forcing screws (4) in the threaded holes of trunnion (1).

4. Tighten the forcing screws evenly in order to separate the trunnion from push beam (2).

5. Remove trunnion (1) from the push beam. The weight of the trunnion is 36 kg (80 lb).

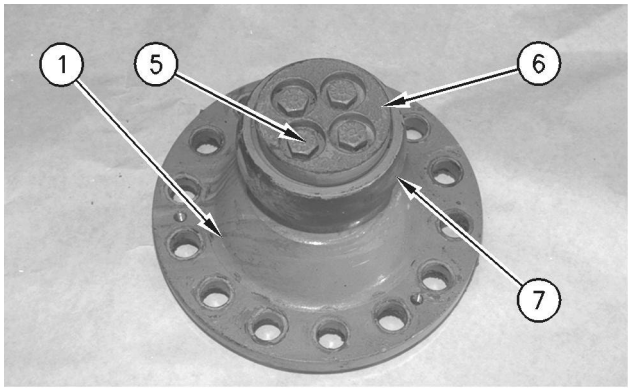


Illustration 743 g00884764

6. Remove four bolts (5) and retainer (6) from trunnion (1).

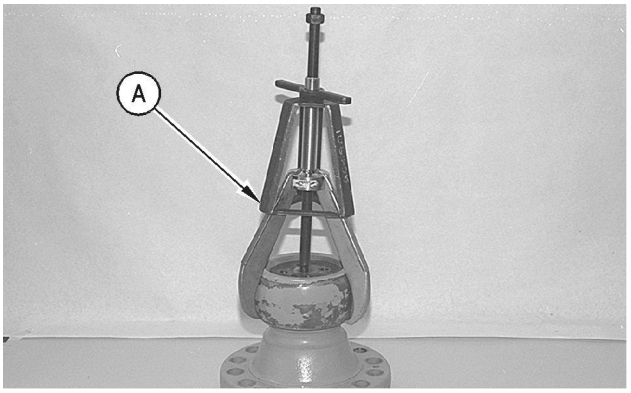


Illustration 744 g00607367

7. Install Tooling (A), as shown.

8. Use Tooling (A) in order to remove the bearing.

i01720780

Bulldozer Trunnion - Install

SMCS Code: 6069-012

Installation Procedure

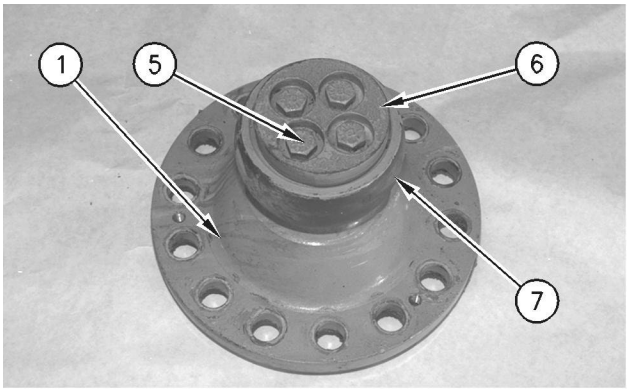


Illustration 745 g00884764

1. Heat bearing (7) to a temperature of 165 °C (329 °F).

2. Use the proper protective equipment in order to install bearing (7).

3. Install retainer (6) and bolts (5).

4. Tighten bolts (5) to a torque of 270 ± 40 N·m (200 ± 30 lb ft).

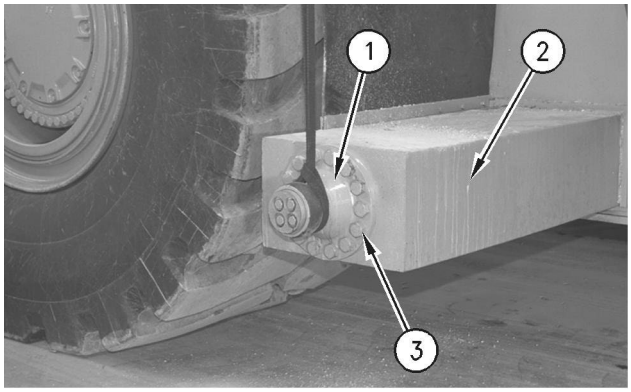


Illustration 746 g00884762

5. Attach a suitable hoist and a suitable lifting sling to trunnion (1).

6. Install trunnion (1) and bolts (3) on push beam (2).

7. Tighten the bolts to a torque of 900 ± 100 N·m (665 ± 75 lb ft).

End By:

a. Install the push arms and the blade. Refer to Disassembly and Assembly, “Push Arms and Blade - Install” for the machine that is being serviced.

i02513810

Tilt and Tip Cylinder - Remove and Install

SMCS Code: 5104-010; 5106-010

Removal Procedure

Start By:

a. Release the system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

b. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

⚠ WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the oil from the hydraulic tank for the implement and the braking system into a suitable container for storage or disposal.

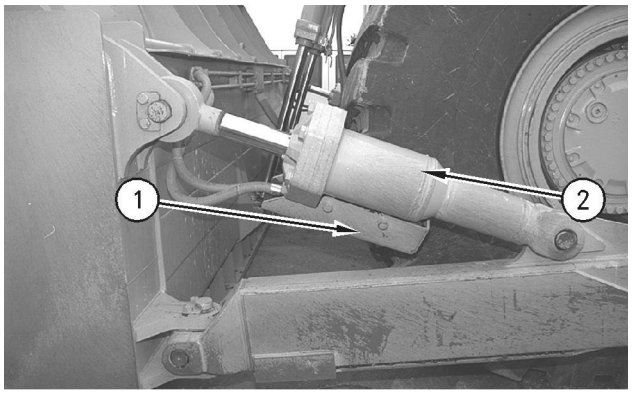


Illustration 747 g00884807

2. Remove guard (1) from tilt cylinder (2).

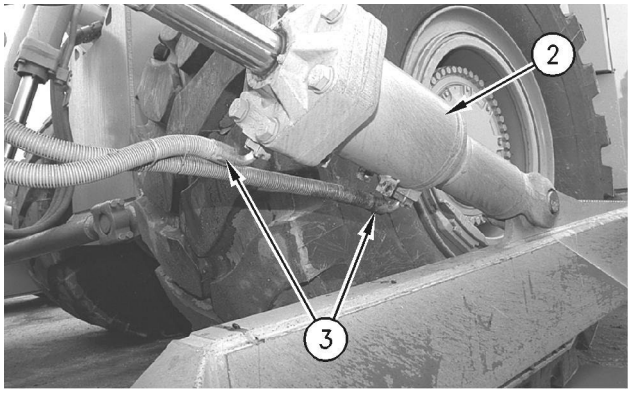


Illustration 748 g00884810

3. Disconnect hose assemblies (3) from tilt cylinder (2).

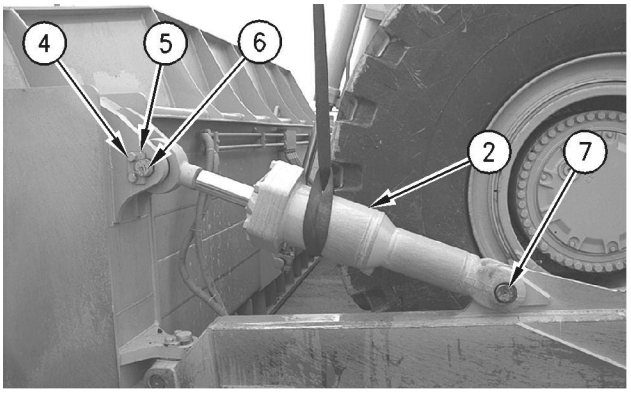


Illustration 749 g00884811

4. Attach a suitable lifting device to cylinder (2).

Note: Position suitable blocking under the blade in order to prevent any sudden movements when pin (6) or pin (7) is removed.

5. Remove bolts (4), retainer (5), and pin (6).

6. Remove pin (7).

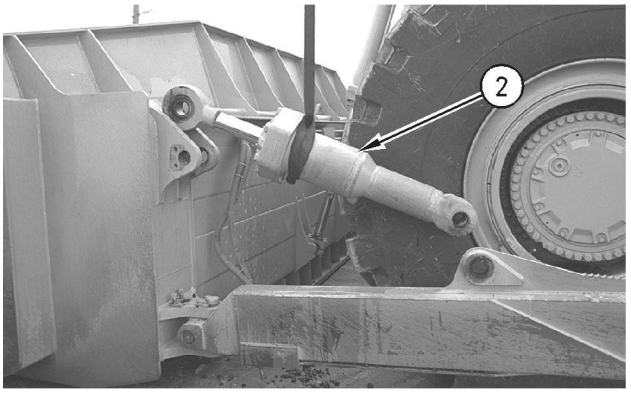


Illustration 750 g00884812

7. Remove tilt cylinder (2). The weight of tilt cylinder (2) is approximately 239 kg (525 lb).

8. Repeat Steps 2 through 7 for the other tilt cylinder.

Disassembly and Assembly Information

Table 37

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	127-4904	Repair Stand	1
B	7M-7456	Bearing Mount Compound	1

⚠ WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

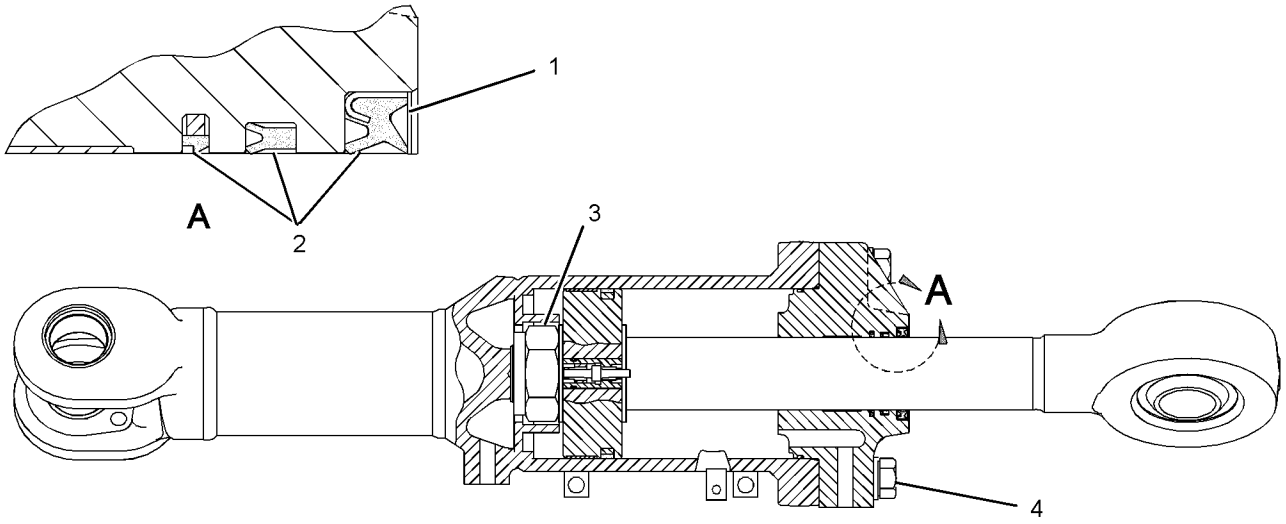


Illustration 751 g01257742

(1) Apply Tooling (B) to the wiper seal groove prior to assembly.

(2) Lubricate the sealing lips with a minimal amount of the lubricant that is being sealed.

(3) Lubricate the threads of the cylinder rod with a minimal amount of the lubricant that is being sealed.
Torque for the nut . . . . . 8000 ± 800 N·m ((5900 ± 590 lb ft))

(4) Torque for the six bolts . . . . . 1050 ± 150 N·m ((774 ± 111 lb ft))

Installation Procedure

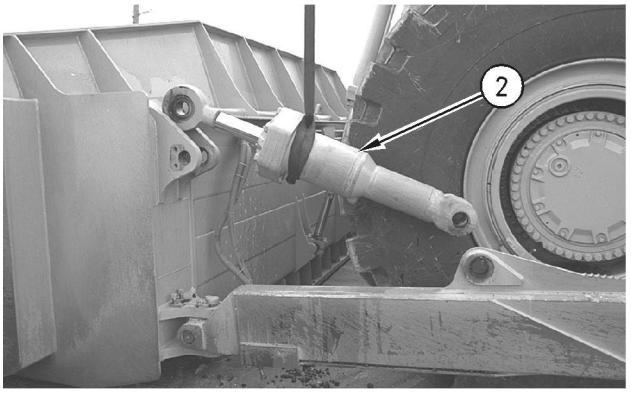


Illustration 752 g00884812

1. Use a suitable lifting device to position tilt cylinder (2) on the blade and the push arm. The weight of tilt cylinder (2) is approximately 239 kg (525 lb).

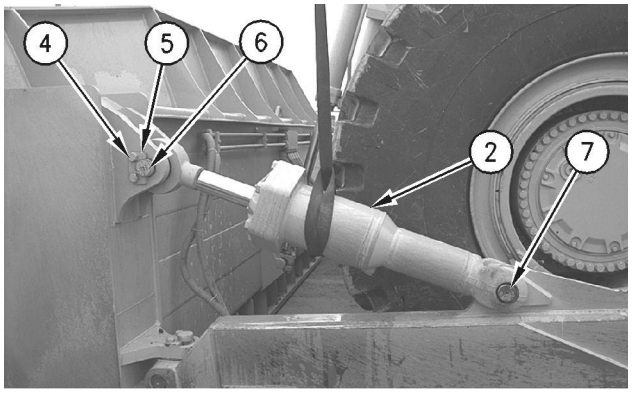


Illustration 753 g00884811

2. Install pin (6), retainer (5) and bolts (4).

3. Install pin (7).

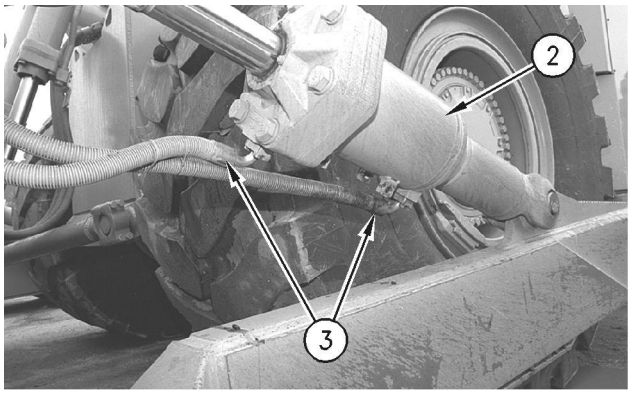


Illustration 754 g00884810

4. Connect hose assemblies (3) to tilt cylinder (2).

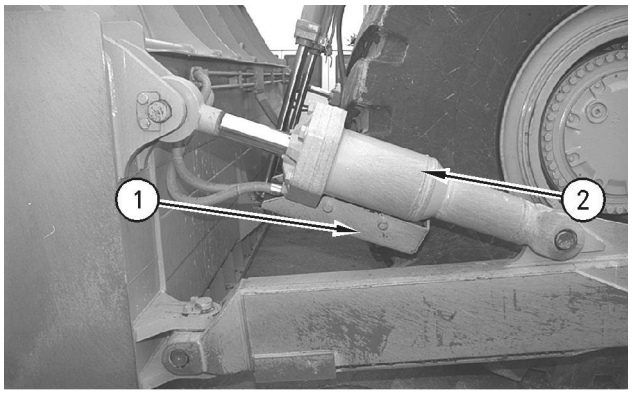


Illustration 755 g00884807

5. Install guard (1) to tilt cylinder (2).

6. Repeat Steps 1 through 5 for the other tilt cylinder.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02517526

Lift Cylinder - Remove and Install

SMCS Code: 5102-010

Removal Procedure

Table 38

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Gp	1

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

⚠ WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

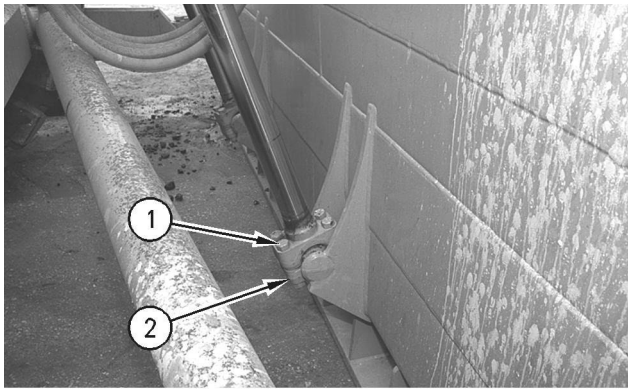


Illustration 756 g00884988

1. Remove bolts (1), bearing cap (2), and the shims. Note the quantity and the location of the shims for assembly purposes.

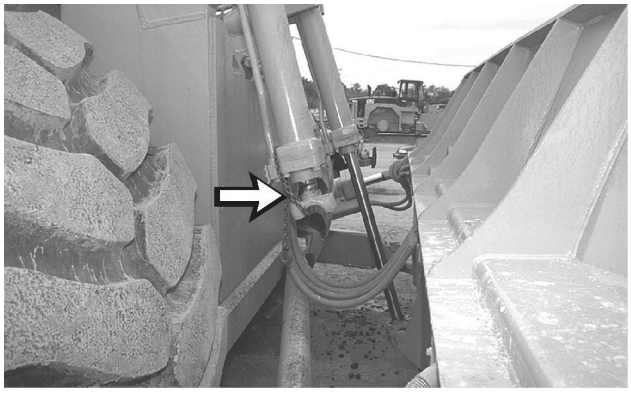


Illustration 757 g00884989

2. Start the engine. Retract the lift cylinder.

3. Stop the engine.

4. Secure the cylinder rod in the up position, as shown. This will prevent the cylinder rod from extending when the hydraulic hoses are disconnected.

5. Release the pressure in the implement hydraulic system. Refer to Disassembly and Assembly, “System Pressure - Release”.

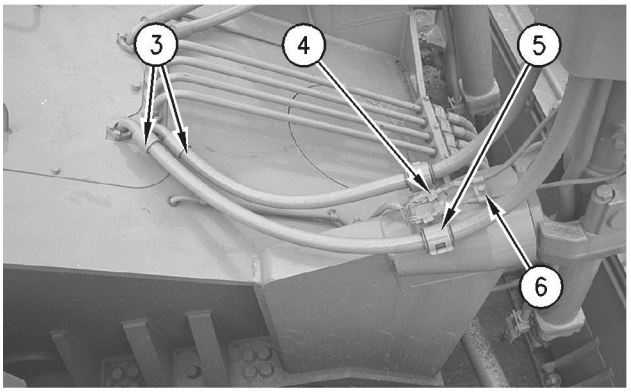


Illustration 758 g00884992

6. Disconnect hose assemblies (3).

7. Disconnect harness connectors (4).

8. Remove clamps (5) and clip (6).

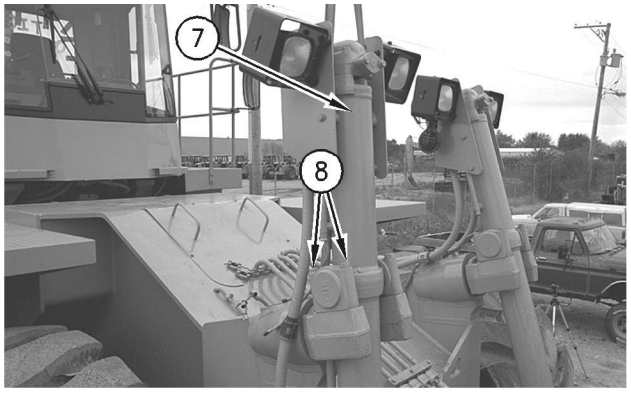


Illustration 759 g00884993

9. Attach a suitable lifting device to lift cylinder (7). The weight of lift cylinder (7) is approximately 239 kg (525 lb).

10. Remove bolts (8).

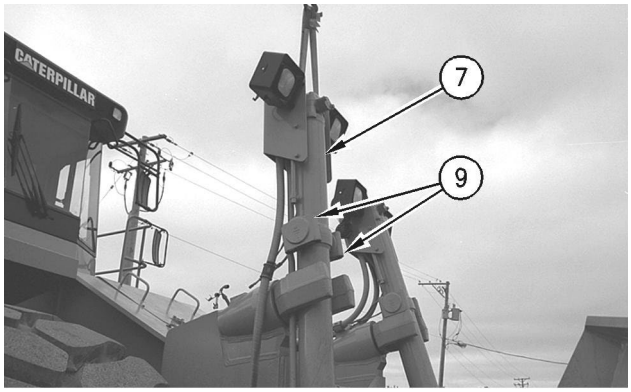


Illustration 760 g00884994

11. Remove bearing caps (9) from both sides of lift cylinder (7).

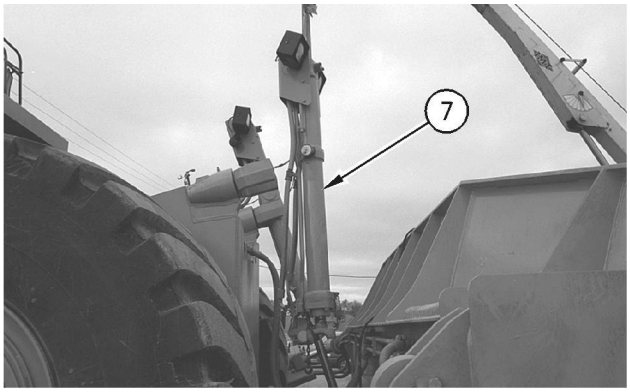


Illustration 761 g00884996

12. Remove lift cylinder (7).

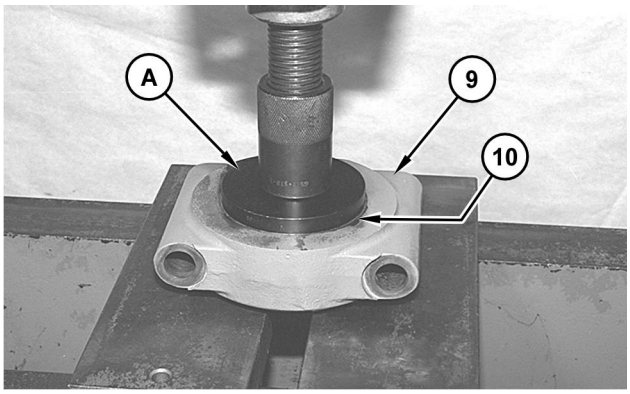


Illustration 762 g01257762

13. Use Tooling (A) and a suitable press in order to remove bearing (10) from bearing cap (9). Repeat this Step for the other bearing cap.

Disassembly and Assembly Information

Table 39

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	127-4904	Repair Stand	1
C	7M-7456	Bearing Mount Compound	1

⚠ WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

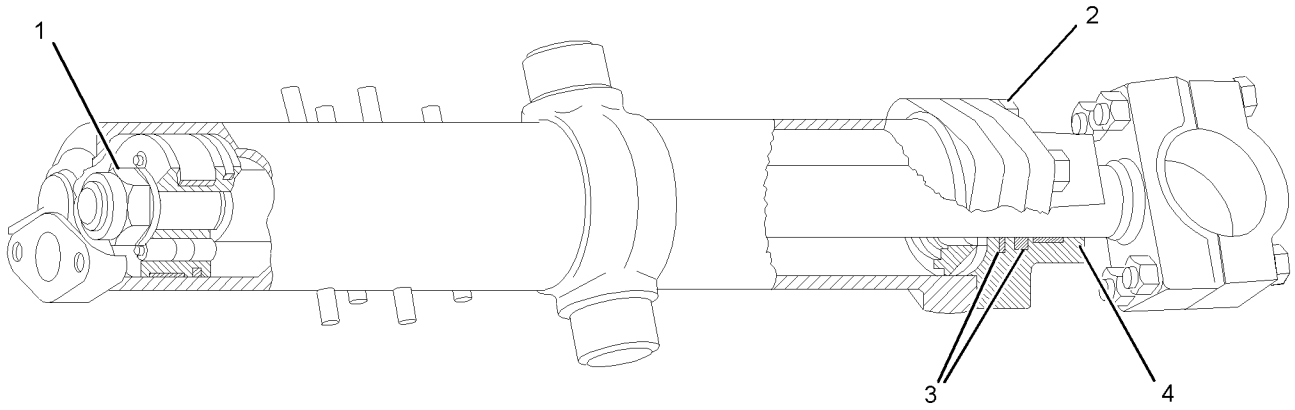


Illustration 763 g01257769

Note: Extend the rod fully before tightening the head bolts.

(1) Lubricate the threads of the cylinder rod with a minimal amount of the lubricant that is being sealed.
Torque for the nut . . . . . 3000 ± 300 N·m ((2210 ± 220 lb ft))

(2) Torque for the four bolts . . . . . 430 ± 60 N·m ((317 ± 44 lb ft))

(3) Lubricate the sealing lips with a minimal amount of the lubricant that is being sealed.

(4) Apply Tooling (C) to the wiper seal groove prior to assembly.

Installation Procedure

Table 40

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Gp	1
D	5P-0960	Grease Cartridge	1

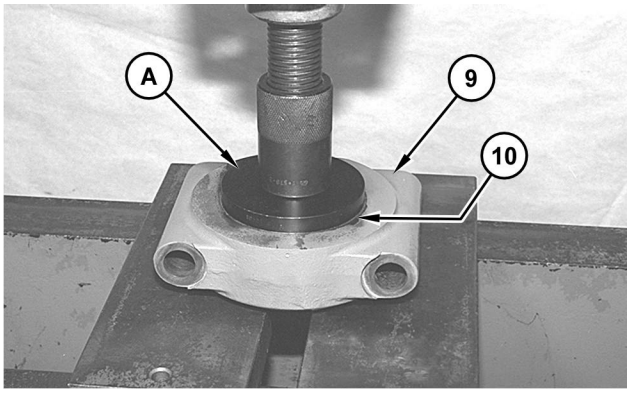


Illustration 764 g01257762

1. Lower the temperature of bearing (10).

2. Use Tooling (A) and a suitable press in order to install bearing (10) in bearing cap (9). The inside diameter of the bearing must be 88.87 ± 0.10 mm (3.5 ± 0.004 inch) after installation.

3. Repeat Steps 1 and 2 for the other bearing cap.

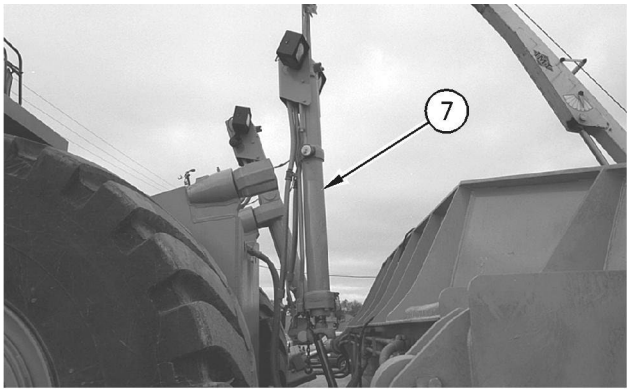


Illustration 765 g00884996

4. Use a suitable lifting device to position lift cylinder (7) on the machine. The weight of lift cylinder (7) is approximately 239 kg (525 lb).

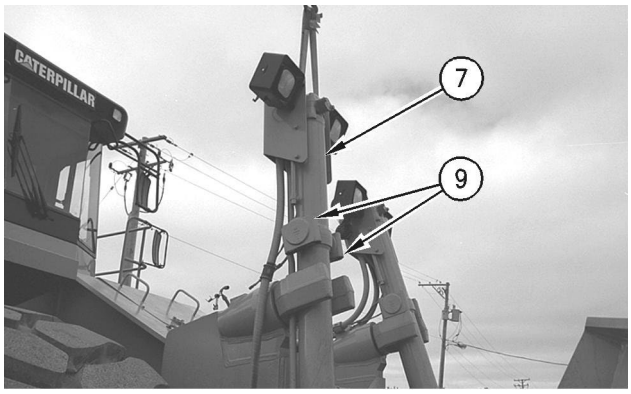


Illustration 766 g00884994

5. Lubricate the inside of bearing caps (9) with Tooling (D) prior to installation.

6. Install bearing caps (9) on both sides of lift cylinder (7).

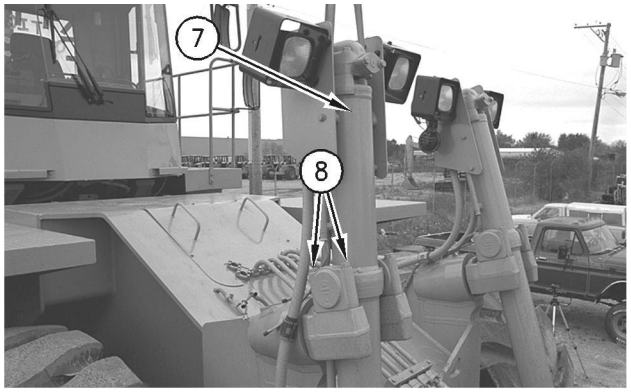


Illustration 767 g00884993

7. Install bolts (8). Tighten bolts (8) to a torque of 370 ± 50 N·m (275 ± 35 lb ft).

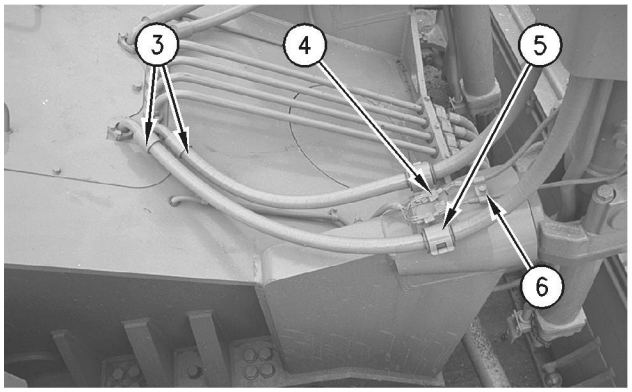


Illustration 768 g00884992

8. Connect hose assemblies (3).

9. Connect harness connectors (4).

10. Install clamps (5) and clip (6).

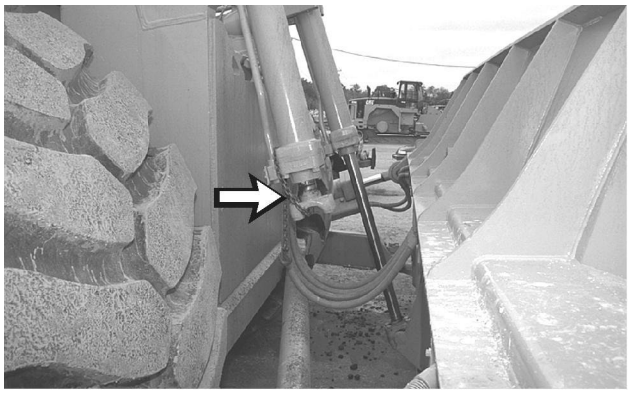


Illustration 769 g00884989

11. Remove the device that was used to secure the cylinder rod in position.

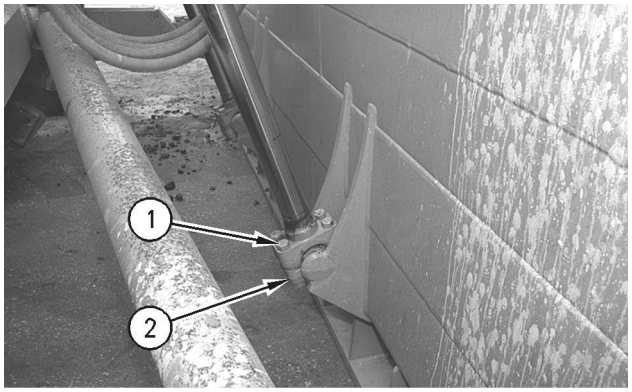


Illustration 770 g00884988

12. Start the machine.

13. Extend the lift cylinder rod to the trunnion.

14. Turn off the machine.

15. Install bolts (1) and bearing cap (2) without shims.

16. Tighten bolts (1) evenly on both sides of the cap.

17. Insert an equal amount of shims in the spaces between the bearing cap and the lift cylinder, as needed.

18. Add one additional shim to each of the spaces. The specified clearance between the trunnion and the rod assembly is 0.50 ± 0.25 mm (0.020 ± 0.010 inch).

19. Tighten bolts (1) to a torque of 620 ± 80 N·m (460 ± 60 lb ft).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i01721617

Lift Cylinder Mounting - Remove and Install

SMCS Code: 5102-010-MT

Removal Procedure

Table 41

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
	0L-1178	Bolt	2
B	1P-7407	Eyebolt	1

Start By:

a. Remove the lift cylinder. Refer to Disassembly and Assembly, “Lift Cylinder - Remove”for the machine that is being serviced.

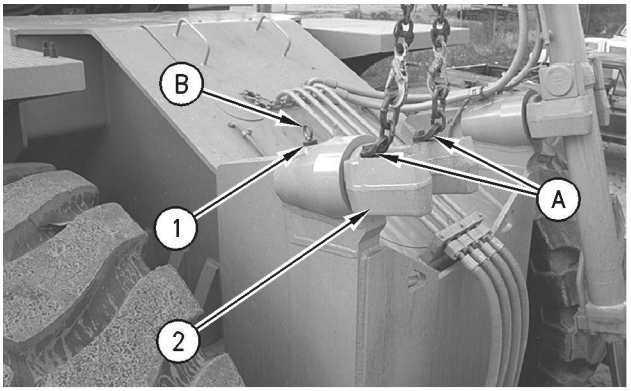


Illustration 771 g00885038

1. Secure Tooling (A) to yoke (2).

2. Attach a suitable hoist and a suitable lifting sling to Tooling (A), as shown.

3. Remove the cover and the gasket from pin (1).

4. Install Tooling (B) in the threaded hole of pin (1).

5. Remove pin (1).

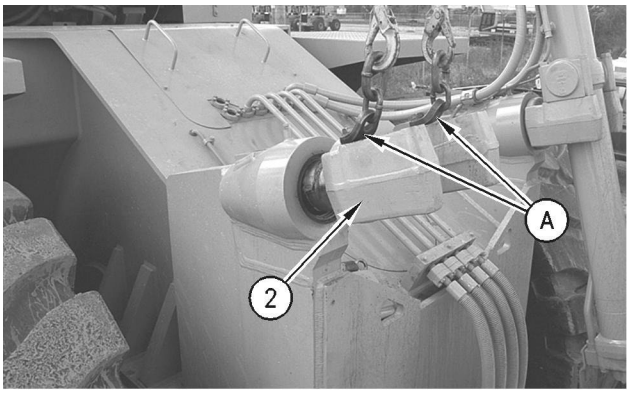


Illustration 772 g00885039

6. Use a suitable hoist and Tooling (A) in order to remove yoke (2). The weight of the yoke is 55 kg (120 lb).

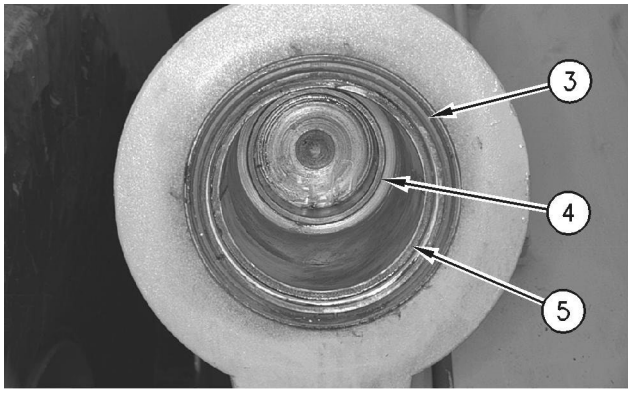


Illustration 773 g00885042

7. Remove lip seal (3) from the front frame assembly.

8. If necessary, remove bearing (4) and (5). Refer to the following steps for the removal procedure:

a. Use 3.0 mm (.125 inch) low hydrogen welding rods. Weld a continuous bead completely around the inside diameter of the bearing.

b. Allow the bearing to cool.

c. Remove the bearing from the cap.

Installation Procedure

Table 42

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
	0L-1178	Bolt	2
B	1P-7407	Eyebolt	1

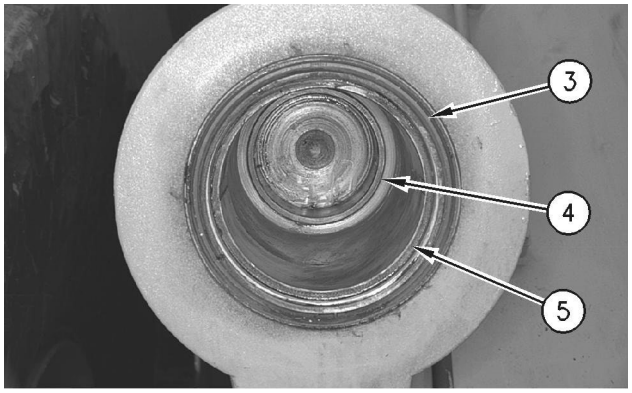


Illustration 774 g00885042

1. Lower the temperature of bearings (4) and (5).

2. Use the proper protective equipment in order to install bearing (4) and bearing (5) in the front frame.

3. Install the bearings with the grooves within 15° of horizontal.

4. Install lip seal (3) in the front frame. The seal must be installed with the lip toward the outside of the frame.

5. Fill the bearings and lubricate the lip seal with 5P-0960 Molybdenum Grease.

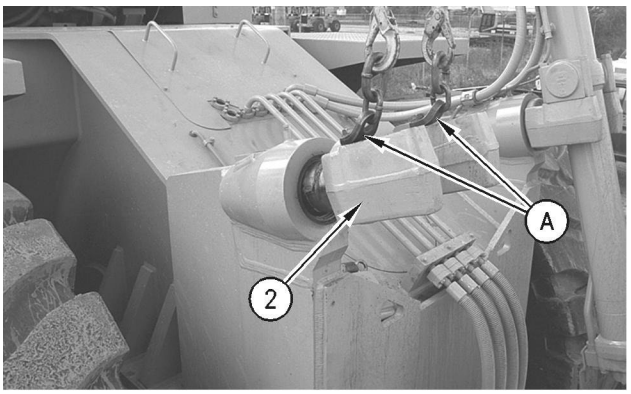


Illustration 775 g00885039

6. Use a suitable hoist and Tooling (A) in order to install yoke (2). The weight of the yoke is 55 kg (120 lb).

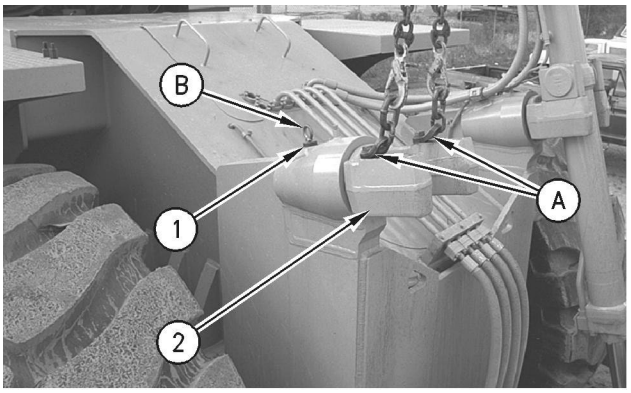


Illustration 776 g00885038

7. Install pin (1).

8. Remove Tooling (A) and Tooling (B).

9. Install the gasket and the cover on pin (1).

End By:

a. Install the lift cylinder. Refer to Disassembly and Assembly, “Lift Cylinder - Install”for the machine that is being serviced.

i02496515

Rollover Protective Structure (ROPS) - Remove

SMCS Code: 7323-011

Removal Procedure

Table 43

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	4
B	138-7576	Link Bracket	4

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “Hydraulic System Pressure - Release”.

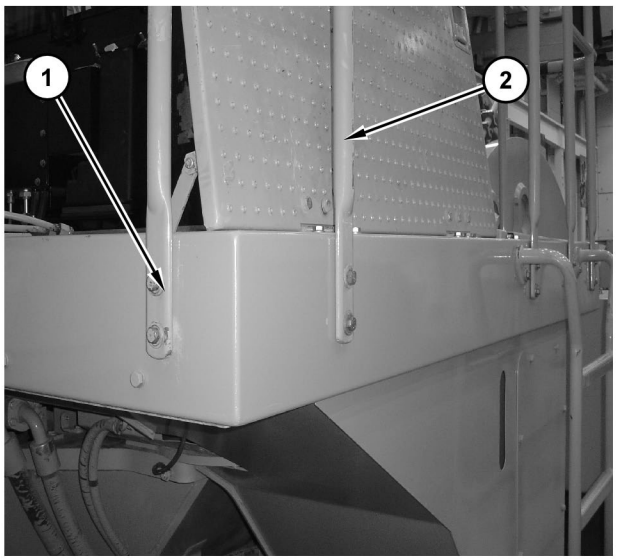


Illustration 777 g01248593

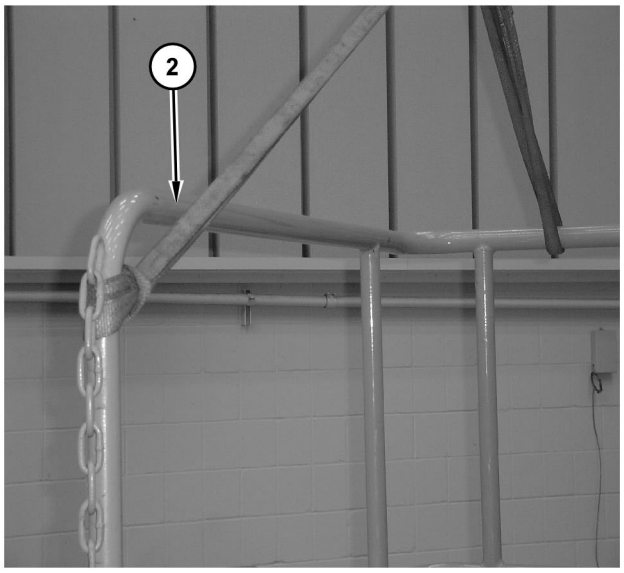


Illustration 778 g01248594

1. Attach a suitable lifting device to hand rail assembly (2). The weight of hand rail assembly (2) is approximately 29 kg (65 lb). Remove bolts (1). Remove hand rail assembly (2).

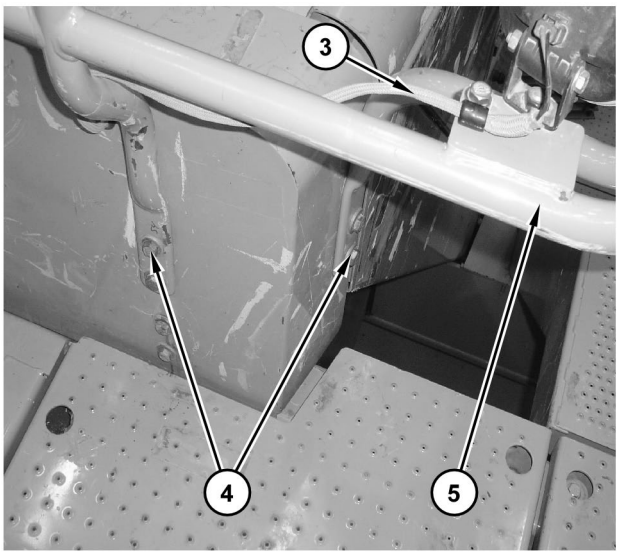


Illustration 779 g01248597

2. Use two people in order to remove hand rail assembly (5). The weight of hand rail assembly (5) is approximately 31 kg (70 lb). Disconnect harness assembly (3). Remove bolts (4). Remove hand rail assembly (5).

3. Repeat Step 2 for the opposite side.

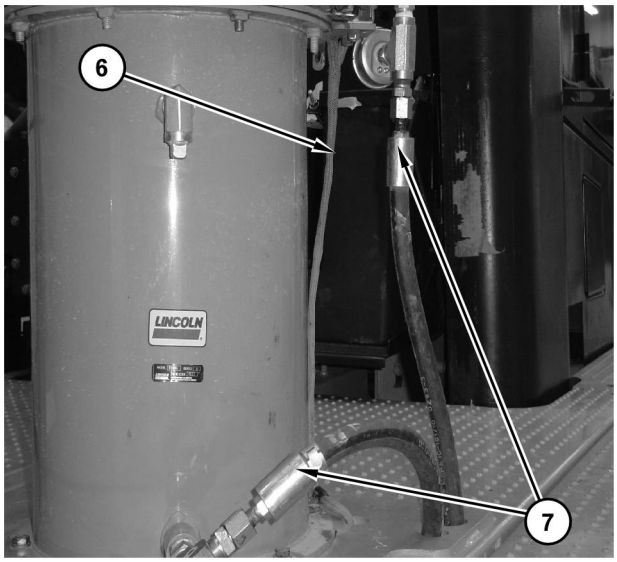


Illustration 780 g01248605

4. Disconnect harness assembly (6) and the mounting hardware. Disconnect hose assemblies (7).

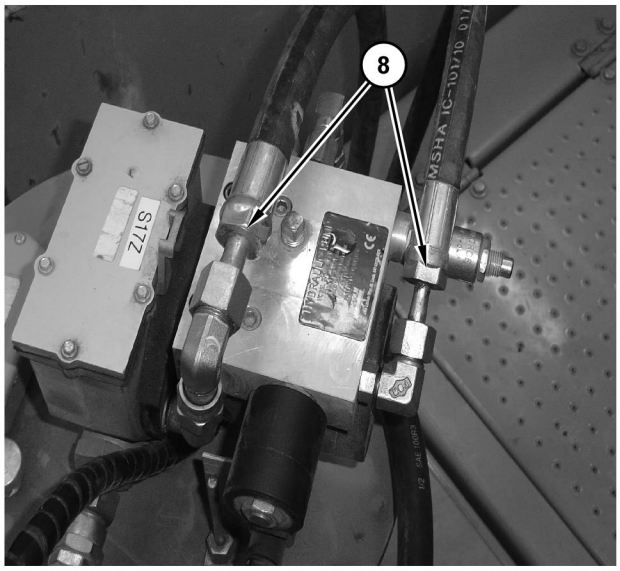


Illustration 781 g01248650

5. Disconnect hose assemblies (8).

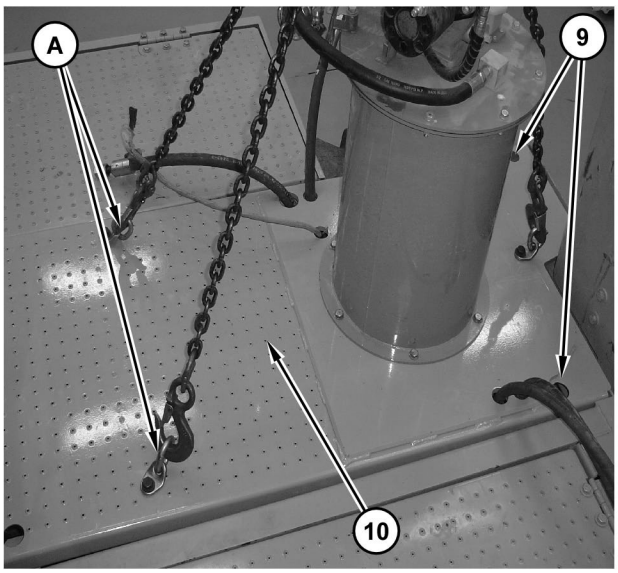


Illustration 782 g01248662

6. Remove bolts (9). Attach Tooling (A) and a suitable lifting device to cover assembly (10). The weight of cover assembly (10) is approximately 159 kg (350 lb). Remove cover assembly (10).

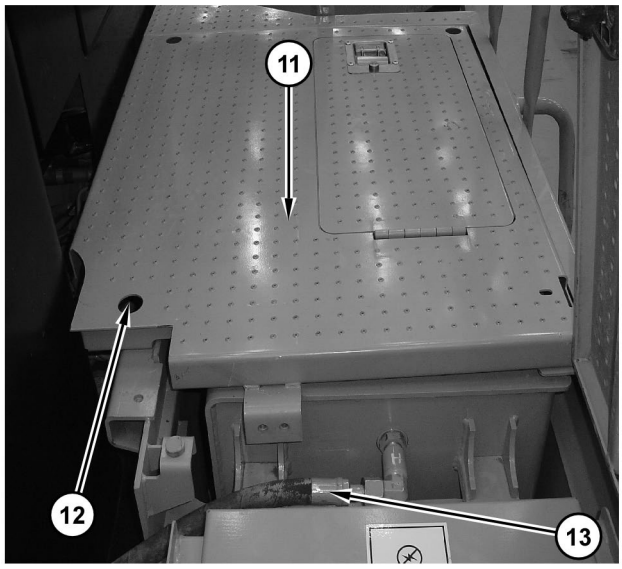


Illustration 783 g01248668

7. Use two people in order to remove platform assembly (11). The weight of platform assembly (11) is approximately 27 kg (60 lb). Remove bolts (12). Remove platform assembly (11). Remove hose assembly (13).

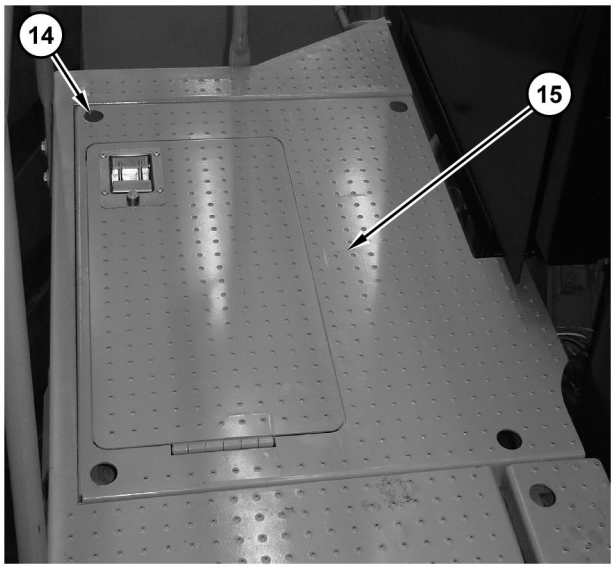


Illustration 784 g01248670

8. Remove bolts (14). Use two people in order to remove platform assembly (15). The weight of platform assembly (15) is approximately 27 kg (60 lb).

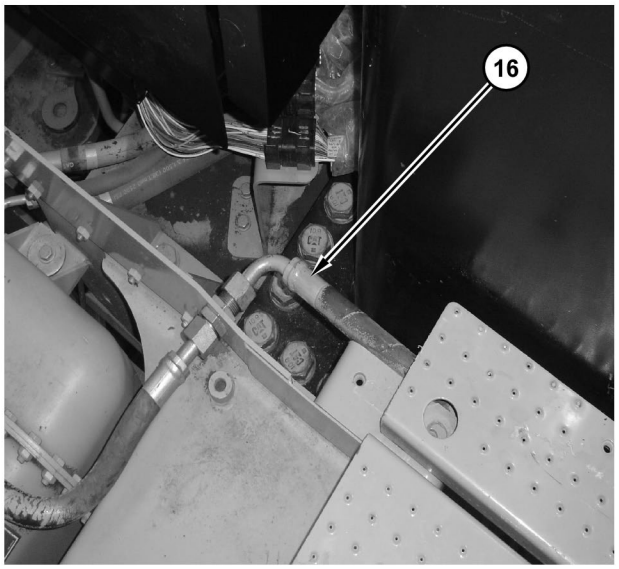


Illustration 785 g01248674

9. Remove hose assembly (16).

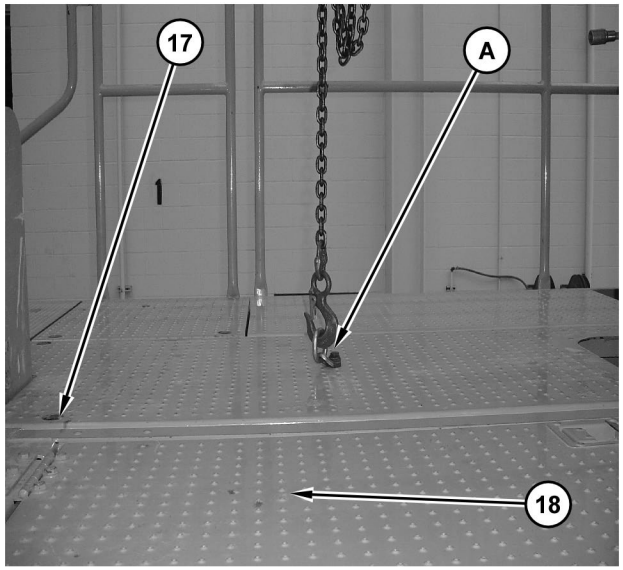


Illustration 786 g01248677

10. Remove bolts (17). Attach Tooling (A) and a suitable lifting device to cover assembly (18). The weight of cover assembly (18) is approximately 118 kg (260 lb). Remove cover assembly (18).

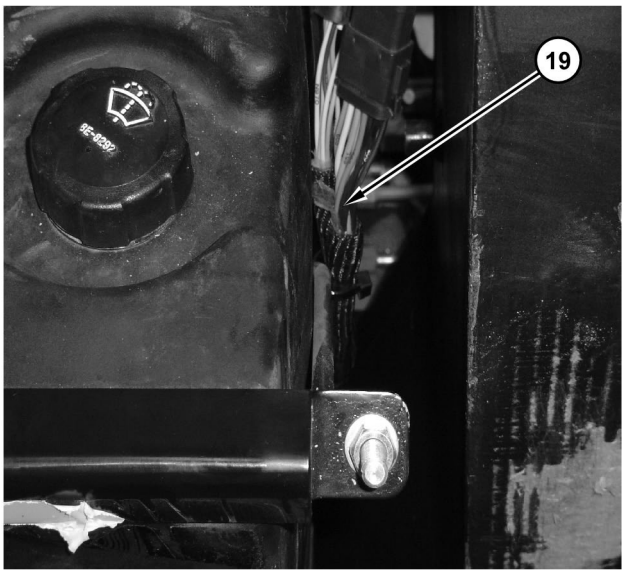


Illustration 787 g01248680

11. Disconnect harness assembly (19).

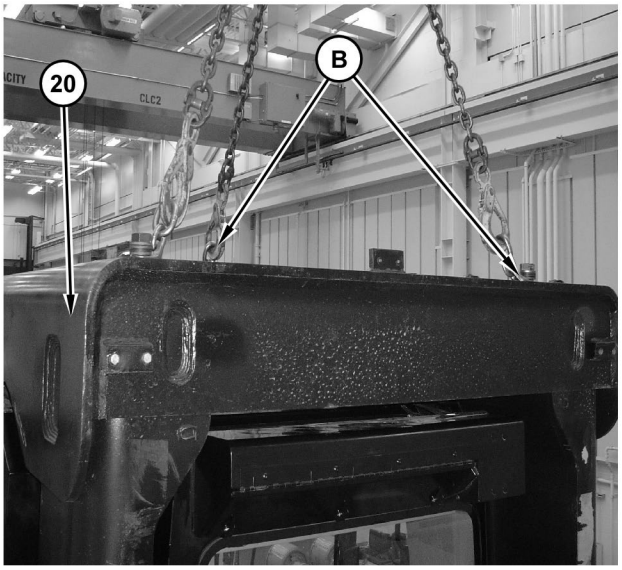


Illustration 788 g01248684

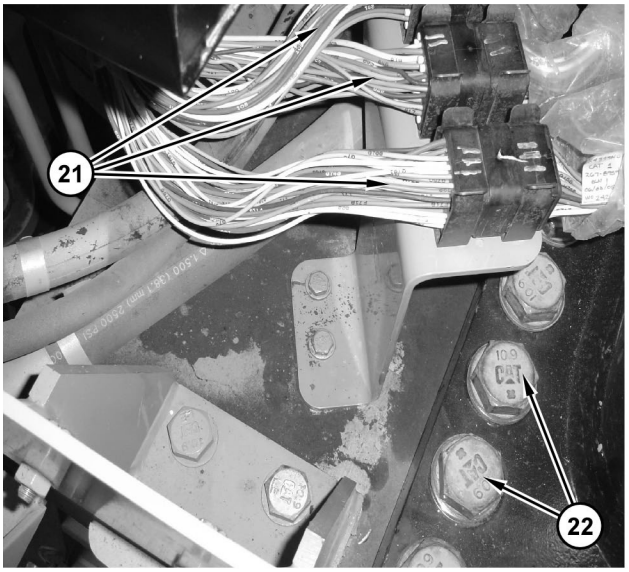


Illustration 789 g01248692

12. Attach Tooling (B) and a suitable lifting device to rollover protective structure (20). The weight of rollover protective structure (20) is approximately 2313 kg (5100 lb). Position harness assemblies (21) out of the way.

13. Remove bolts (22).

14. Repeat Step 13 for the other side.

15. Remove rollover protective structure (20).

i02497476

Rollover Protective Structure (ROPS) - Install

SMCS Code: 7323-012

Installation Procedure

Table 44

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	4
B	138-7576	Link Bracket	4
C	194-7586	Wrench	1
	4C-6724	Socket	1
	290-7531	Double Ended Blank	1

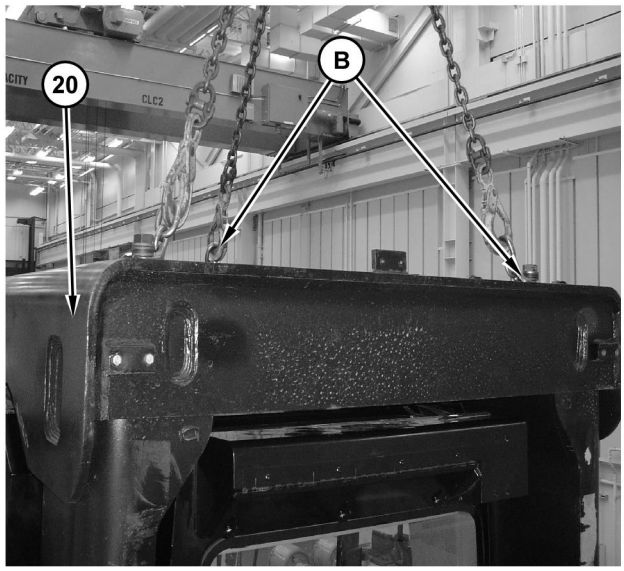


Illustration 790 g01248684

1. Attach Tooling (B) and a suitable lifting device to rollover protective structure (20). The weight of rollover protective structure (20) is approximately 2313 kg (5100 lb).

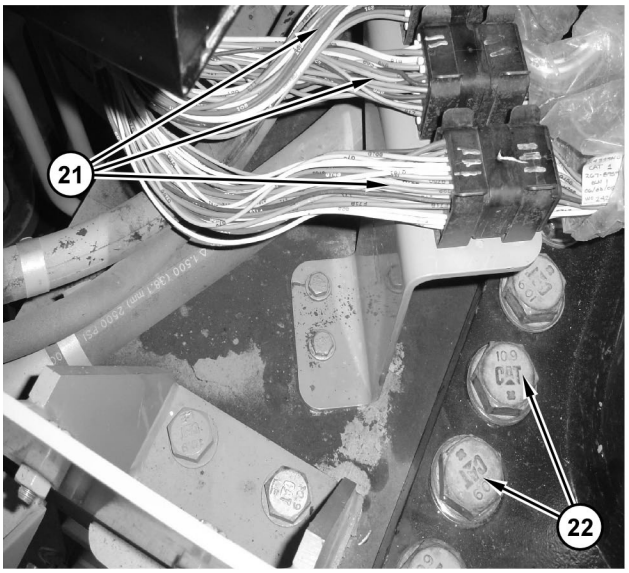


Illustration 791 g01248692

2. Position rollover protective structure (20). Install bolts (22). Use Tooling (C) in order to tighten bolts (22) to a torque of 1600 ± 200 N·m (1180 ± 148 lb ft). Position harness assembly (21) into the original location. Remove Tooling (B).

Note: Surfaces must be free of paint, clean and dry.

Note: The reaction arm of Tooling (C) must securely contact rollover protective structure (20).

3. Repeat Step 2 for the other side.

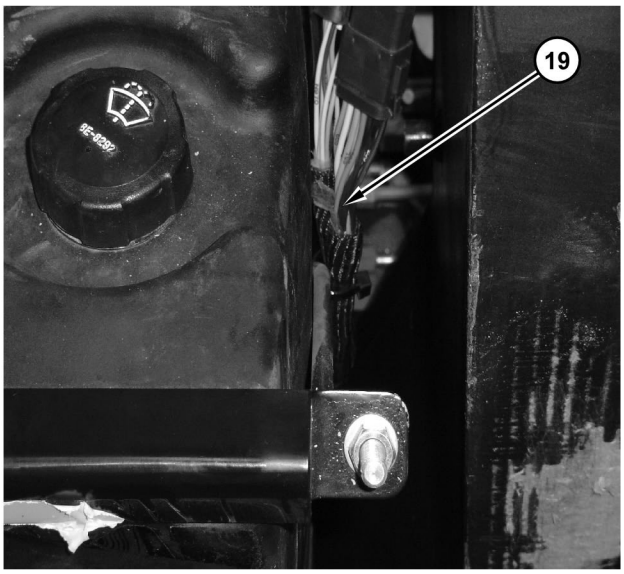


Illustration 792 g01248680

4. Connect harness assembly (19).

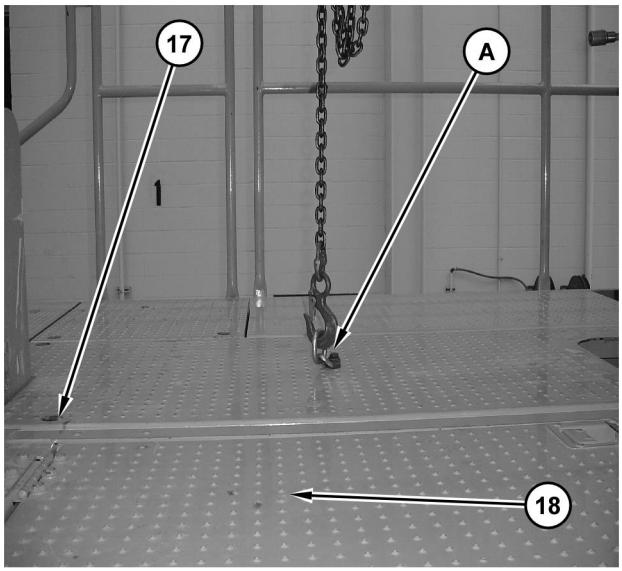


Illustration 793 g01248677

5. Attach Tooling (A) and a suitable lifting device to cover assembly (18). Install cover assembly (18). The weight of cover assembly (18) is approximately 118 kg (260 lb). Install bolts (17).

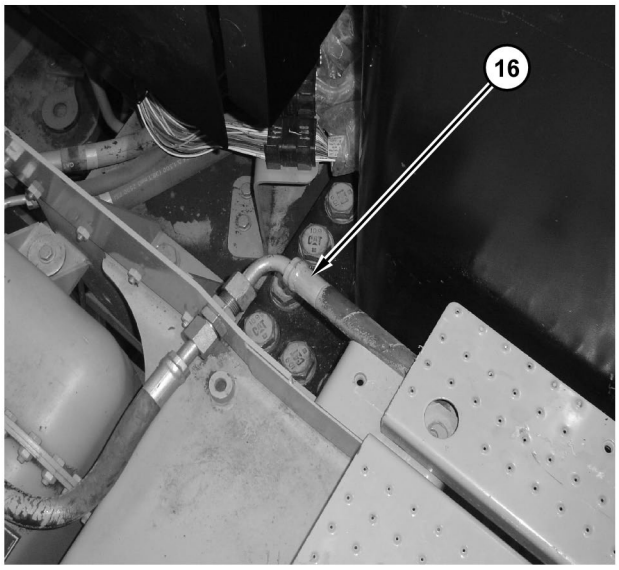


Illustration 794 g01248674

6. Install hose assembly (16).

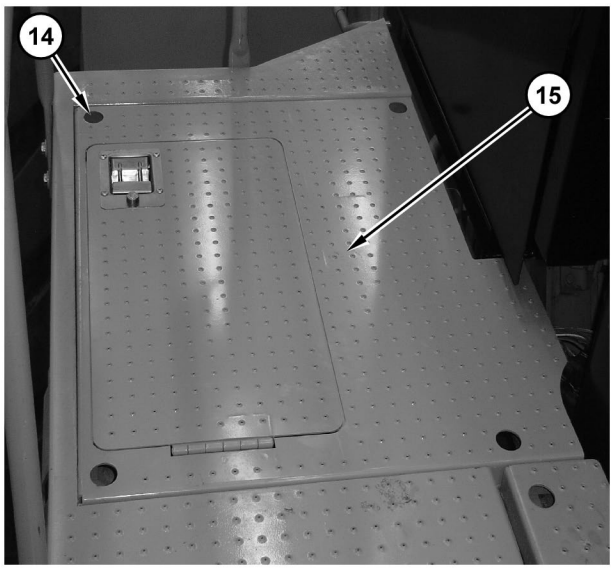


Illustration 795 g01248670

7. Use two people in order to install platform assembly (15). The weight of platform assembly (15) is approximately 27 kg (60 lb). Install platform assembly (15). Install bolts (14).

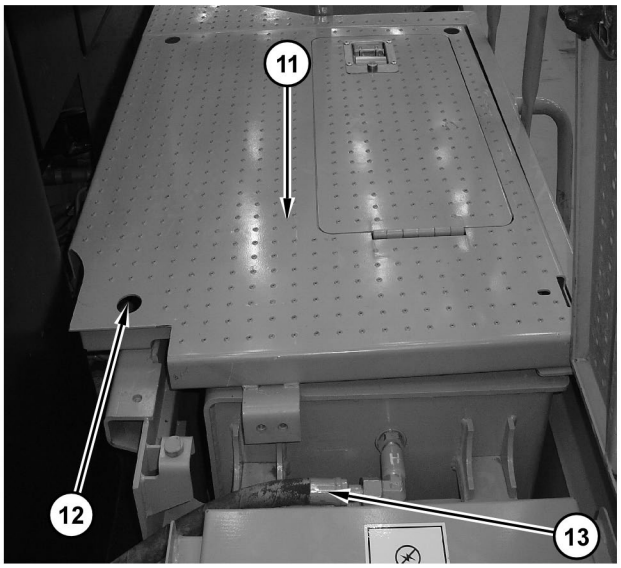


Illustration 796 g01248668

8. Use two people in order to install platform assembly (11). The weight of platform assembly (11) is approximately 27 kg (60 lb). Install platform assembly (11). Install hose assembly (13).

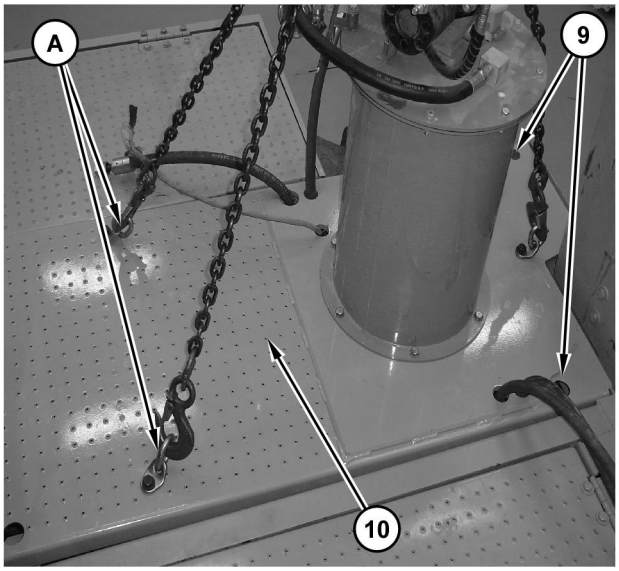


Illustration 797 g01248662

9. Attach Tooling (A) and a suitable lifting device to cover assembly (10). The weight of cover assembly (10) is approximately 159 kg (350 lb). Install cover assembly (10). Install bolts (9).

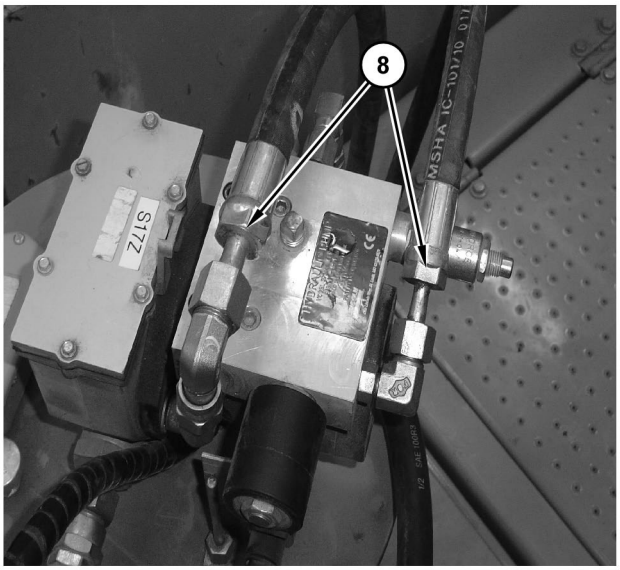


Illustration 798 g01248650

10. Connect hose assemblies (8).

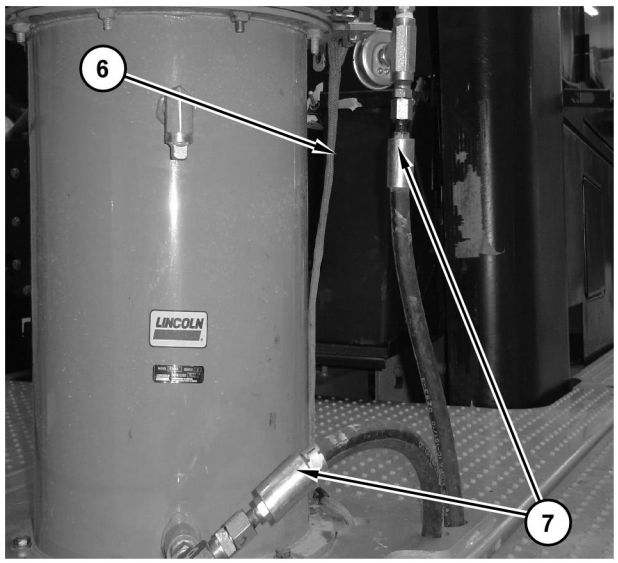


Illustration 799 g01248605

11. Connect hose assemblies (7). Connect harness assembly (6) and the mounting hardware.

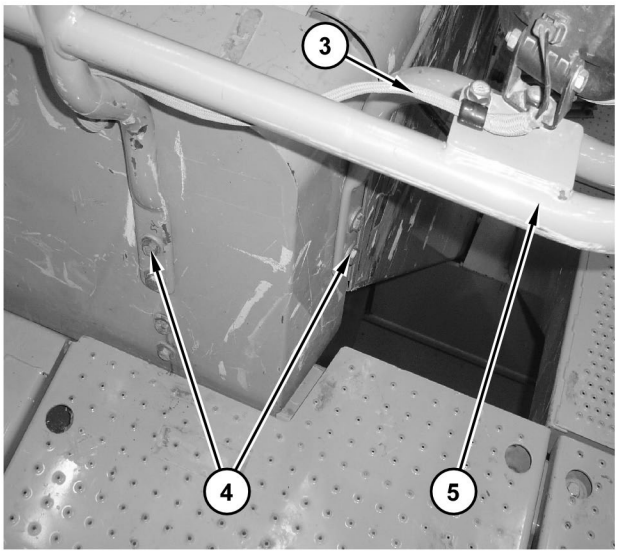


Illustration 800 g01248597

12. Use two people in order to install hand rail assembly (5). The weight of hand rail assembly (5) is approximately 31 kg (70 lb). Connect harness assembly (3). Install bolts (4).

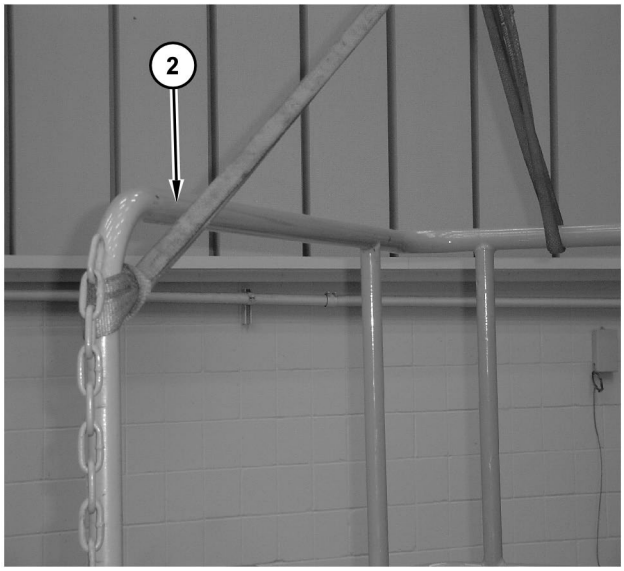


Illustration 801 g01248594

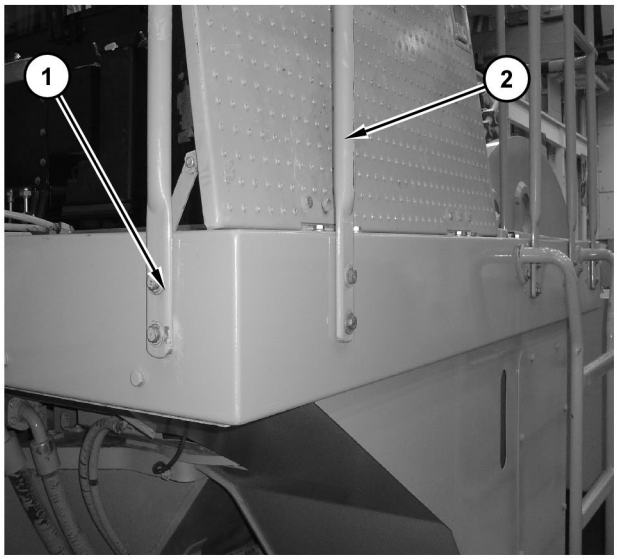


Illustration 802 g01248593

13. Attach a suitable lifting device to hand rail assembly (2). The weight of hand rail assembly (2) is approximately 29 kg (65 lb). Install bolts (1).

End By:

a. Separate steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

i02499140

Cab and Platform - Remove

SMCS Code: 7253-011; 7301-011

Removal Procedure

Table 45

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-8622	Shackle	4

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

b. Remove the rollover protective structure. Refer to Disassembly and Assembly , " Rollover Protective Structure - Remove and Install".

c. Release the hydraulic system pressure. Refer to Disassembly and Assembly , " Hydraulic System Pressure - Release".

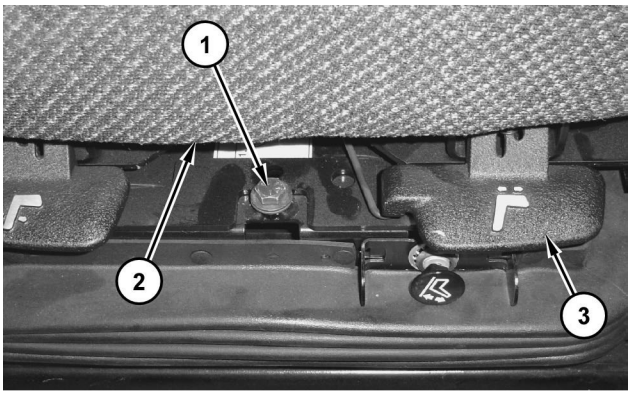


Illustration 803 g01236941

1. Remove bolt (1). Actuate lever (3). Move seat assembly (2) forward.

Note: Do not slide seat assembly (2) all the way forward. Seat assembly (2) will come off from seat suspension.

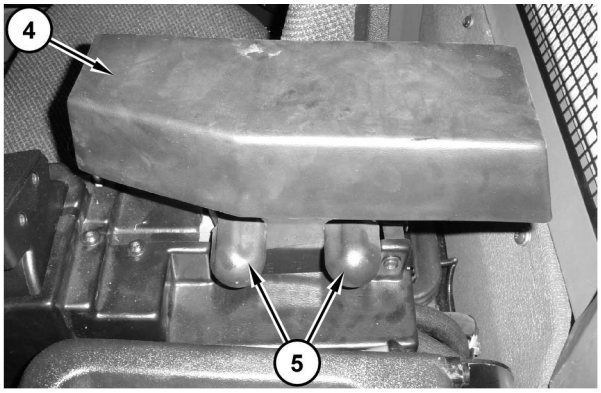


Illustration 804 g01236943

2. Remove knobs (5) and armrest assembly (4). Repeat for opposite side.

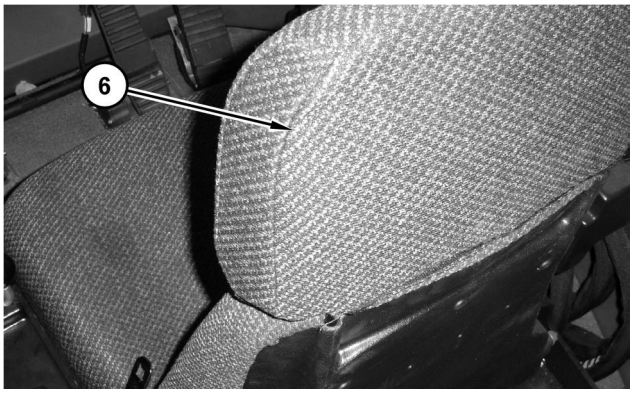


Illustration 805 g01236944

3. Remove headrest (6).

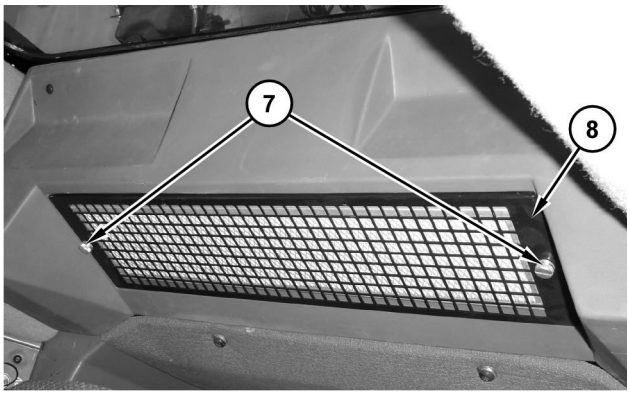


Illustration 806 g01236945

4. Remove bolts (7). Remove cover assembly (8).

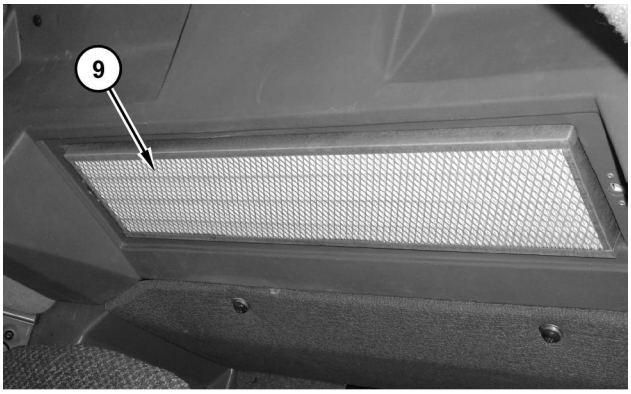


Illustration 807 g01236946

5. Remove filter assembly (9).

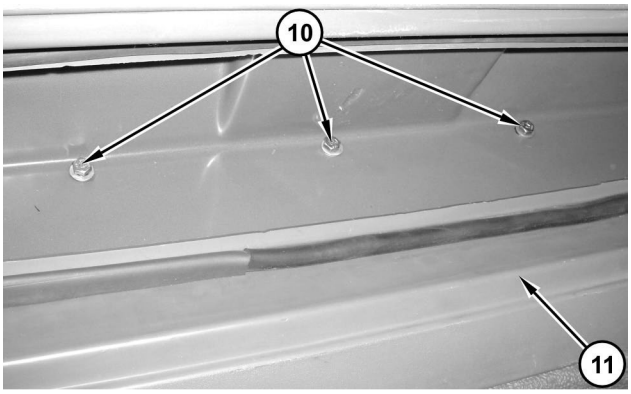


Illustration 808 g01236947

6. Remove bolts (10). Remove air duct (11).

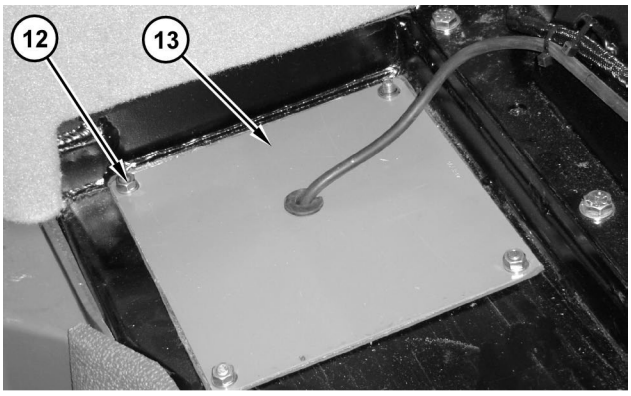


Illustration 809 g01236948

7. Remove nuts (12). Position panel (13) aside.

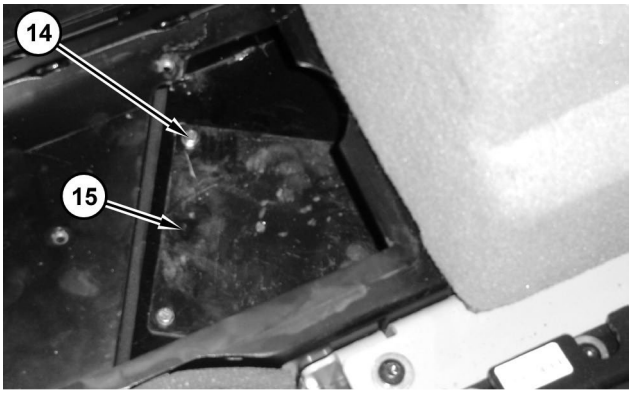


Illustration 810 g01236949

8. Remove bolts (14) and plate (15). Repeat for opposite side.

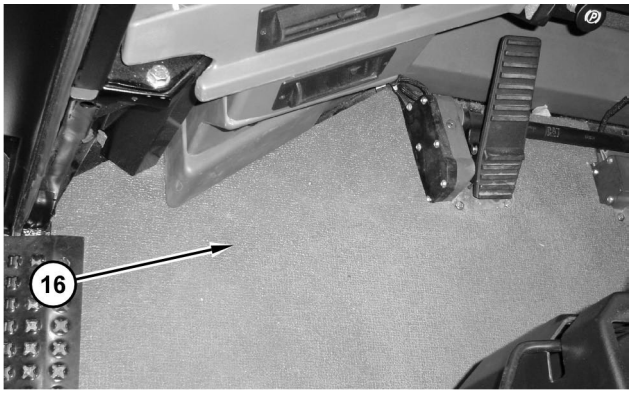


Illustration 811 g01236950

9. Remove floor mat (16).

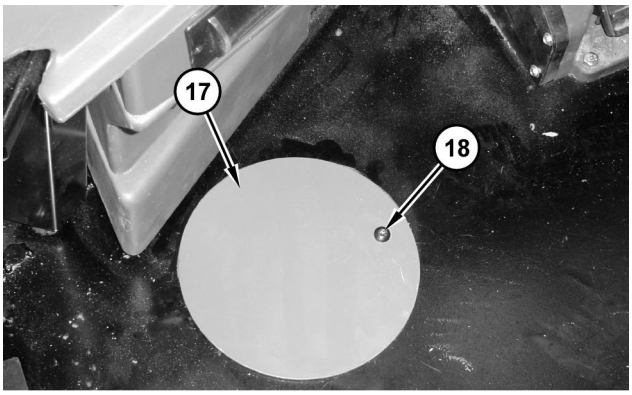


Illustration 812 g01236951

10. Remove bolt (18) and plate (17). Repeat for opposite side.

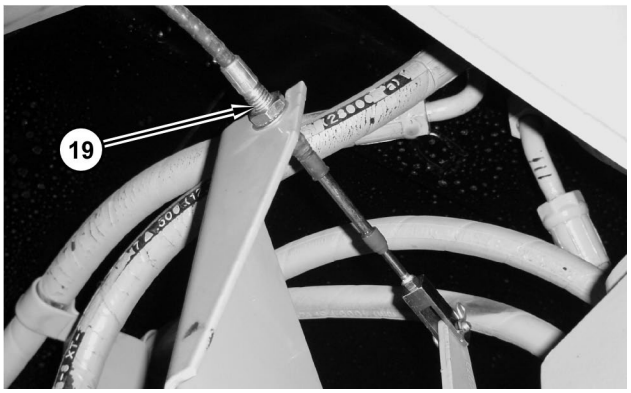


Illustration 813 g01236952

11. Disconnect cable assembly (19).

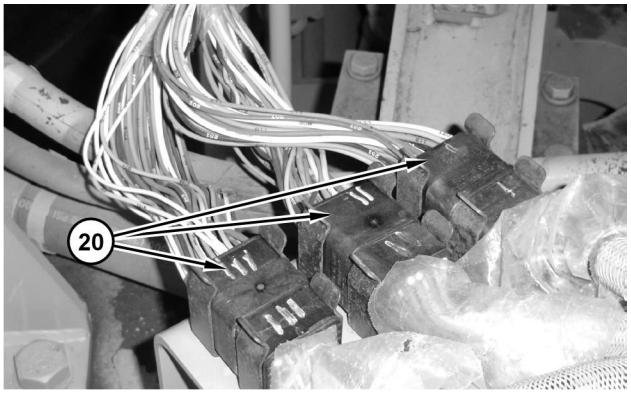


Illustration 814 g01236953

12. Disconnect harness assemblies (20).

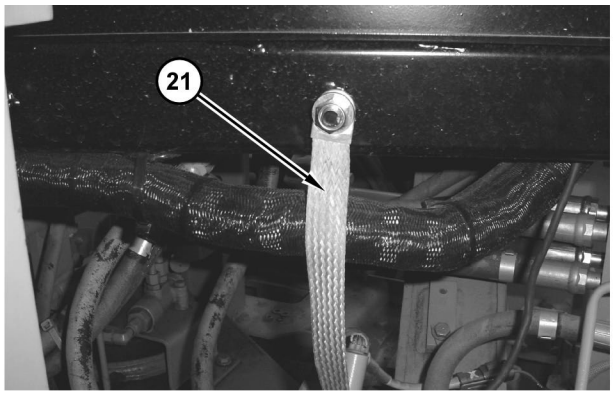


Illustration 815 g01236954

13. Disconnect ground strap (21).

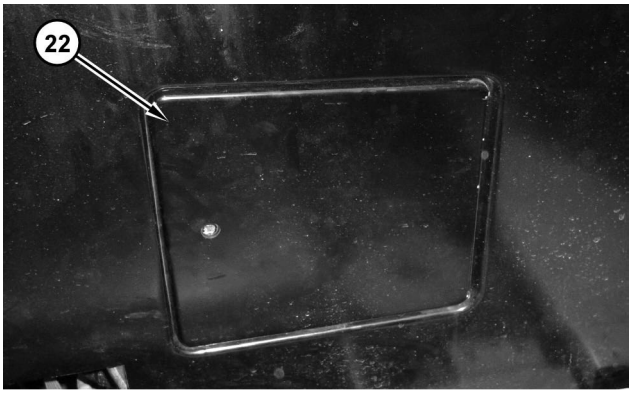


Illustration 816 g01236957

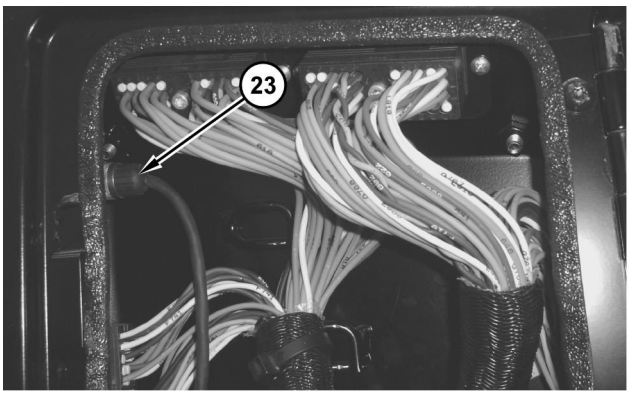


Illustration 817 g01236955

14. Open door assembly (22). Disconnect harness assembly (23).

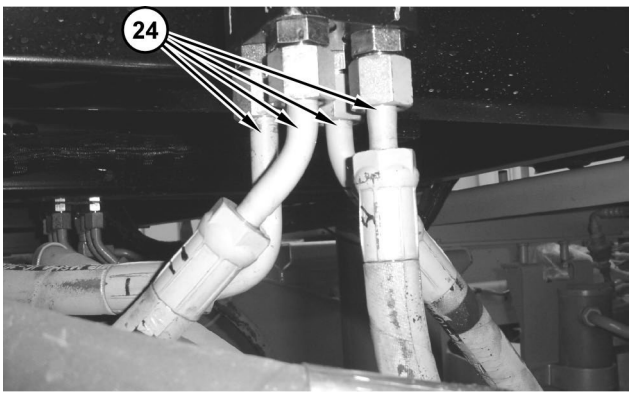


Illustration 818 g01236959

15. Disconnect hose assemblies (24).

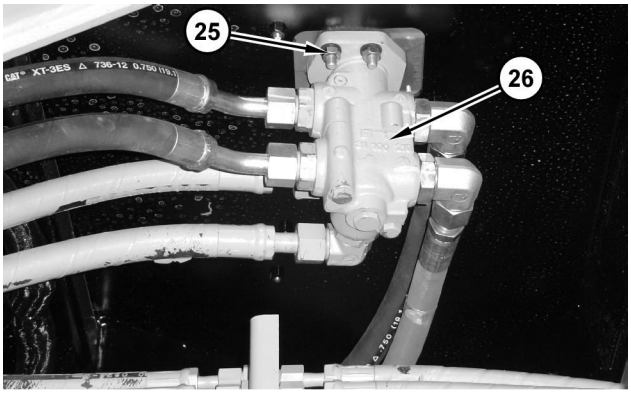


Illustration 819 g01236961

16. Remove nuts (25). Position valve assembly (26) aside .

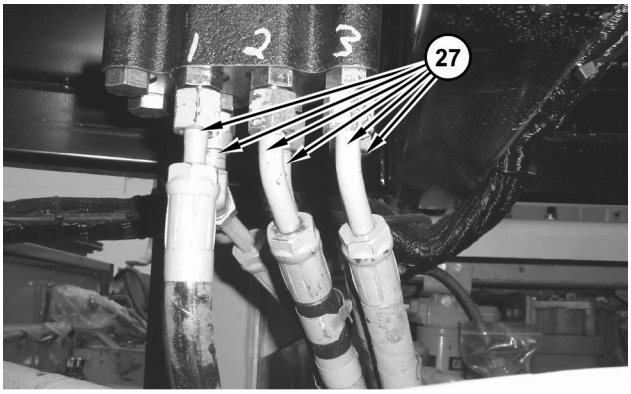


Illustration 820 g01236963

17. Disconnect hose assemblies (27).

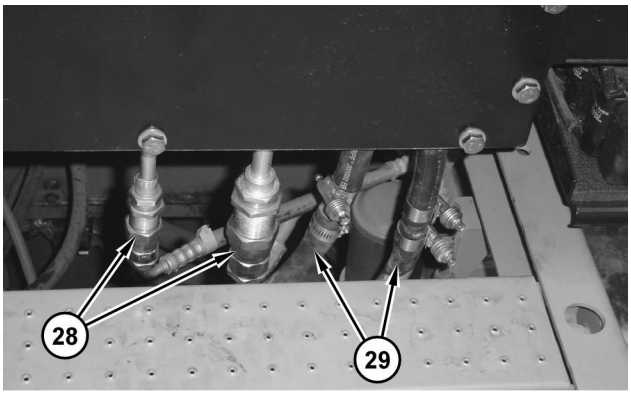


Illustration 821 g01236964

18. Disconnect air conditioning hose assemblies (28). Disconnect hoses (29).

Note: Shut off the heater valves at the water pump before disconnecting the heater hoses.

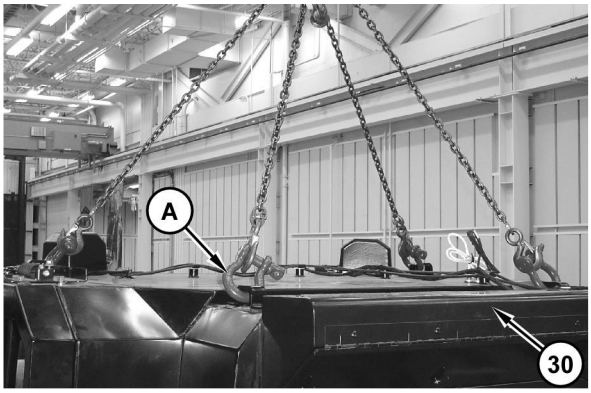


Illustration 822 g01236965

19. Attach Tooling (A) and a suitable lifting device to cab (30).

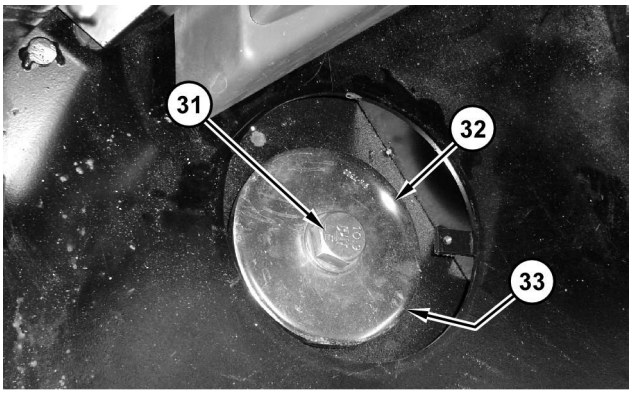


Illustration 823 g01237132

20. Remove bolts (31), washers (32), and pads (33). Repeat for the remaining three mounts.

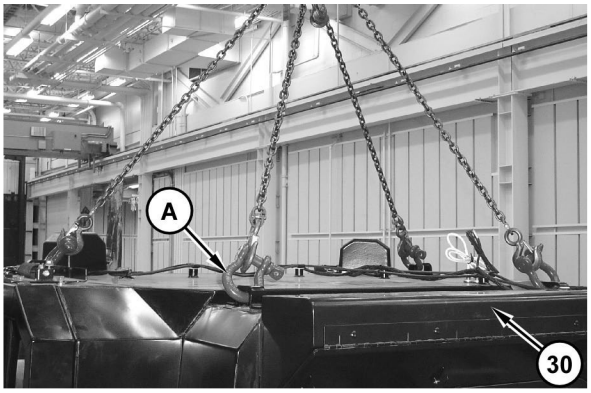


Illustration 824 g01236965

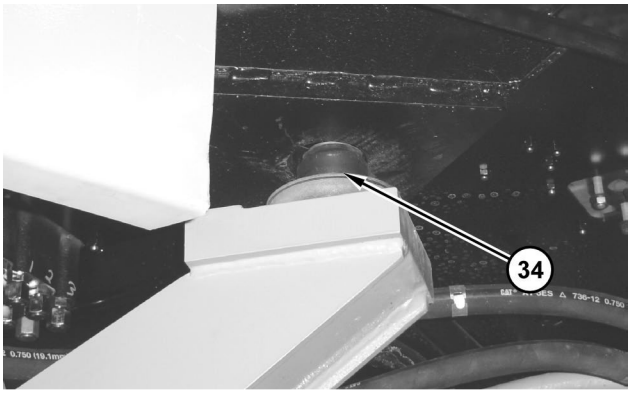


Illustration 825 g01236967

21. Use Tooling (A) and a suitable lifting device to remove cab (30). The weight of cab (30) is approximately 1315 kg (2900 lb). Remove mount assemblies (34).

i02499142

Cab and Platform - Install

SMCS Code: 7253-012; 7301-012

Installation Procedure

Table 46

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-8622	Shackle	4

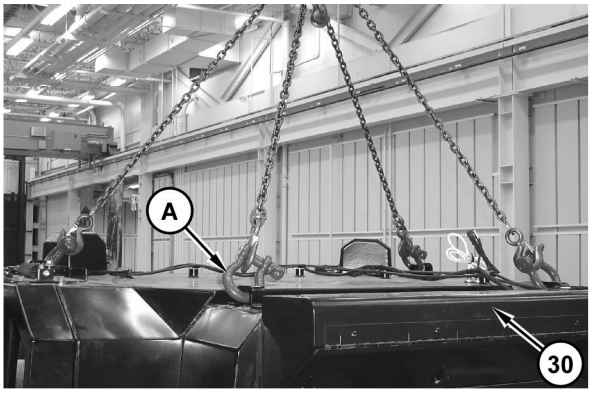


Illustration 826 g01236965

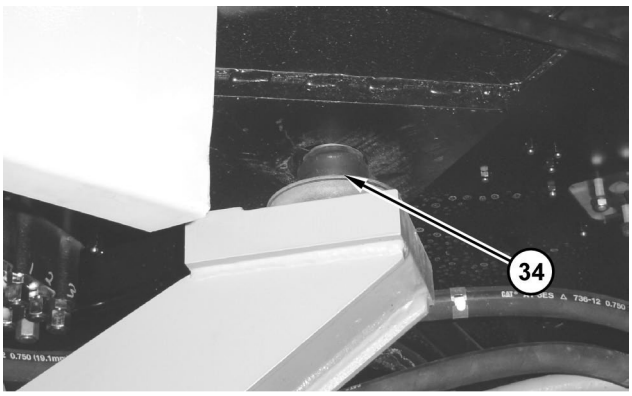


Illustration 827 g01236967

1. Attach Tooling (A) and a suitable lifting device to cab (30). The weight of cab (30) is approximately 1315 kg (2900 lb). Install mount assemblies (34) and cab (30).

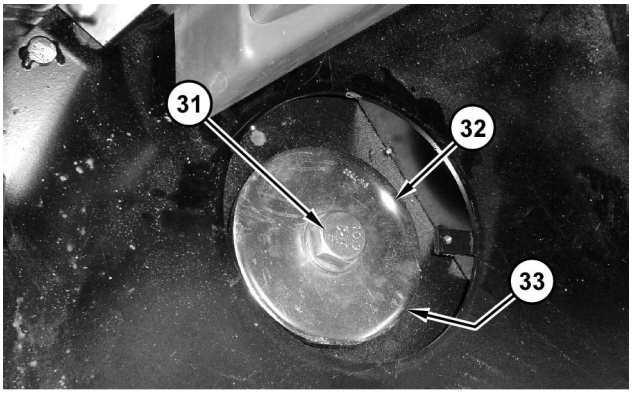


Illustration 828 g01237132

2. Install pads (33), washers (32), and bolts (31) to all the mounts.

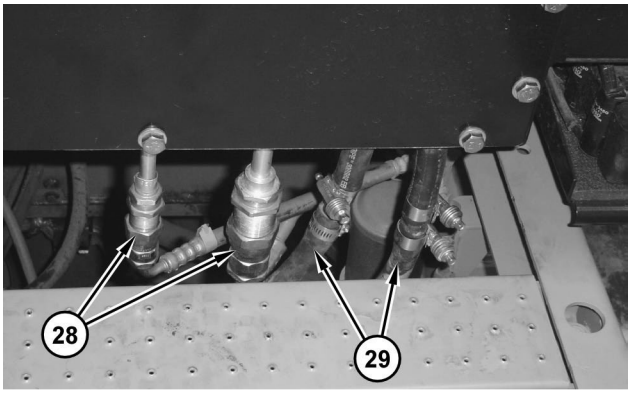


Illustration 829 g01236964

3. Connect hoses (29). Connect air conditioning hose assemblies (28).

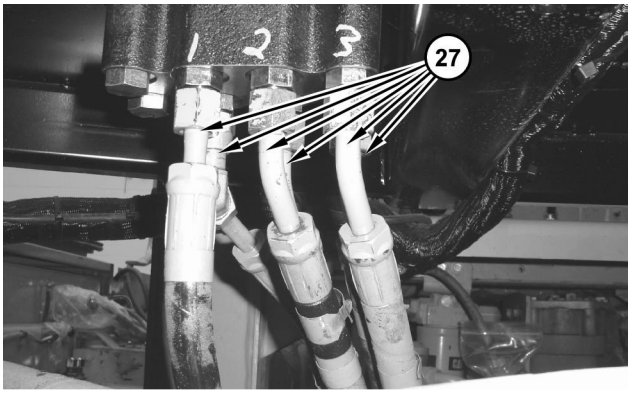


Illustration 830 g01236963

4. Connect hose assemblies (27).

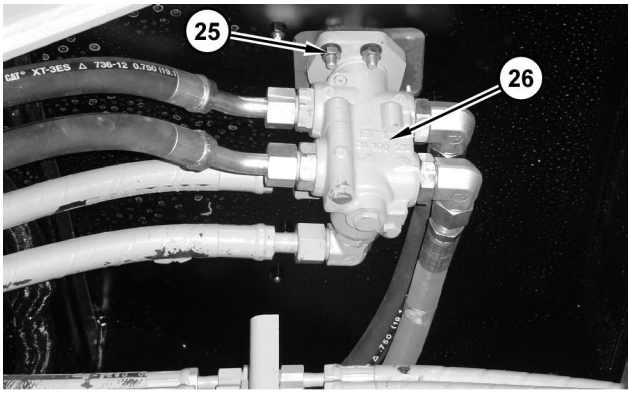


Illustration 831 g01236961

5. Position valve assembly (26). Install nuts (25).

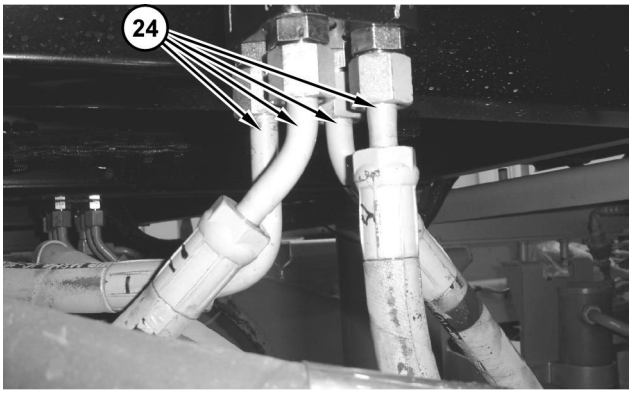


Illustration 832 g01236959

6. Connect hose assemblies (24).

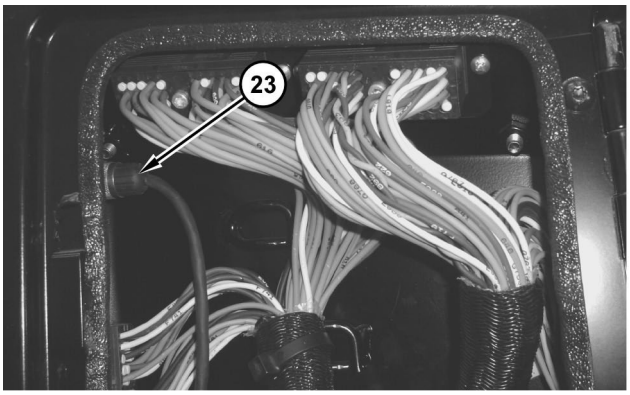


Illustration 833 g01236955

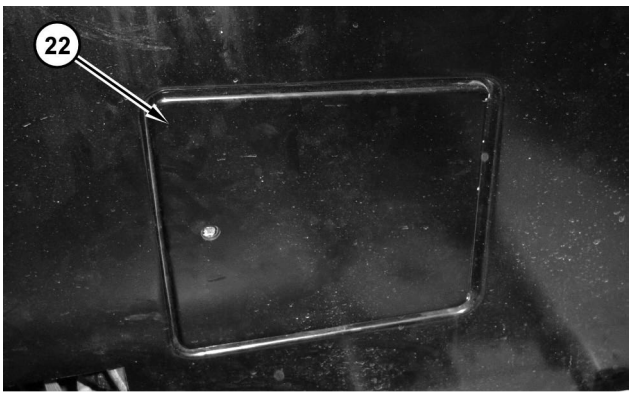


Illustration 834 g01236957

7. Connect harness assembly (23). Close door assembly (22).

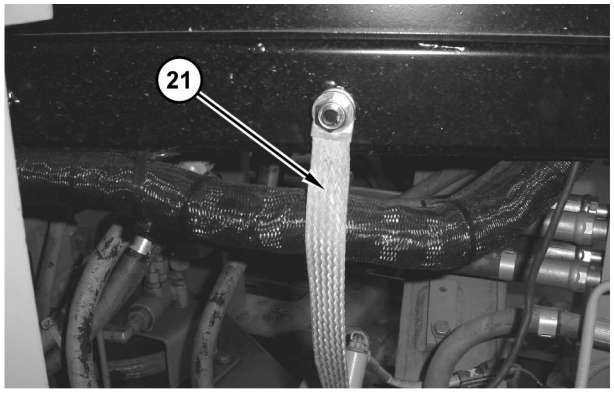


Illustration 835 g01236954

8. Connect ground strap (21).

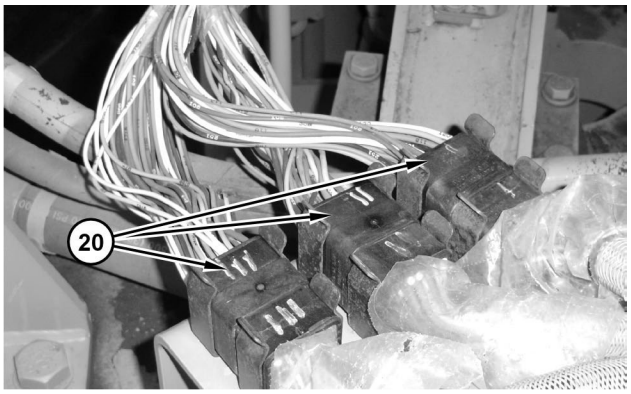


Illustration 836 g01236953

9. Connect harness assembly (20).

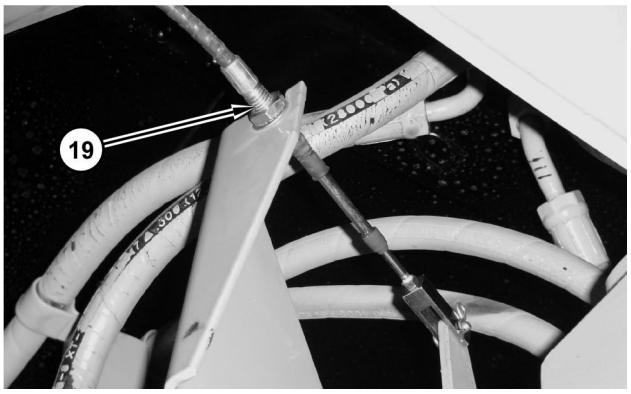


Illustration 837 g01236952

10. Connect cable assembly (19).

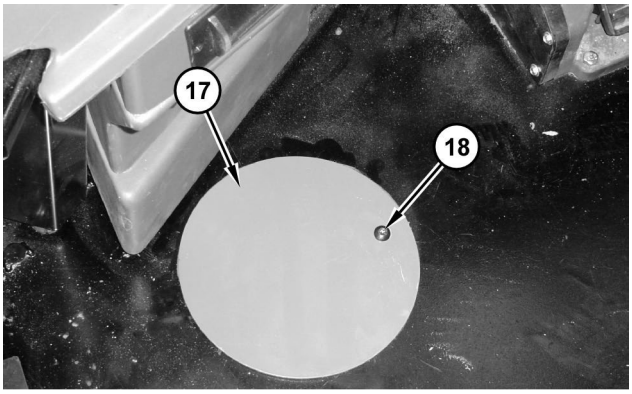


Illustration 838 g01236951

11. Position plate (17) and install bolt (18). Repeat for opposite side.

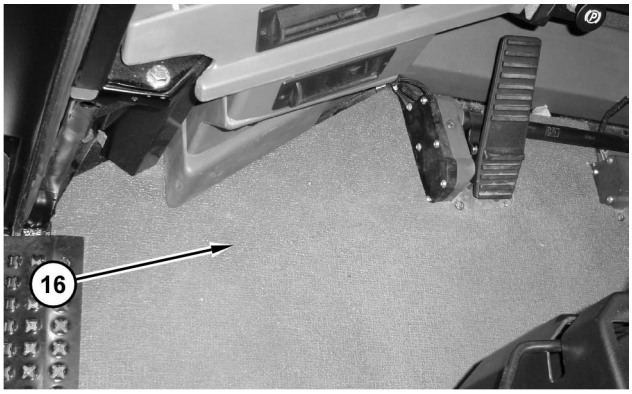


Illustration 839 g01236950

12. Install floor mat (16).

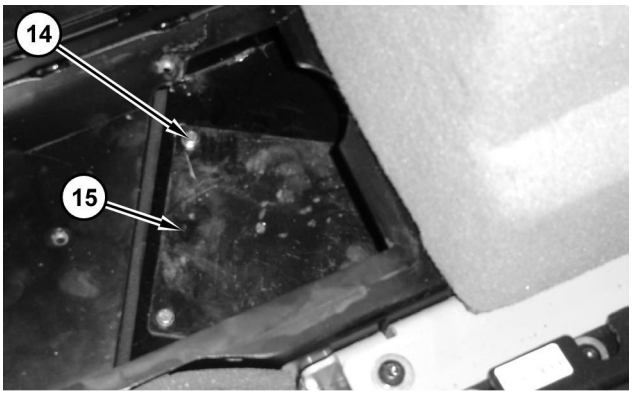


Illustration 840 g01236949

13. Position plate (15) and bolts (14). Repeat for opposite side.

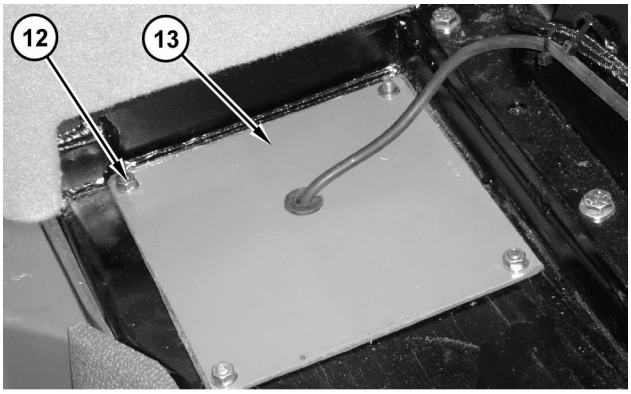


Illustration 841 g01236948

14. Position panel (13) and install nuts (12).

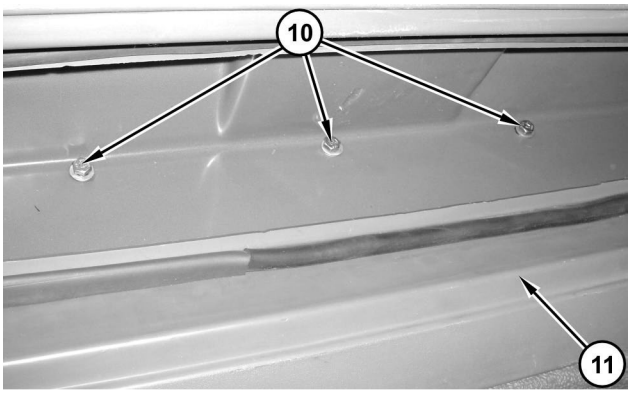


Illustration 842 g01236947

15. Position air duct (11) and install bolts (10).

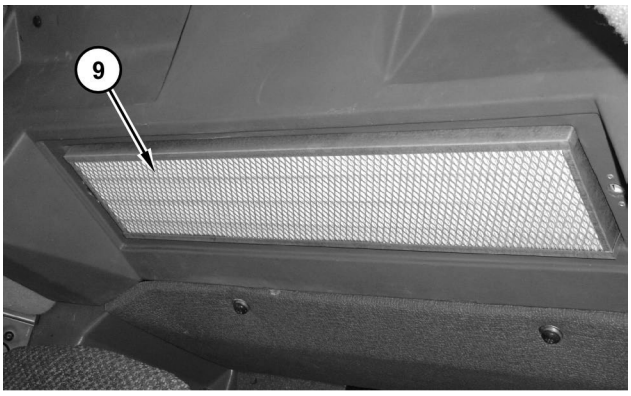


Illustration 843 g01236946

16. Install filter assembly (9).

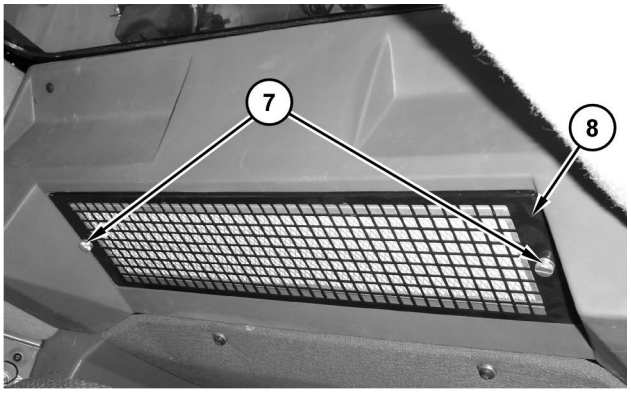


Illustration 844 g01236945

17. Position cover assembly (8) and install bolts (7).

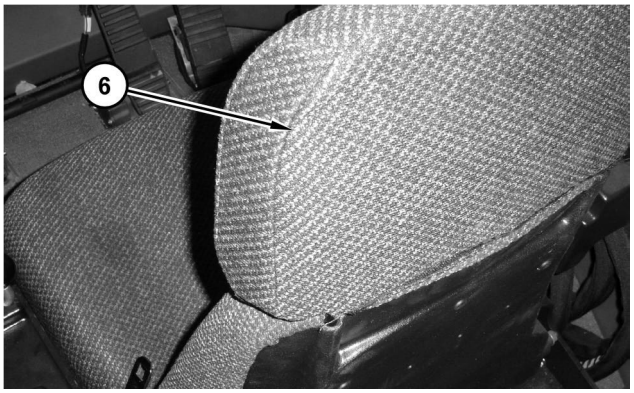


Illustration 845 g01236944

18. Install headrest (6).

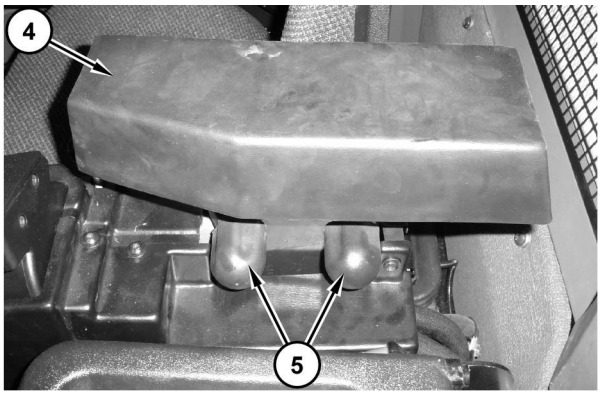


Illustration 846 g01236943

19. Position armrest assembly (4) and install knobs (5).

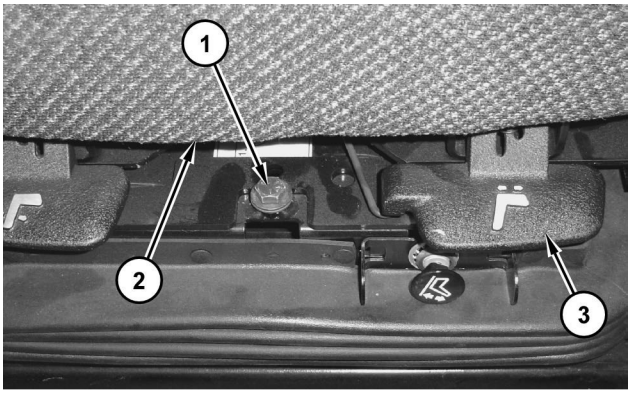


Illustration 847 g01236941

20. Actuate lever (3) and move seat assembly (2) backward. Install bolt (1).

End By:

a. Install the rollover protective structure. Refer to Disassembly and Assembly , " Rollover Protective Structure - Remove and Install".

b. Separate the steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

i02492609

Cab - Remove

SMCS Code: 7325-011

Removal Procedure

Table 47

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	5P-8622	Shackle	4

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

b. Remove the rollover protective structure. Refer to Disassembly and Assembly , “ Rollover Protective Structure - Remove and Install”.

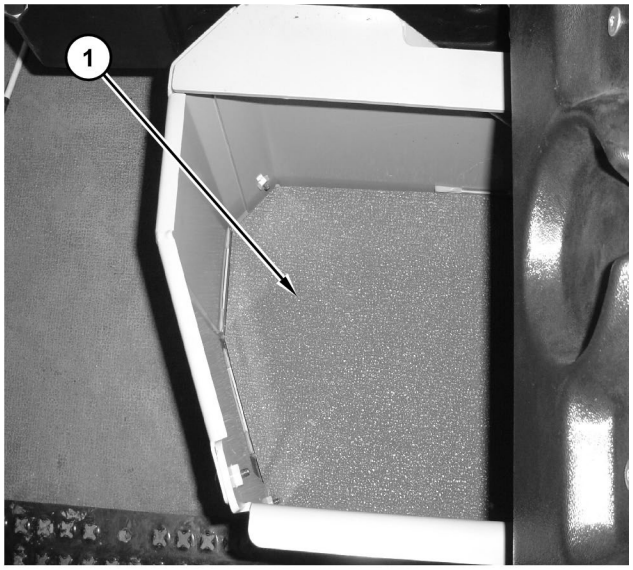


Illustration 848 g01246440

1. Remove plate (1).

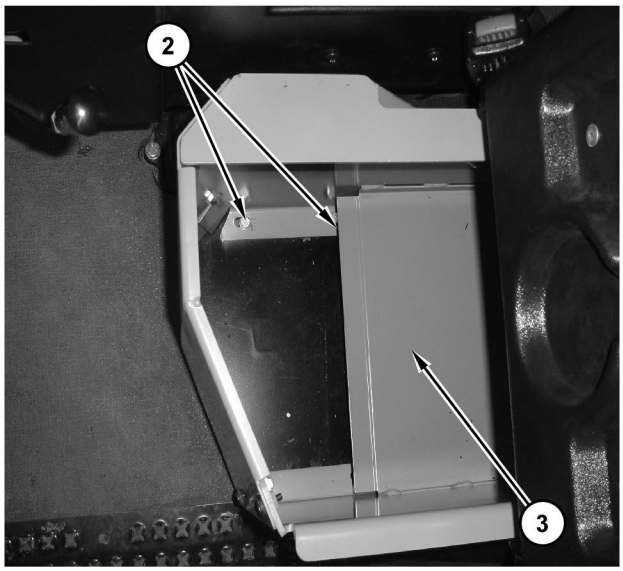


Illustration 849 g01246446



Illustration 850 g01246448

2. Remove bolts (2) and (4). Remove storage box assembly (3).

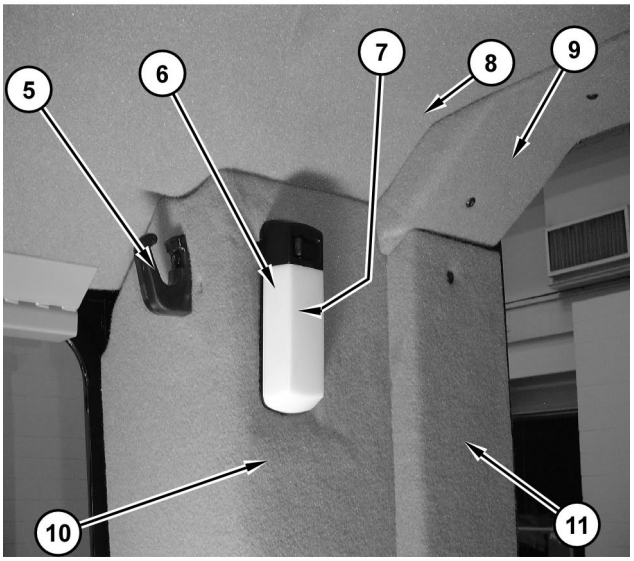


Illustration 851 g01246449

3. Remove hanger (5). Remove light assembly (6). Disconnect harness assembly (7).

4. Remove headliner (8). Remove panels (9), (10), and (11).

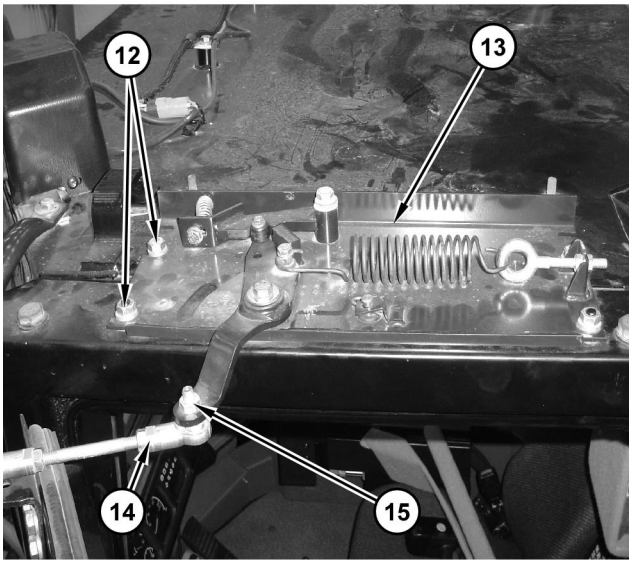


Illustration 852 g01246451

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

5. Remove nut (15). Disconnect rod assembly (14). Remove nuts (12). Remove spring assembly (13).

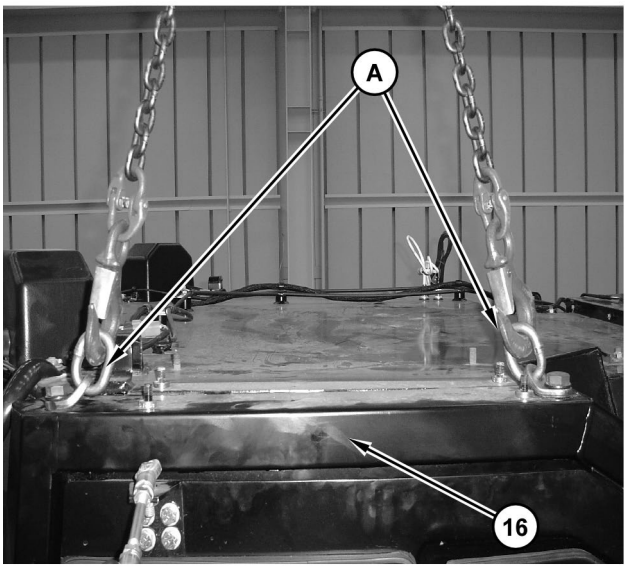


Illustration 853 g01246688

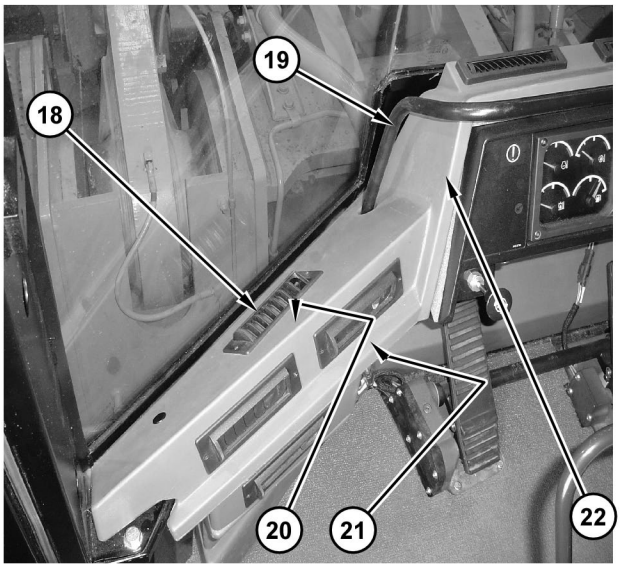


Illustration 855 g01246718

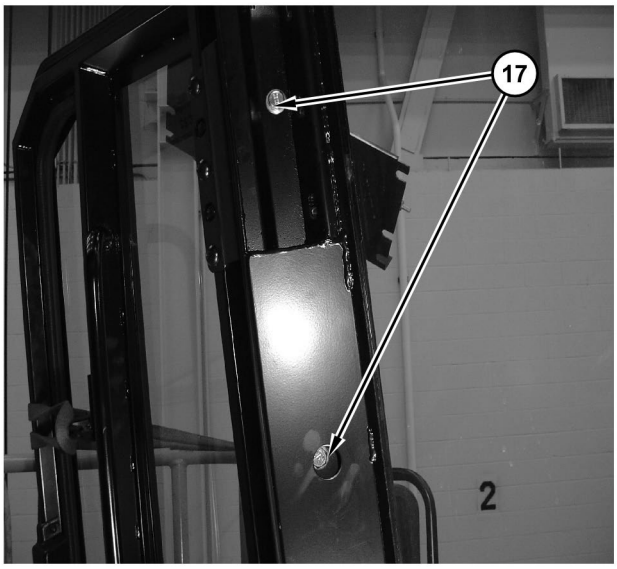


Illustration 854 g01246689

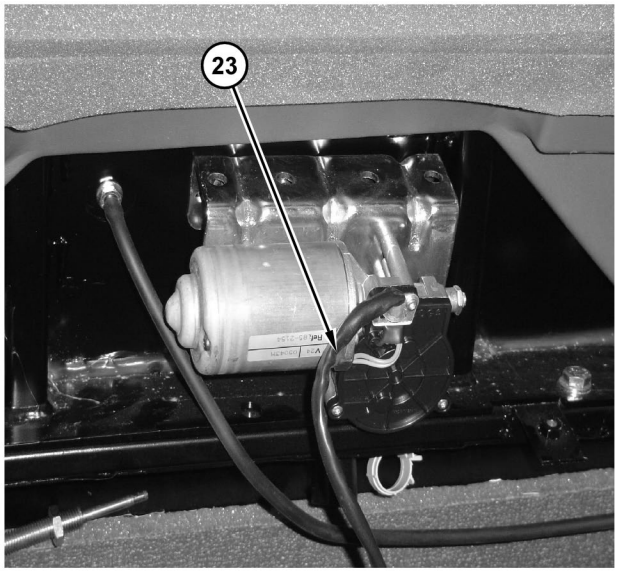


Illustration 856 g01246720

6. Install Tooling (A) and a suitable lifting device to frame assembly (16) of the door. The weight of frame assembly (16) of the door is approximately 86 kg (190 lb). Remove frame assembly (16) and bolts (17).

7. Remove bolts (21) and handle (19). Remove louver assembly (18) and bolts (20) from both sides. Remove duct assembly (22). Disconnect harness assembly (23).



Illustration 857 g01246734

8. Disconnect gauge assembly (24) and the harness assembly from the cab.

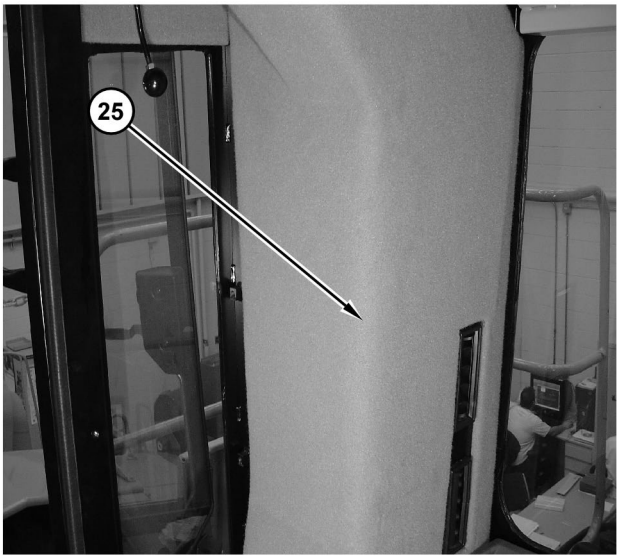


Illustration 858 g01246770

9. Remove panel (25).

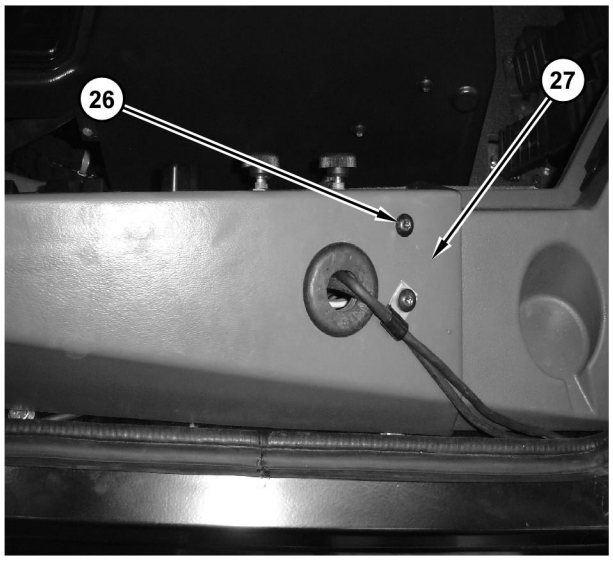


Illustration 859 g01246772

10. Remove bolts (26). Position panel (27) out of the way.

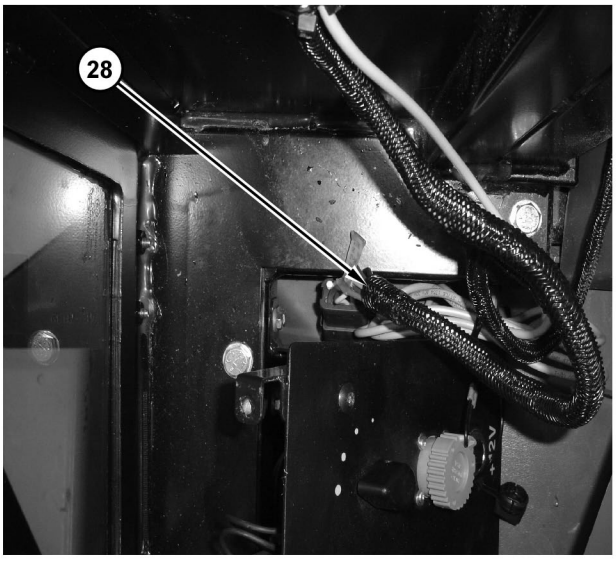


Illustration 860 g01246793

11. Disconnect harness assembly (28).

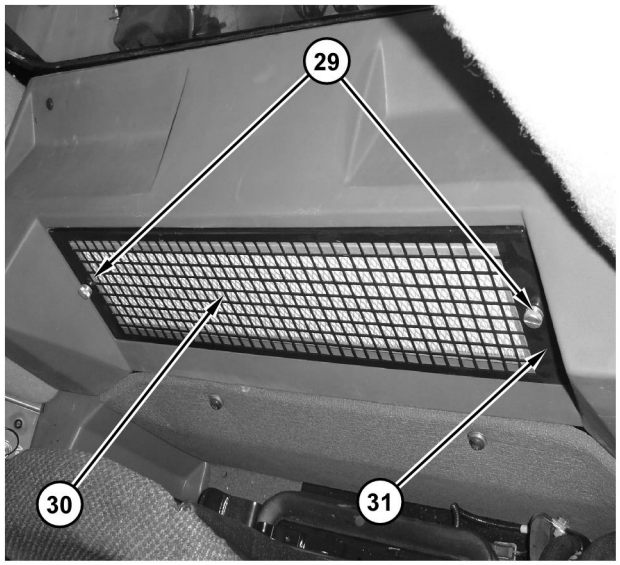


Illustration 861 g01246799

12. Remove screws (29) and cover assembly (31). Remove filter element (30).

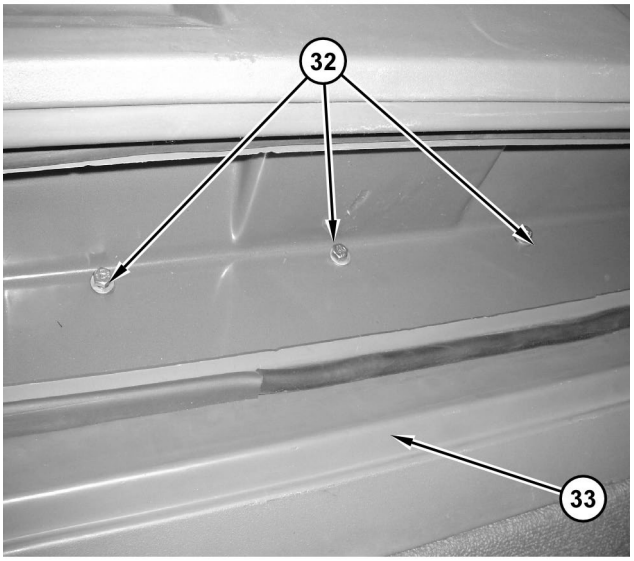


Illustration 862 g01246861

13. Remove bolts (32) and duct assembly (33).

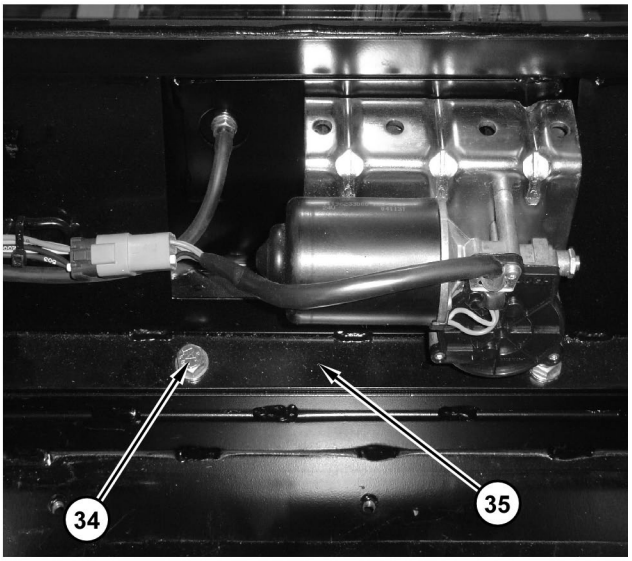


Illustration 863 g01246864

14. Remove bolts (34) in order to separate cab assembly (35) from the platform.

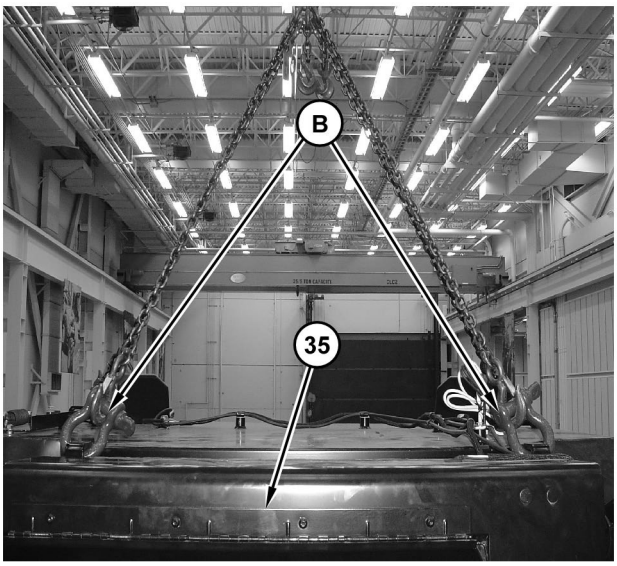


Illustration 864 g01246898

15. Attach Tooling (B) and a suitable lifting device to cab assembly (35). The weight of cab assembly (35) is approximately 503 kg (1110 lb). Remove cab assembly (35).

i02493831

Cab - Install

SMCS Code: 7325-012

Installation Procedure

Table 48

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	5P-8622	Shackle	4

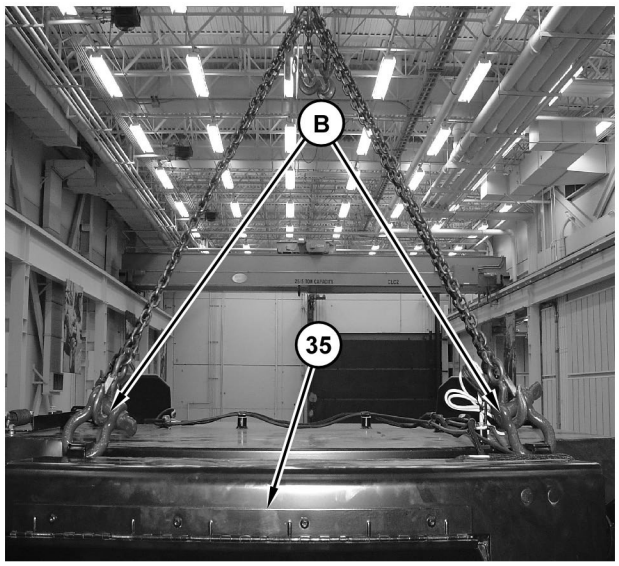


Illustration 865 g01246898

1. Attach Tooling (B) and a suitable lifting device to cab assembly (35). The weight of cab assembly (35) is approximately 503 kg (1110 lb). Install cab assembly (35).

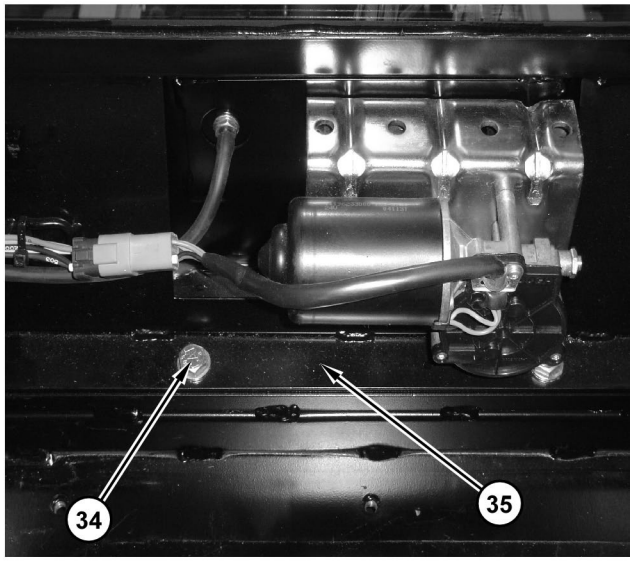


Illustration 866 g01246864

2. Install bolts (34) in order to connect cab assembly (35) onto the platform.

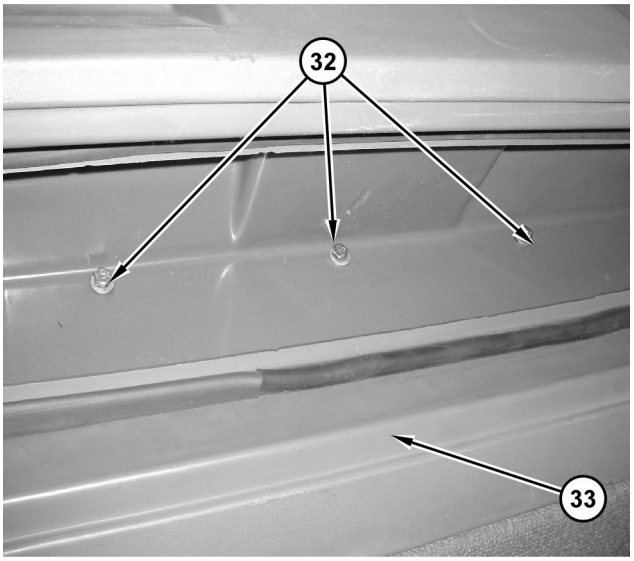


Illustration 867 g01246861

3. Install duct assembly (33) and bolts (32).

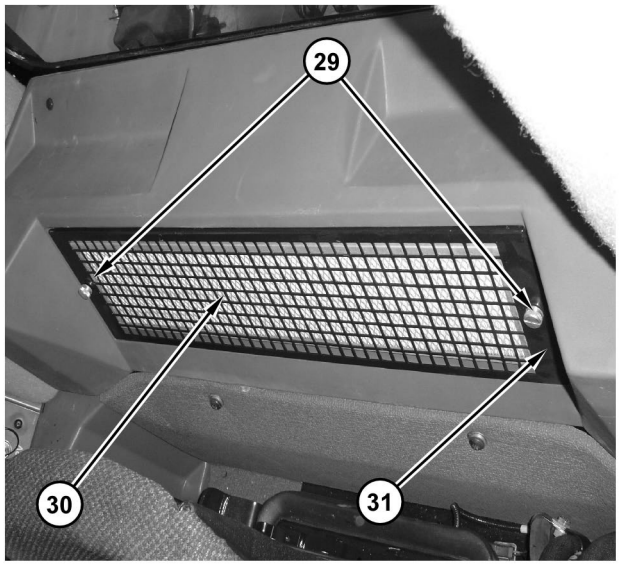


Illustration 868 g01246799

4. Install filter element (30). Install cover assembly (31). Install screws (29).

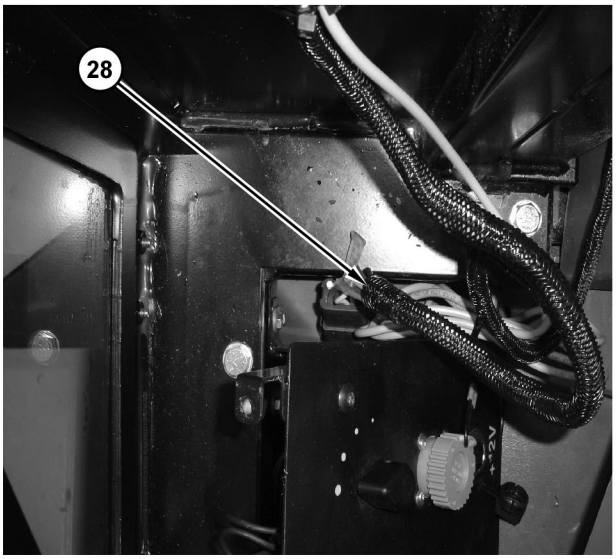


Illustration 869 g01246793

5. Connect harness assembly (28).

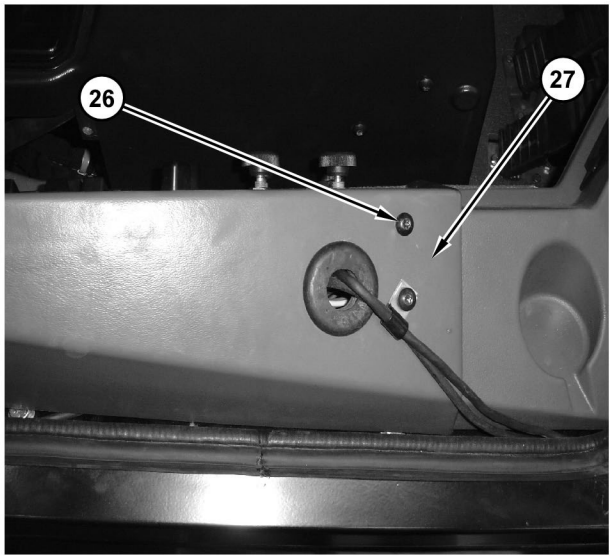


Illustration 870 g01246772

6. Position panel (27). Install bolts (26).

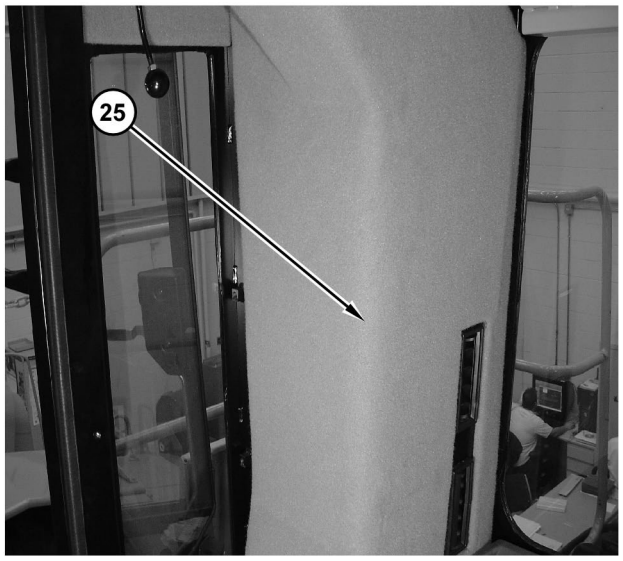


Illustration 871 g01246770

7. Install panel (25).



Illustration 872 g01246734

8. Connect gauge assembly (24) and the harness assembly onto the cab.

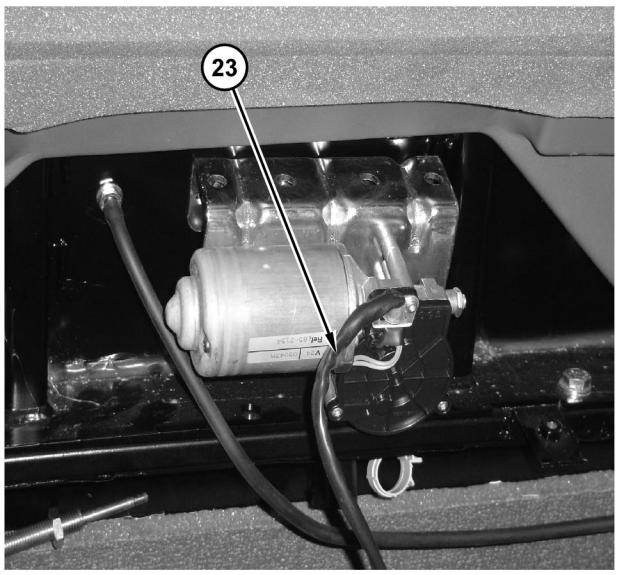


Illustration 873 g01246720

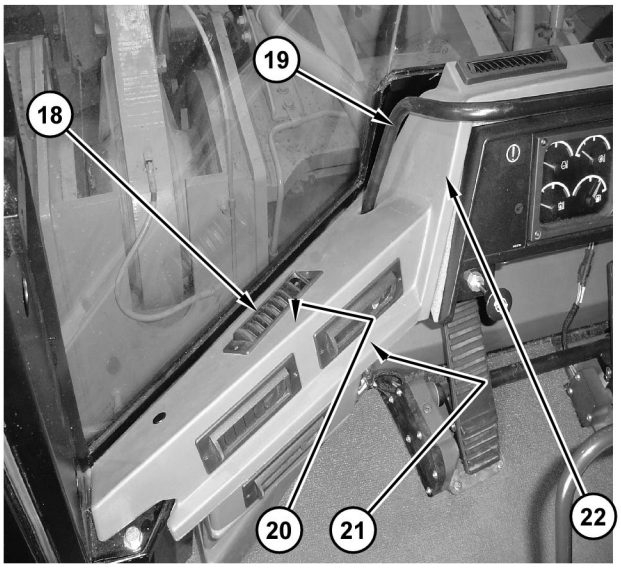


Illustration 874 g01246718

9. Connect harness assembly (23). Install duct assembly (22). Install louver assembly (18) and bolts (20) onto both sides. Install bolts (21) and handle (19).

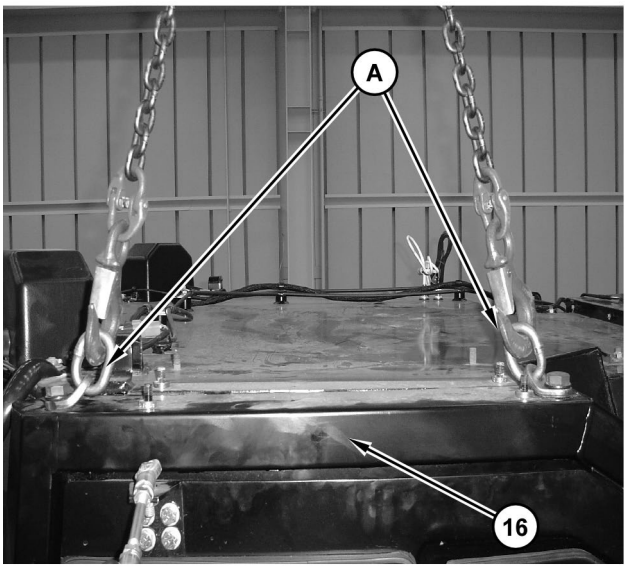


Illustration 875 g01246688

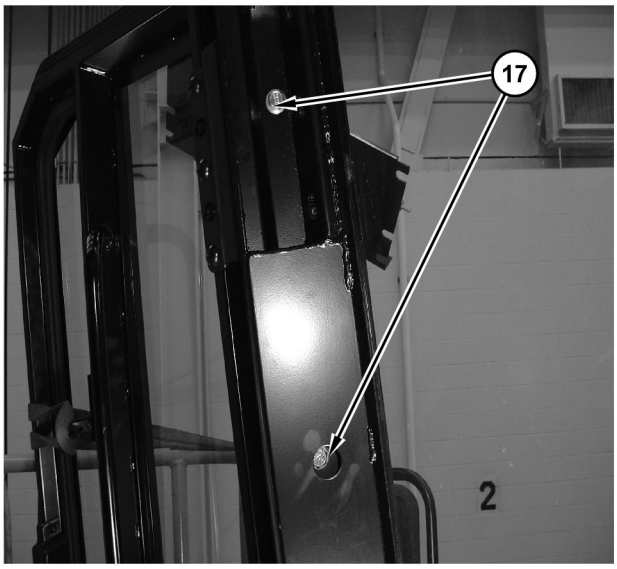


Illustration 876 g01246689

10. Install Tooling (A) and a suitable lifting device to frame assembly(16) of the door. The weight of frame assembly (16) of the door is approximately 86 kg (190 lb). Position frame assembly (16). Install bolts (17). Remove Tooling (A).

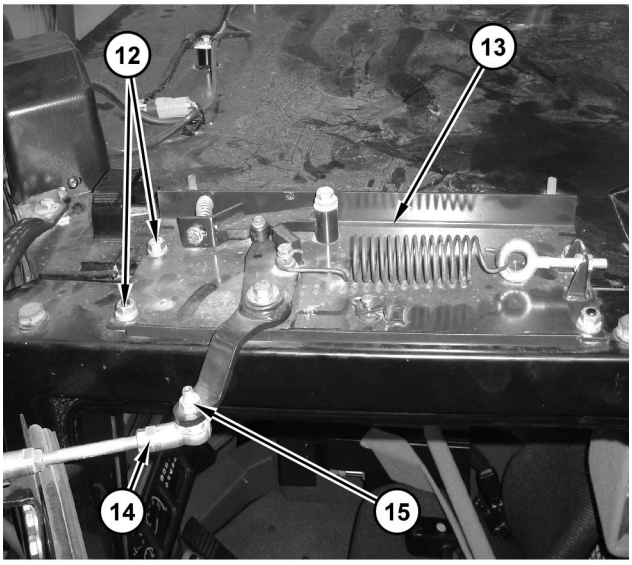


Illustration 877 g01246451

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

11. Install spring assembly (13). Install nuts (12). Connect rod assembly (14). Install nut (15).

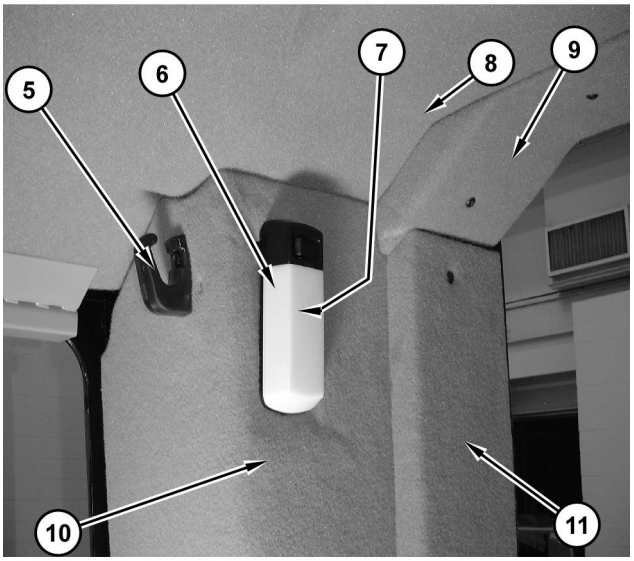


Illustration 878 g01246449

12. Install panels (9), (10), and (11). Install headliner (8).

13. Connect harness assembly (7). Install hanger (5). Install light assembly (6).

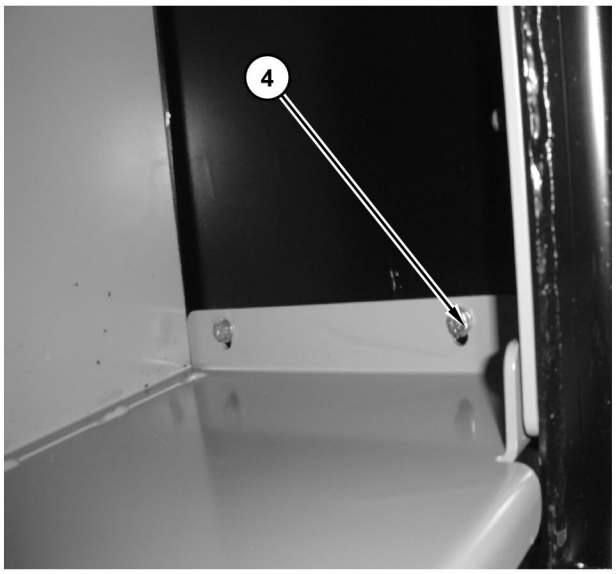


Illustration 879 g01246448

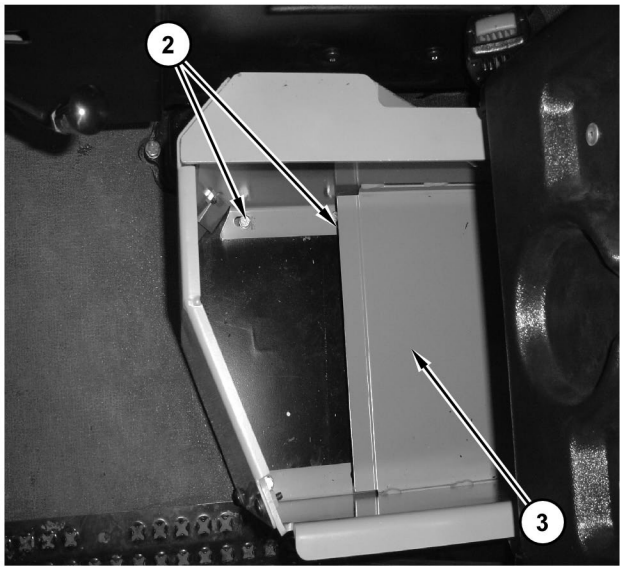


Illustration 880 g01246446

14. Install storage box assembly (3). Install bolts (2) and (4).

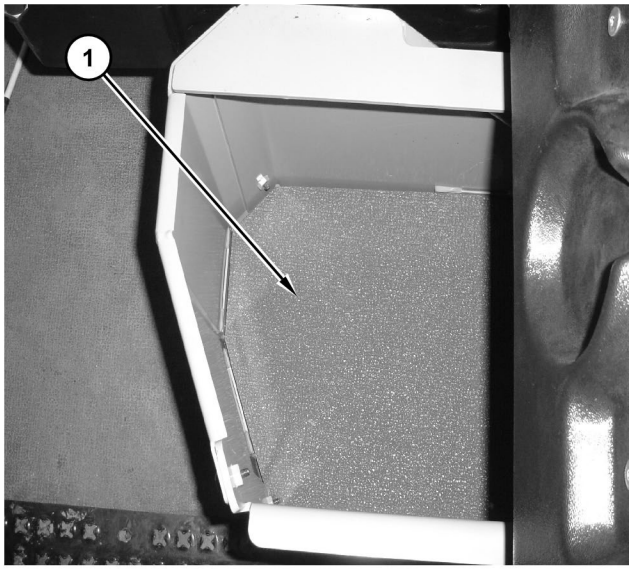


Illustration 881 g01246440

15. Install plate (1).

End By:

a. Install the rollover protective structure. Refer to Disassembly and Assembly , " Rollover Protective Structure - Remove and Install".

b. Separate steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

i02494938

Operator Platform - Remove

SMCS Code: 7253-011

Removal Procedure

Table 49

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	5P-8622	Shackle	4

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , "Steering Frame Lock - Seperate and Connect".

b. Remove the cab. Refer to Disassembly and Assembly , "Cab - Remove and Install".

c. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

1. Recover the air conditioner refrigerant from the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.

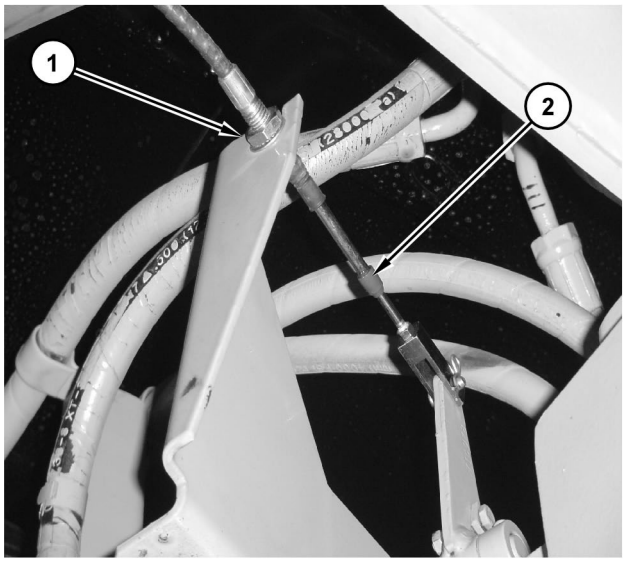


Illustration 882 g01247504

2. Loosen nuts (1). Disconnect parking brake cable (2). Position parking brake cable (2) out of the way.

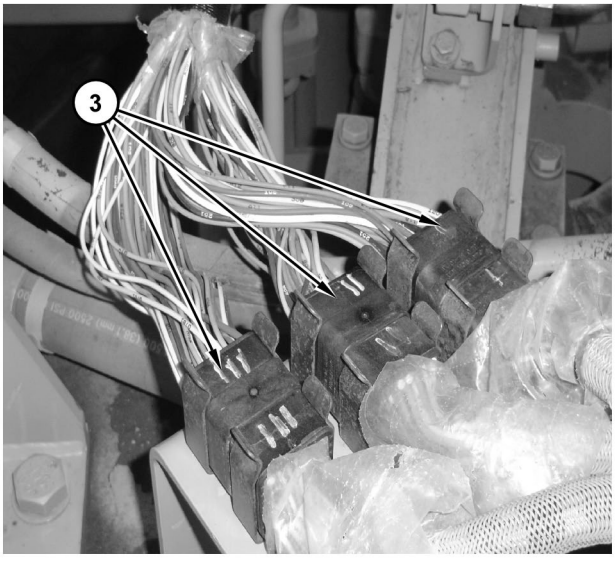


Illustration 883 g01247506

3. Disconnect harness assemblies (3). Position the harness assembly out of the way.

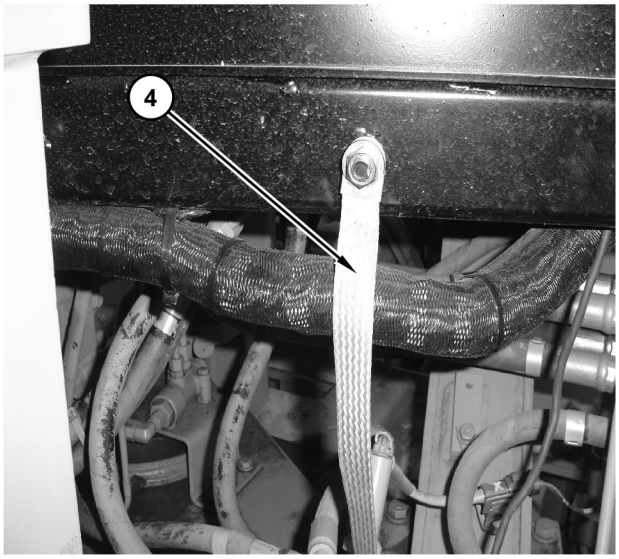


Illustration 884 g01247508

4. Disconnect ground strap (4).

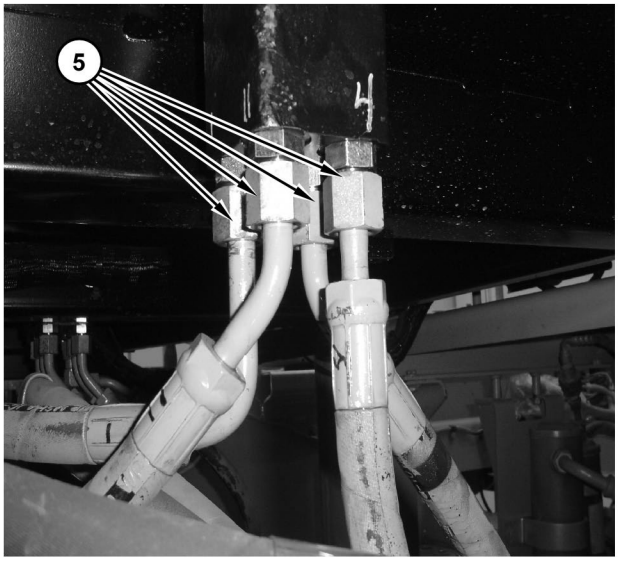


Illustration 885 g01247511

5. Disconnect hose assemblies (5).

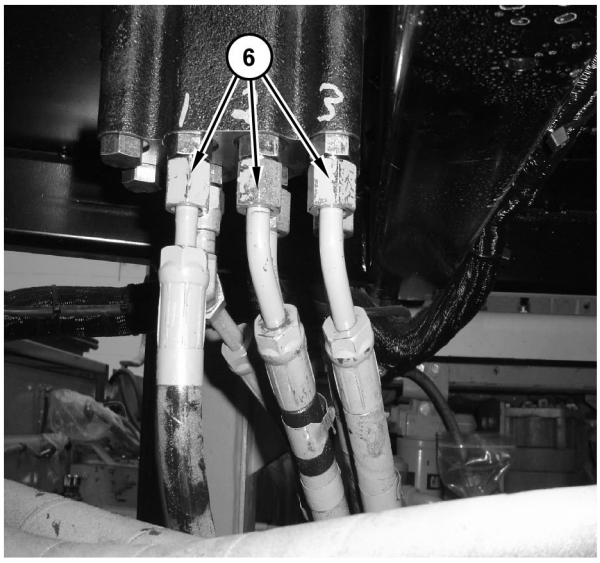


Illustration 886 g01247652

6. Disconnect hose assemblies (6).

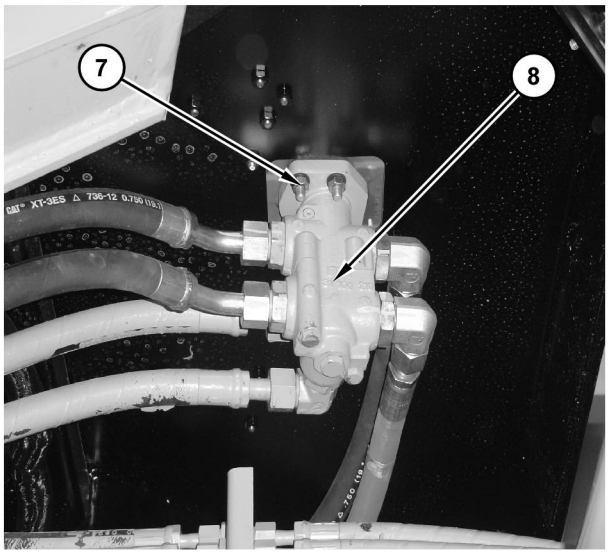


Illustration 887 g01247564

7. Remove nuts (7) and the washers. Lower brake valve assembly (8).

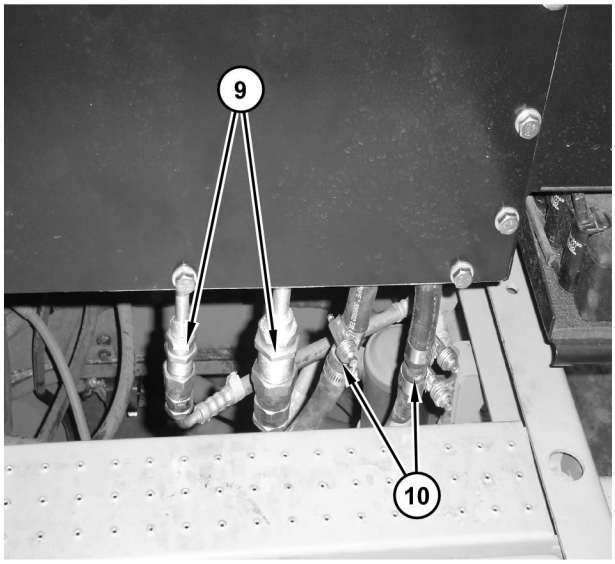


Illustration 888 g01247567

8. Disconnect air conditioning hose assemblies (9). Disconnect heater hoses (10).

Note: Move the heater valves to the OFF position prior to disconnecting the heater hoses. The heater valves are located at the water pump.

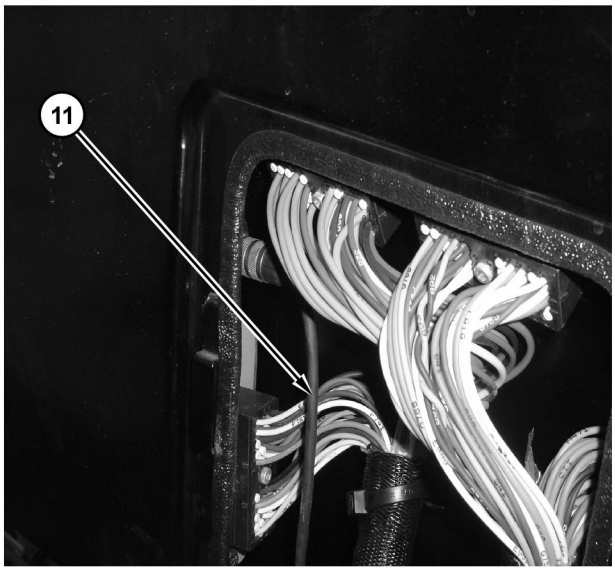


Illustration 889 g01247574

9. Open the access door on the right side of the cab in order to disconnect harness assembly (11).

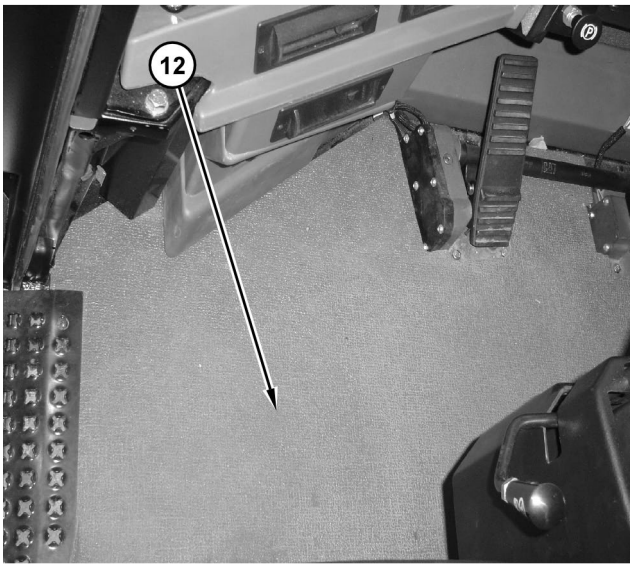


Illustration 890 g01247581

10. Remove floor mat (12).

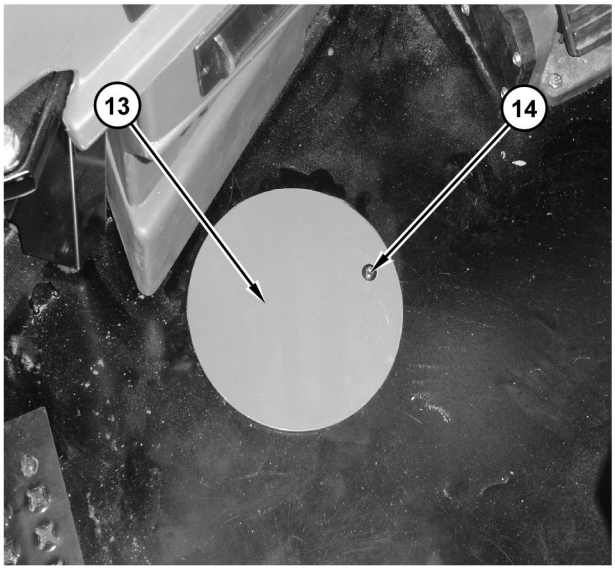


Illustration 891 g01247585

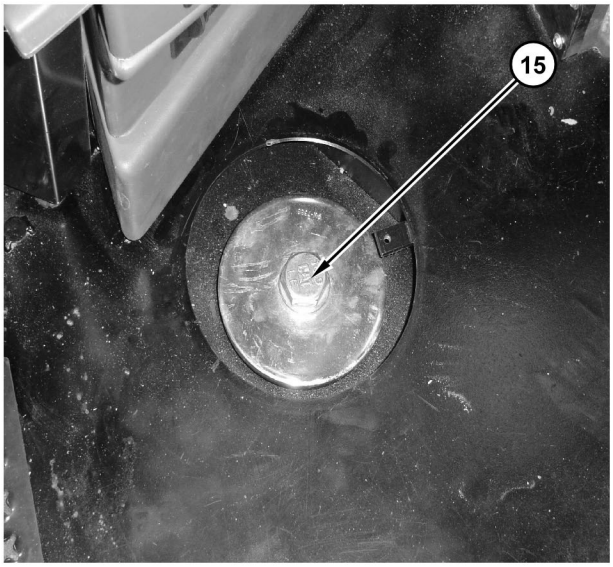


Illustration 892 g01247763

11. Remove screw (14) and plate (13). Remove bolt (15).

12. Repeat Step 11 for the opposite side.

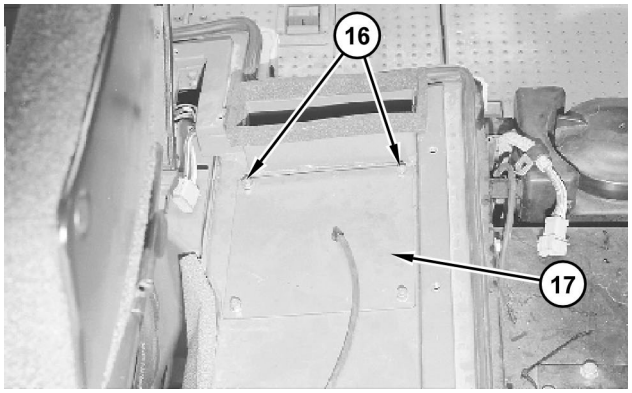


Illustration 893 g01247769

13. Remove nuts (16) and the washers. Remove cover (17).

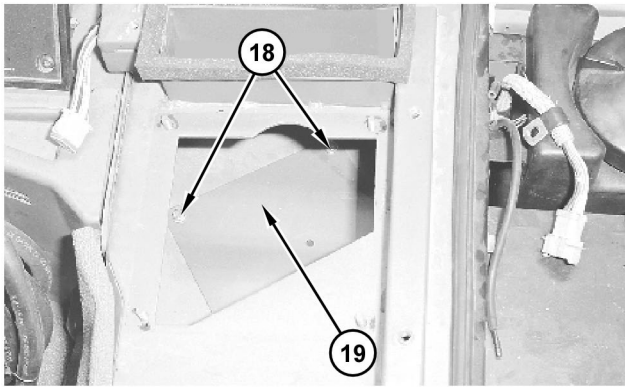


Illustration 894 g01247776

14. Remove bolts (18) and cover (19).

15. Repeat Step 14 for the opposite side.

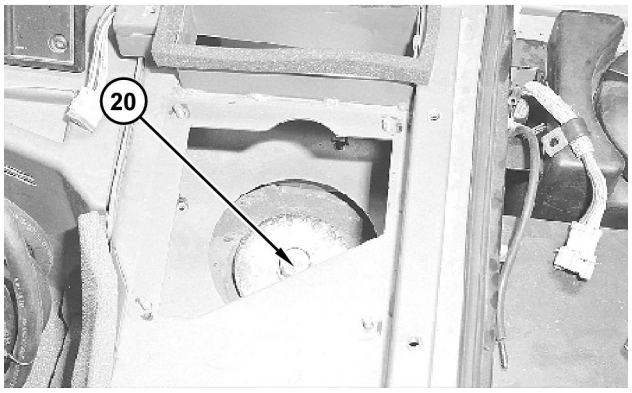


Illustration 895 g01247788

16. Remove bolt (20).

17. Repeat Step 16 for the opposite side.

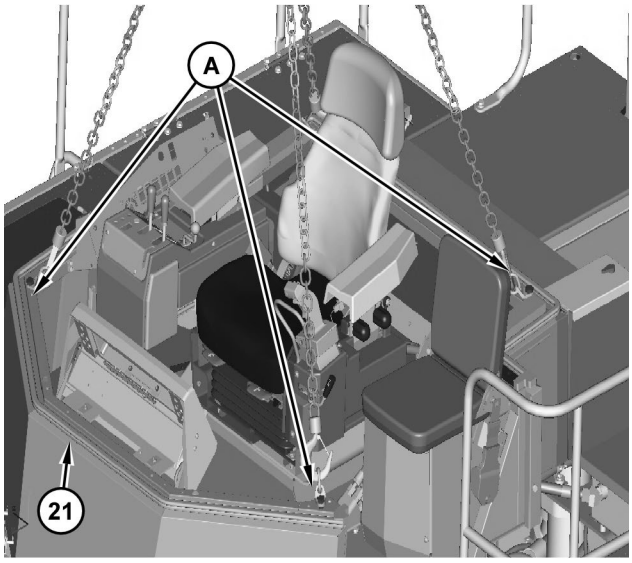


Illustration 896 g01247793

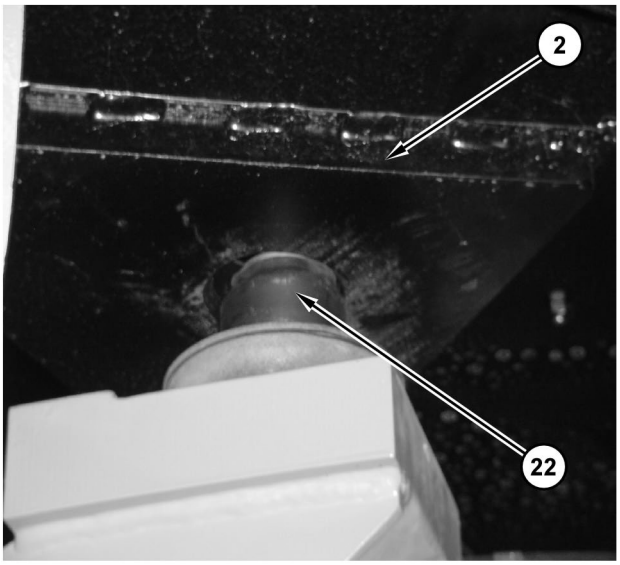


Illustration 897 g01249102

18. Attach Tooling (A) and a suitable lifting device to operator platform (21). The weight of operator platform (21) is approximately 726 kg (1600 lb). Remove operator platform (21) and mount assemblies (22).

i02495795

Operator Platform - Install

SMCS Code: 7253-012

Installation Procedure

Table 50

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7574	Link Bracket	2
B	5P-8622	Shackle	4

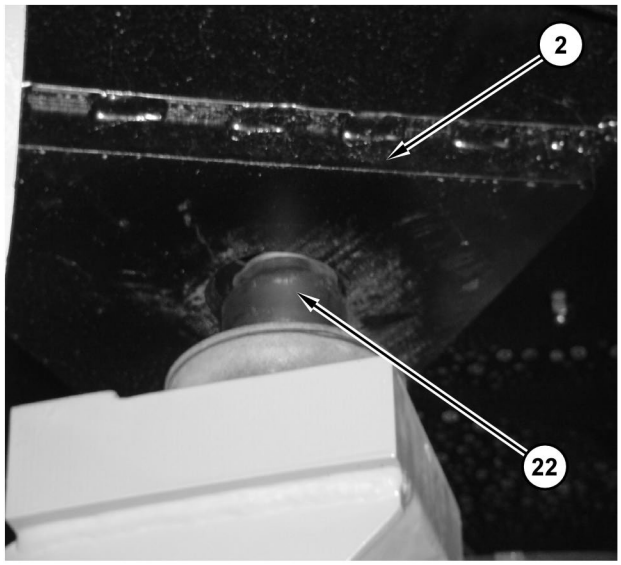


Illustration 898 g01249102

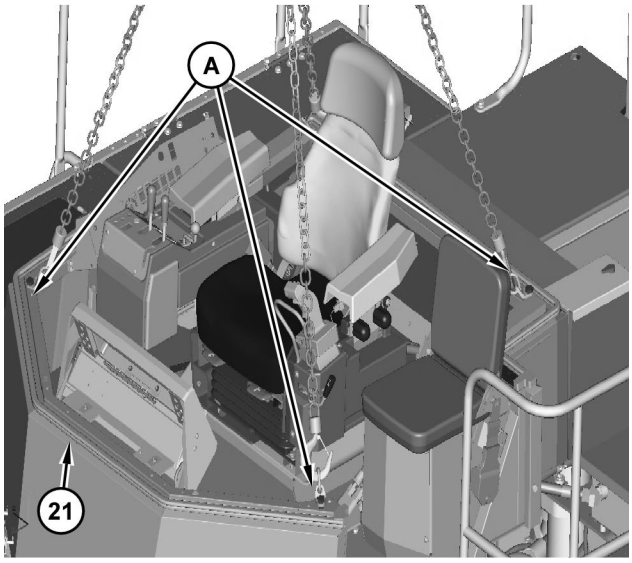


Illustration 899 g01247793

1. Attach Tooling (A) and a suitable lifting device to operator platform (21). The weight of operator platform (21) is approximately 726 kg (1600 lb). Install operator platform (21) and mount assemblies (22).

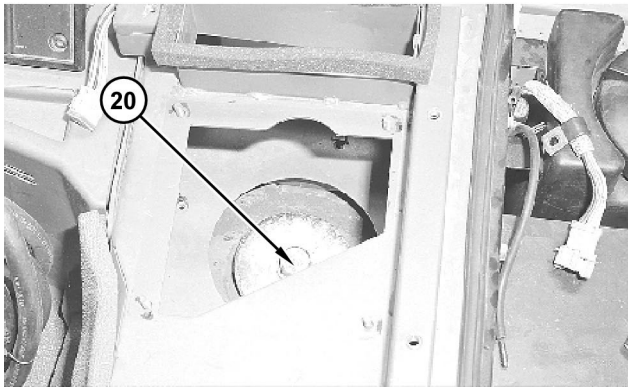


Illustration 900 g01247788

2. Install bolt (20).

3. Repeat Step 2 for the opposite side.

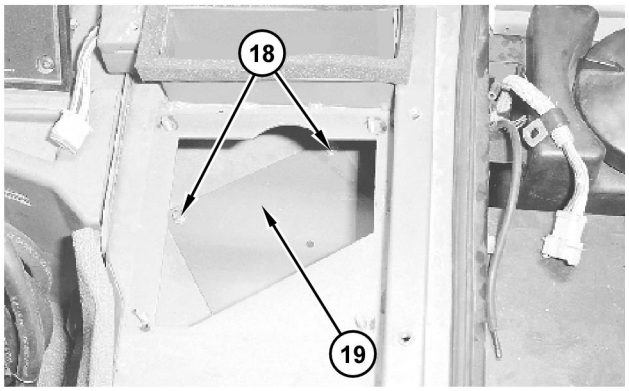


Illustration 901 g01247776

4. Install cover (19). Install bolts (18).

5. Repeat Step 4 for the opposite side.

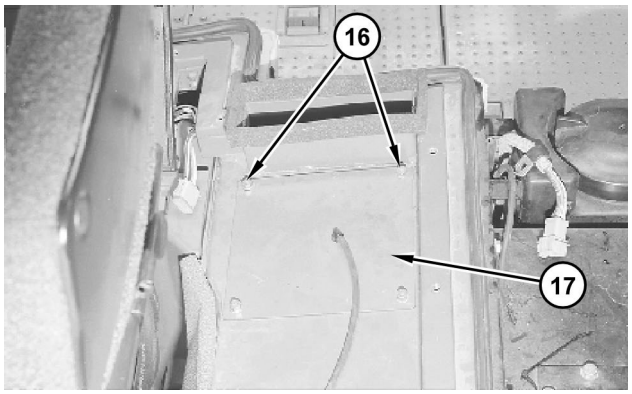


Illustration 902 g01247769

6. Install cover (17). Install nuts (16) and the washers.

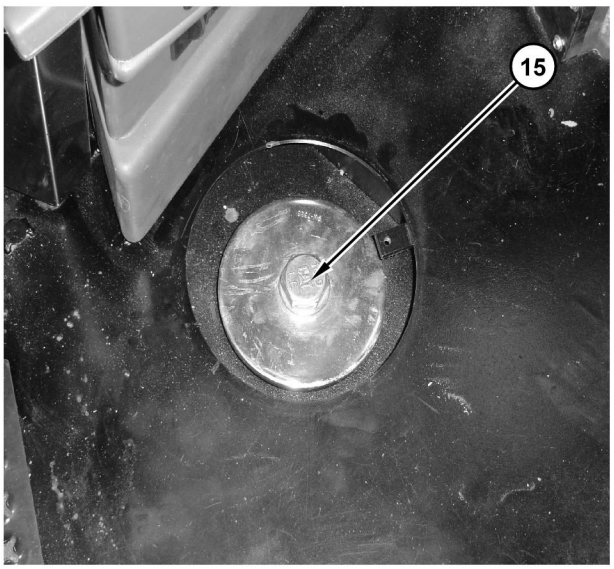


Illustration 903 g01247763

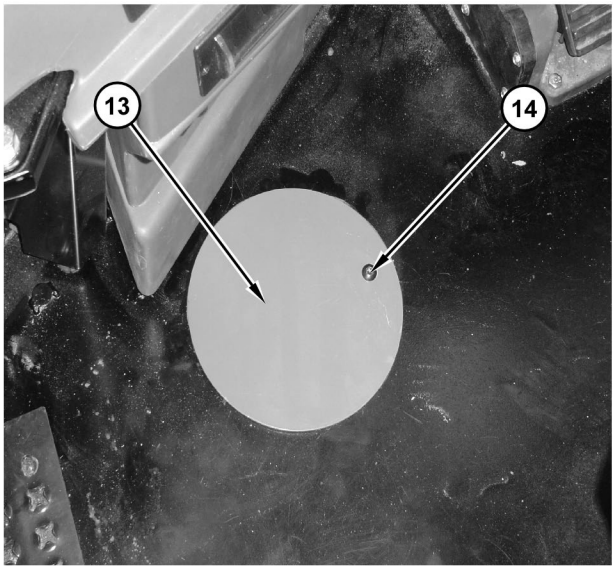


Illustration 904 g01247585

7. Install bolt (15). Install plate (13) and screw (14).

8. Repeat Step7 for the opposite side.

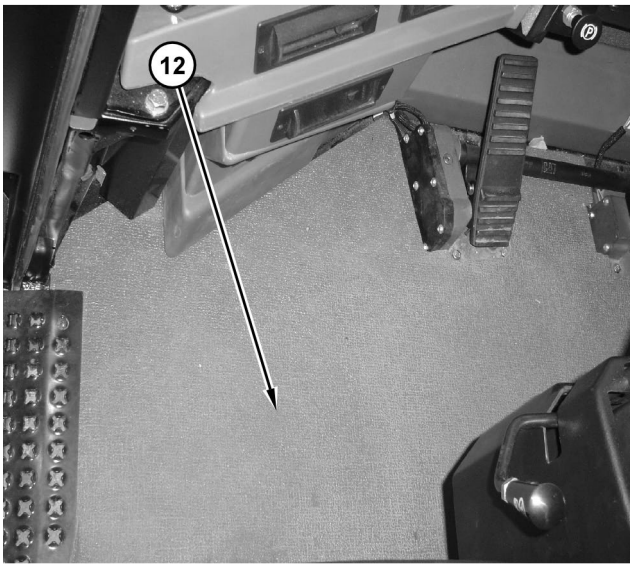


Illustration 905 g01247581

9. Install floor mat (12).

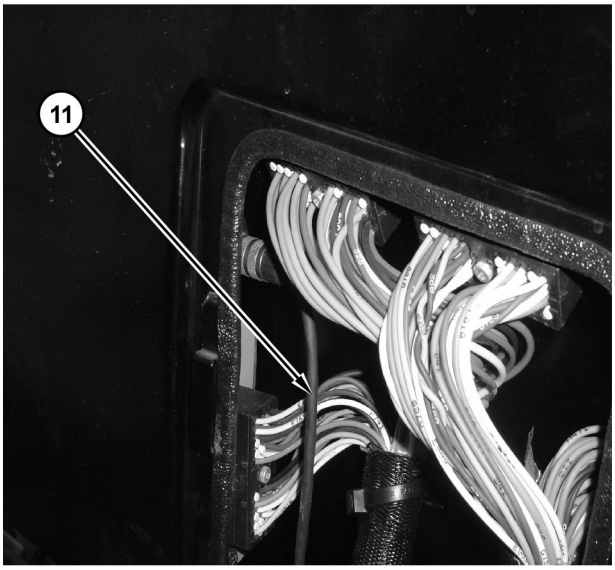


Illustration 906 g01247574

10. Connect harness assembly (11). Close the access door on the right side of the cab.

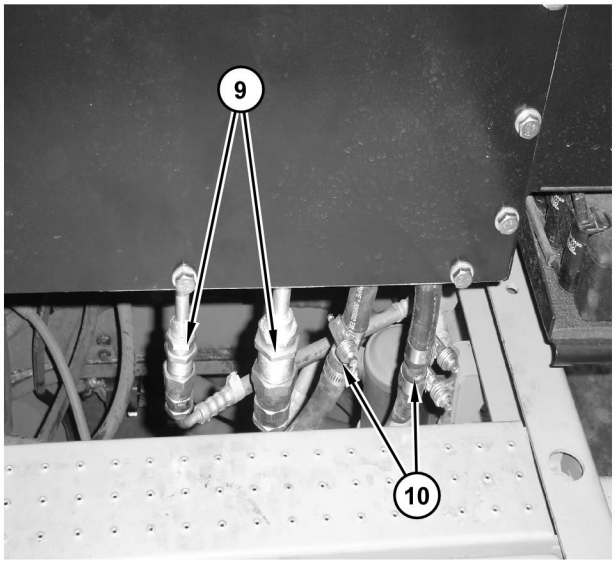


Illustration 907 g01247567

11. Connect heater hoses (10). Connect air conditioning hose assemblies (9).

Note: Move the heater valves to the ON position after connecting the heater hoses. The heater valves are located at the water pump.

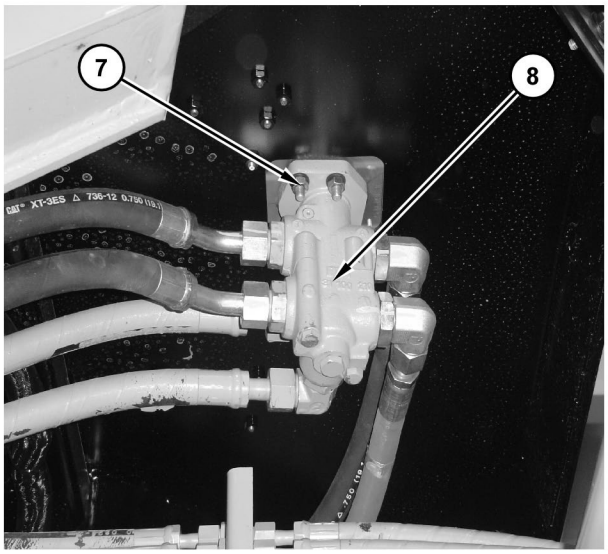


Illustration 908 g01247564

12. Raise brake valve assembly (8). Install nuts (7) and the washers.

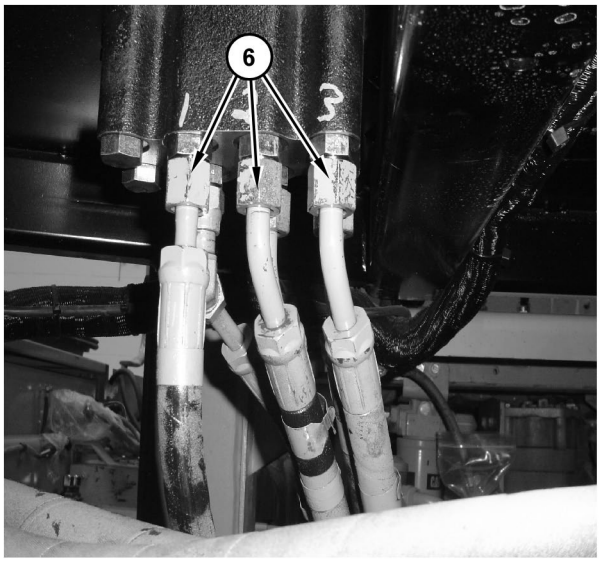


Illustration 909 g01247652

13. Connect hose assemblies (6).

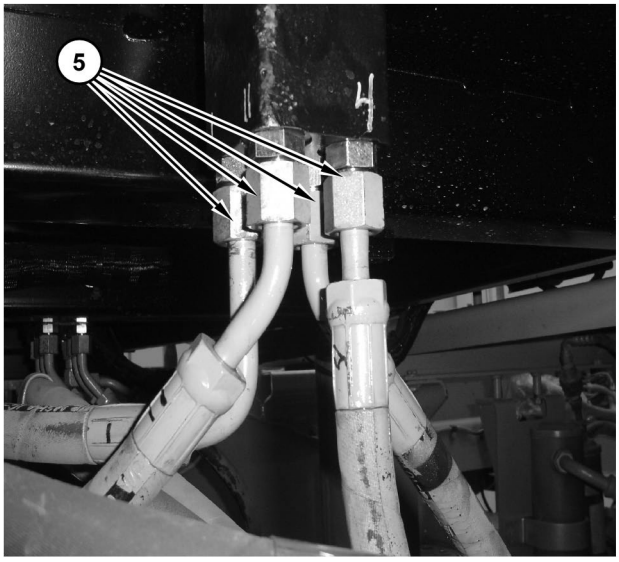


Illustration 910 g01247511

14. Connect hose assemblies (5).

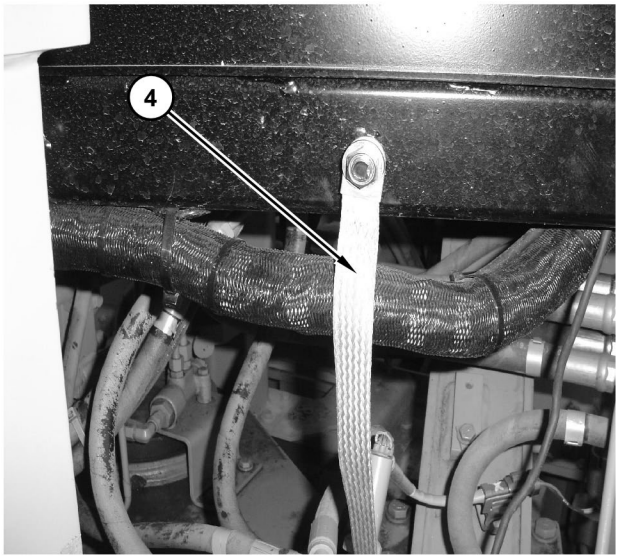


Illustration 911 g01247508

15. Connect ground strap (4).

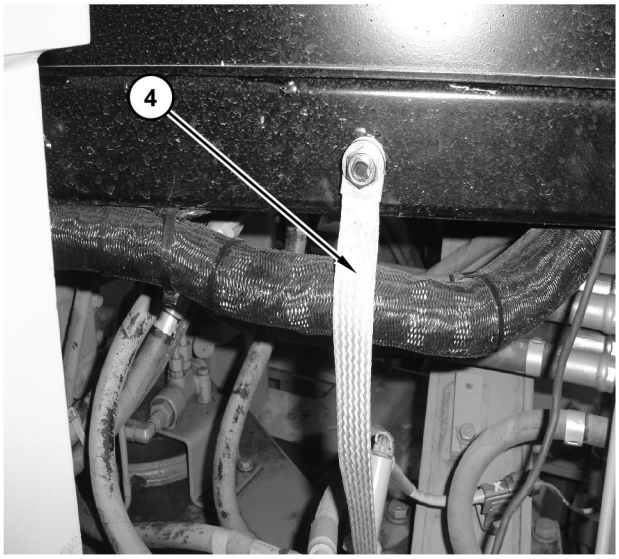


Illustration 912 g01247508

16. Position the harness assembly (3). Connect harness assemblies (3).

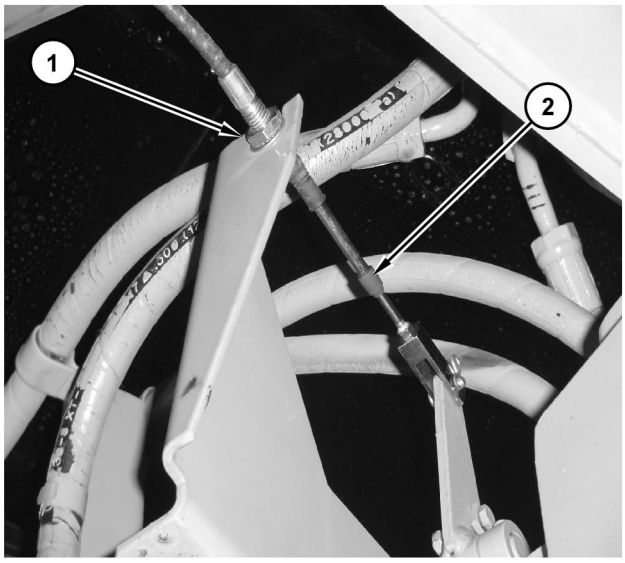


Illustration 913 g01247504

17. Position parking brake cable (2). Connect parking brake cable (2). Tighten nuts (1).

18. Charge the air conditioner refrigerant into the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.

End By:

a. Install the cab. Refer to Disassembly and Assembly , “Cab - Remove and Install”.

b. Separate steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02474653

Instrument Panel (Front) - Remove

SMCS Code: 7451-011-FR

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

Note: For installation purposes, put identification marks on all wire connections.

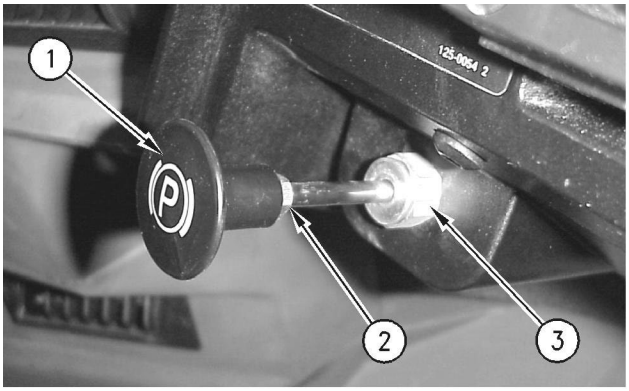


Illustration 914 g00878535

1. Loosen nut (2).

2. Remove knob (1).

3. Remove nut (2) and nut (3).

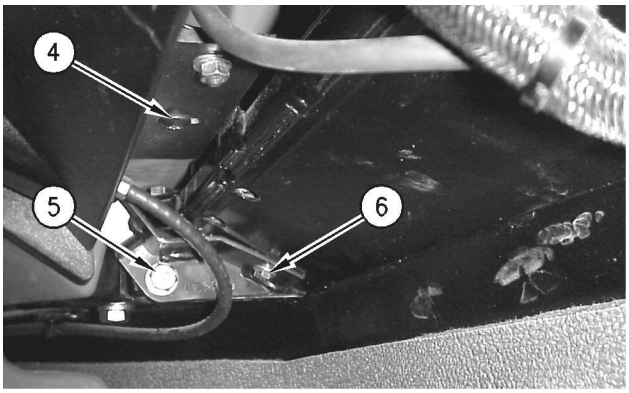


Illustration 915 g00878537

4. Remove screw (4), bolt (5), and bolt (6) from the lower left side of the instrument panel. Repeat for the opposite side.

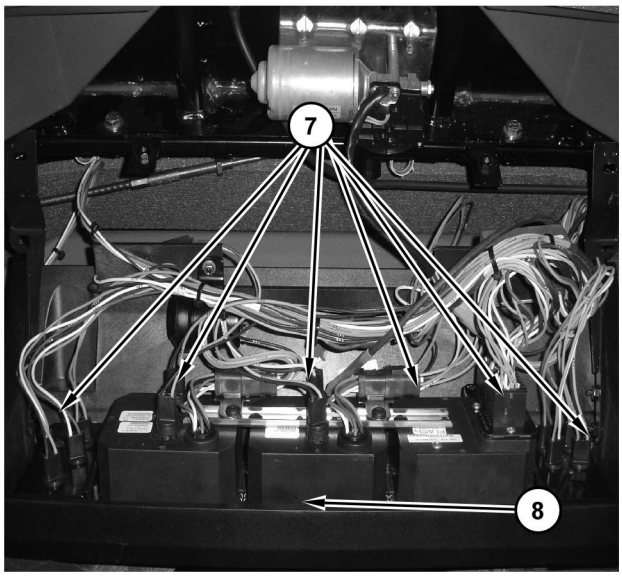


Illustration 916 g01234871

5. Disconnect all the electrical connectors and instrument lights (7) from the back of the instrument panel.

6. Remove panel instrument (8).

i02474704

Instrument Panel (Front) - Install

SMCS Code: 7451-012-FR

Installation Procedure

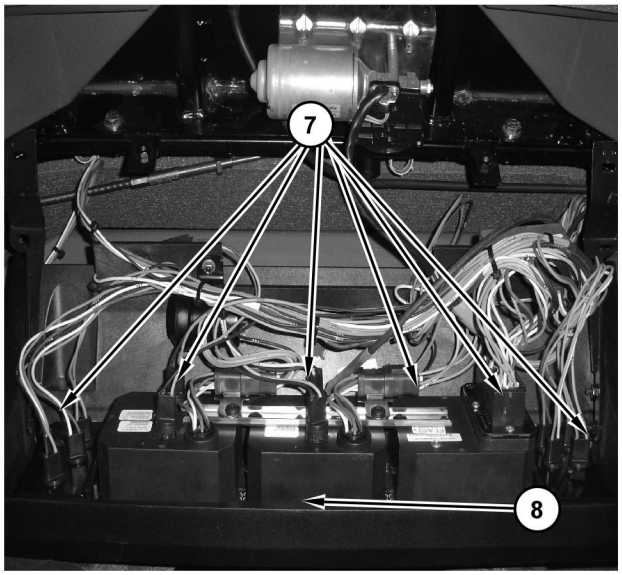


Illustration 917 g01234871

1. Install panel instrument (8).

2. Connect all the electrical connectors and instrument lights (7) onto the back of the instrument panel.

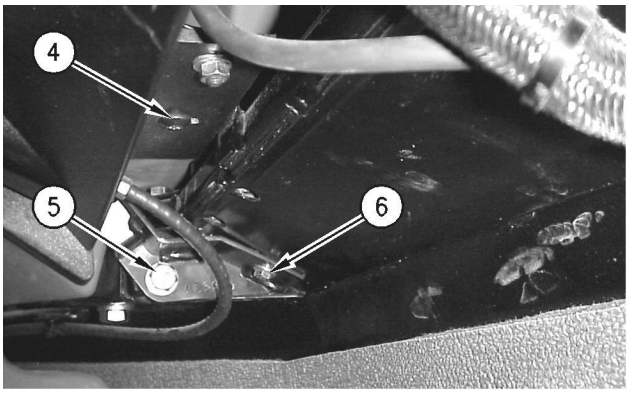


Illustration 918 g00878537

3. Install screw (4), bolt (5), and bolt (6) from the lower left side of the instrument panel. Repeat for the opposite side.

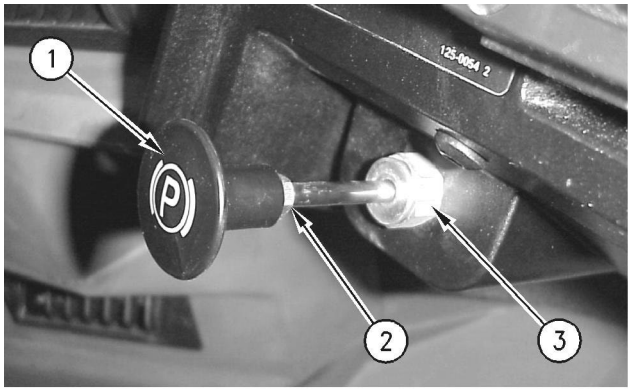


Illustration 919 g00878535

4. Install nut (2) and nut (3).

5. Install knob (1).

6. Tighten nut (2).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02480106

Instrument Panel (Side) - Remove

SMCS Code: 7451-011-SI

Removal Procedure

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.



Illustration 920 g01238668

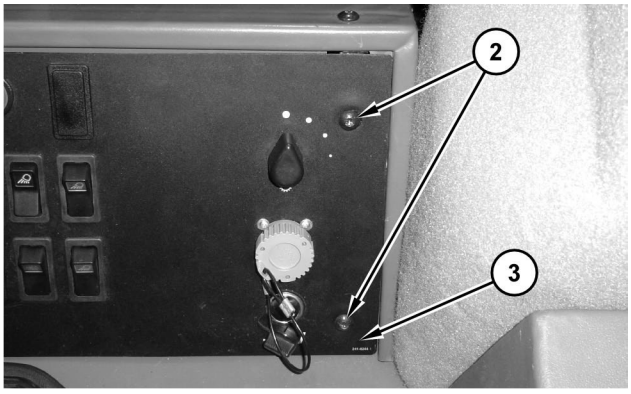


Illustration 921 g01238669

1. Turn the disconnect switch to OFF position. Remove screws (1) and (2). Position panel assembly (3) aside.

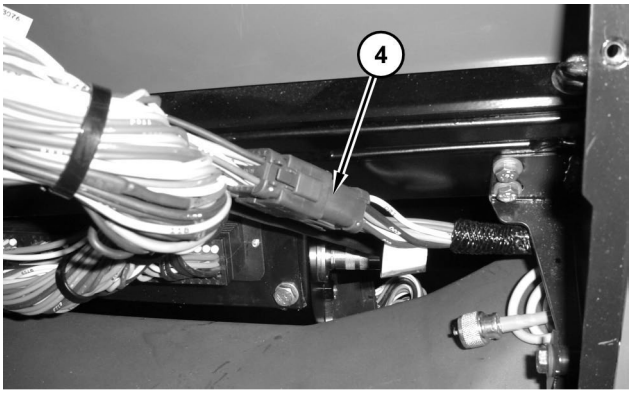


Illustration 922 g01238670

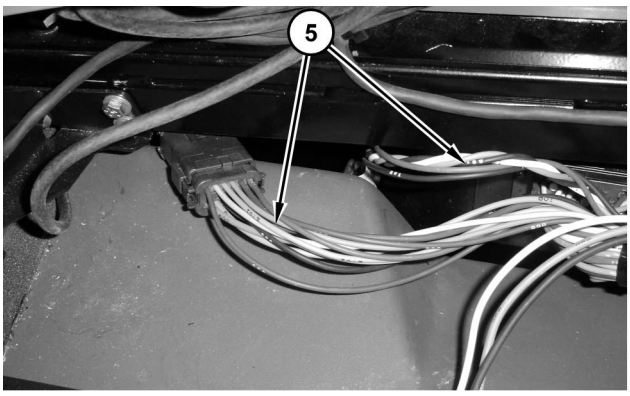


Illustration 923 g01238671

2. Disconnect harness assemblies (4) and (5).

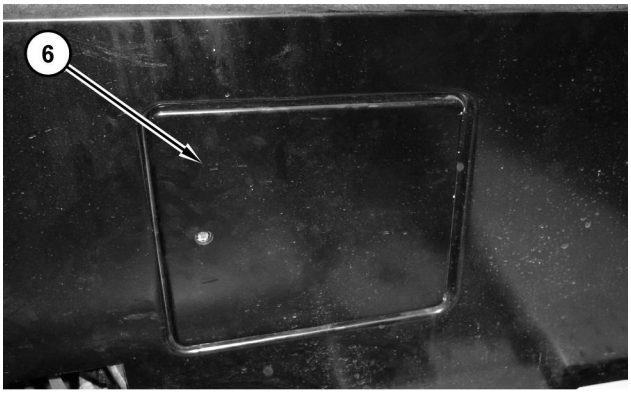


Illustration 924 g01238672

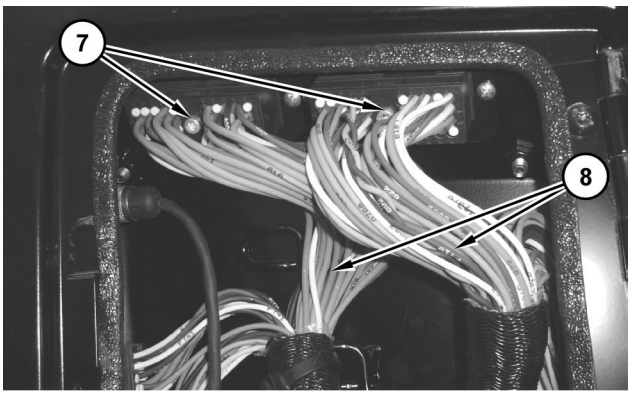


Illustration 925 g01238673

3. Open access door (6). Loosen bolts (7). Disconnect harness assemblies (8).

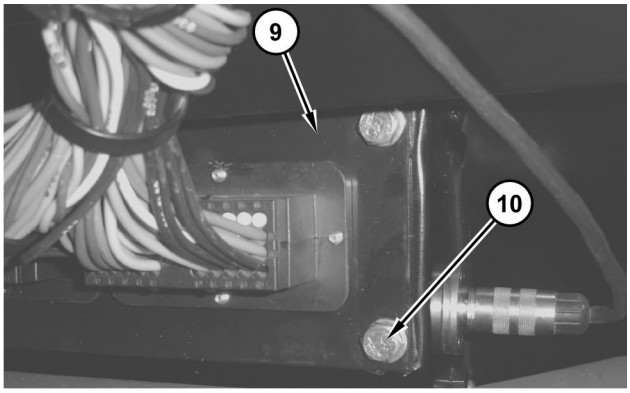


Illustration 926 g01238674

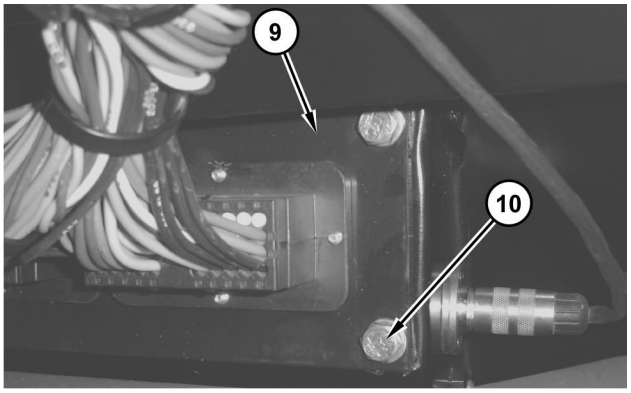


Illustration 928 g01238674

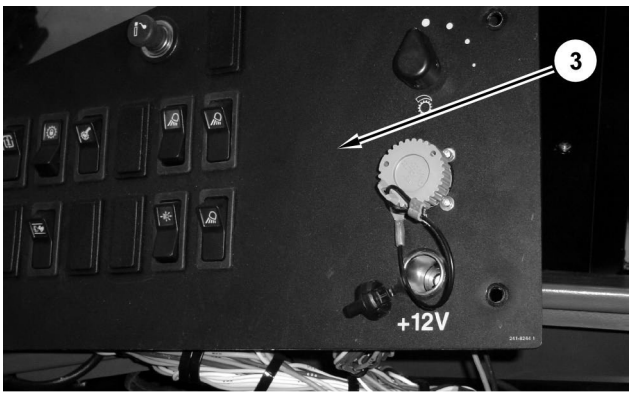


Illustration 927 g01238675

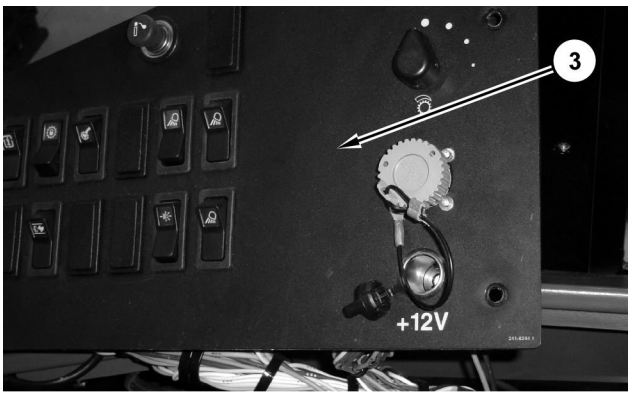


Illustration 929 g01238675

4. Remove bolts (10). Remove plate assembly (9) with instrument panel assembly (3).

i02480110

Instrument Panel (Side) - Install

SMCS Code: 7451-012-SI

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

1. Position plate assembly (9) with instrument panel assembly (3) and install bolts (10).

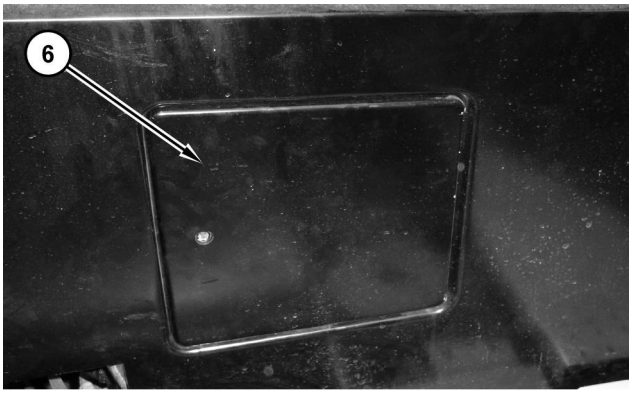


Illustration 930 g01238672

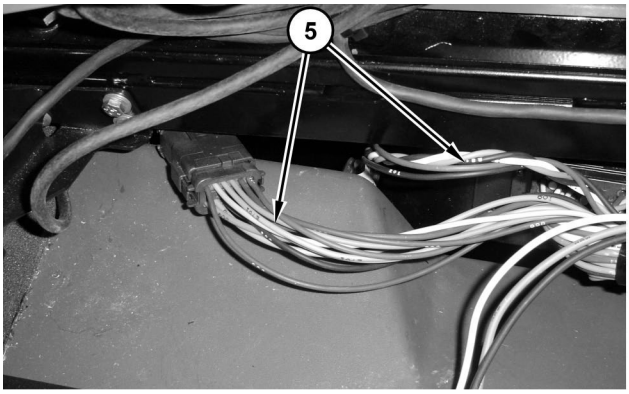


Illustration 932 g01238671

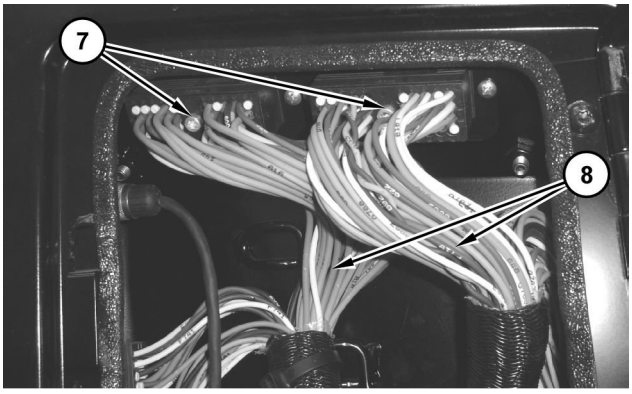


Illustration 931 g01238673

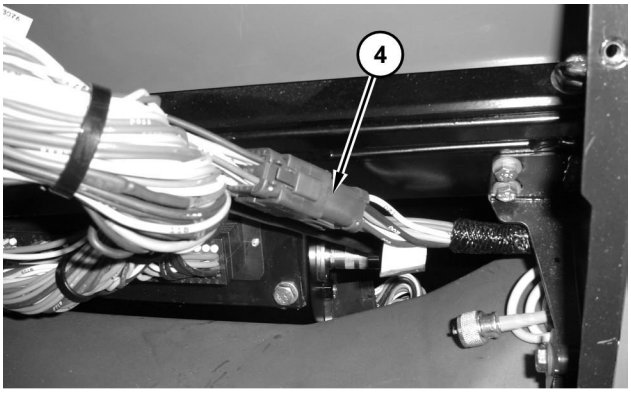


Illustration 933 g01238670

2. Position harness assemblies (8). Tighten bolts (7) to a torque of 2.25 ± .25 N·m (19 ± 2 lb in). Close access door (6).

3. Connect harness assemblies (4) and (5).



Illustration 934 g01238668

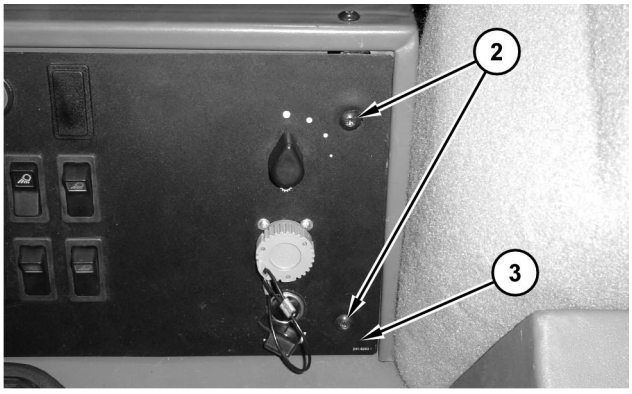


Illustration 935 g01238669

4. Position panel assembly (3). Install screws (1) and (2).

i02477748

Window Wiper and Wiper Motor (Front) - Remove

SMCS Code: 7305-011-FR; 7305-011-MQ

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

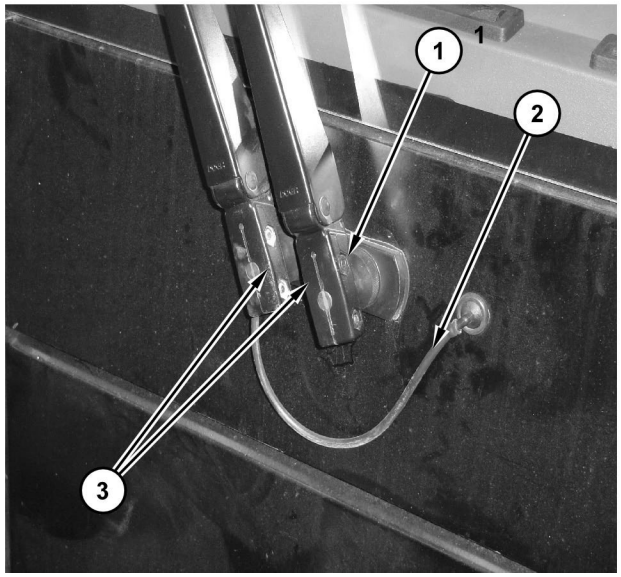


Illustration 936 g01237534

1. Loosen bolts (1). Disconnect hose (2). Remove wiper arm assembly (3).

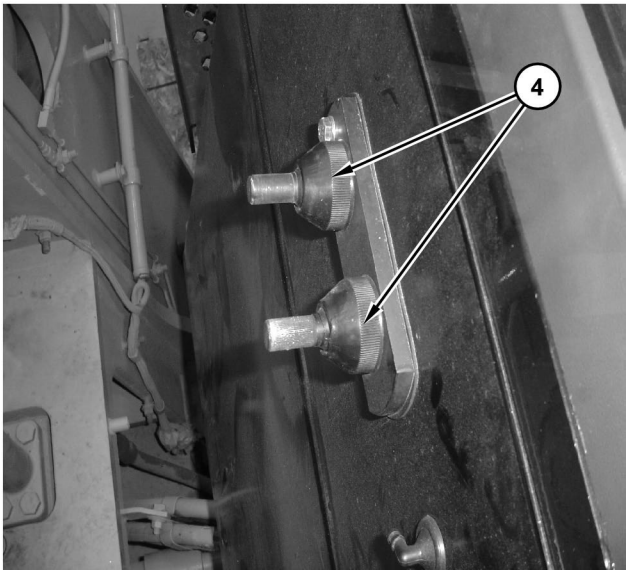


Illustration 937 g01237536

2. Remove caps (4).

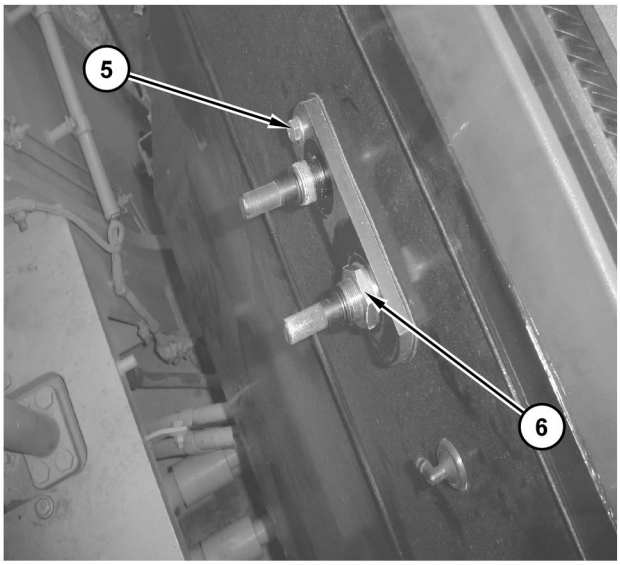


Illustration 938 g01237539

3. Remove bolt (5). Remove nut (6).

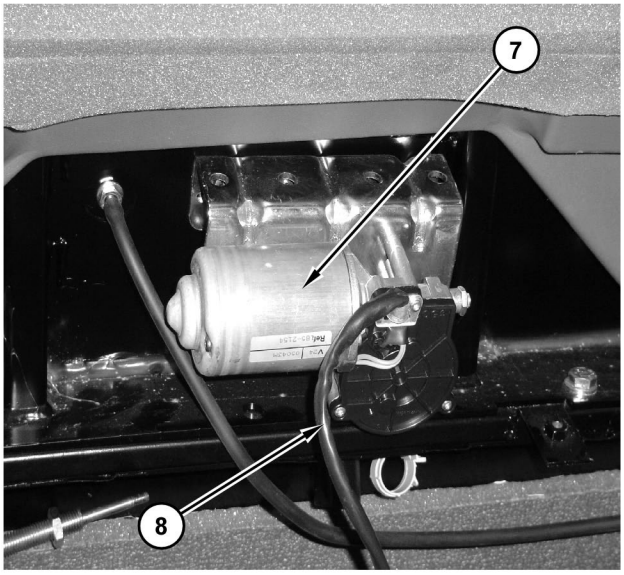


Illustration 939 g01237541

4. Disconnect harness assembly (8). Remove wiper motor (7).

i02478008

Window Wiper and Wiper Motor (Front) - Install

SMCS Code: 7305-012-MQ; 7305-012-FR

Installation Procedure

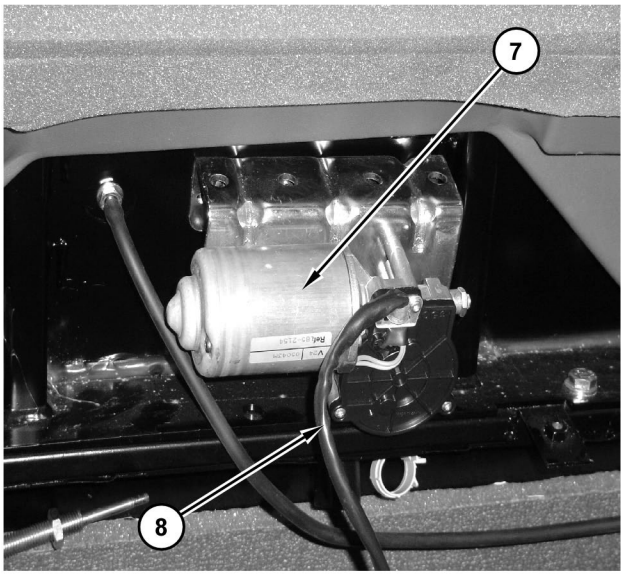


Illustration 940 g01237541

1. Carefully install wiper motor assembly (7).

2. Connect harness assembly (8).

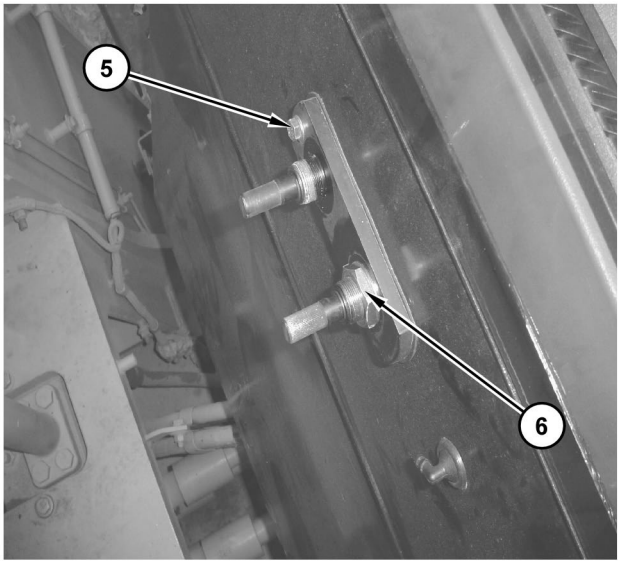


Illustration 941 g01237539

3. Install bolt (5) and nut (6). Tighten nut (6) to a torque of 19 ± 1 N·m (14 ± 1 lb ft).

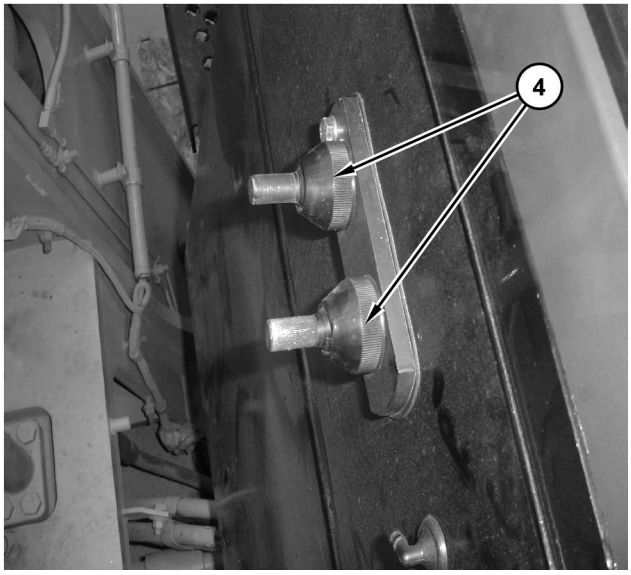


Illustration 942 g01237536

4. Install caps (4).

5. Use the following procedure to place the wiper motor in the parked position:

a. Turn the engine start switch to the ON position.

b. Turn the wiper switch to the OFF position. Wait until the wiper motor stops moving. This is the parked position.

c. Turn the engine start switch to the OFF position.

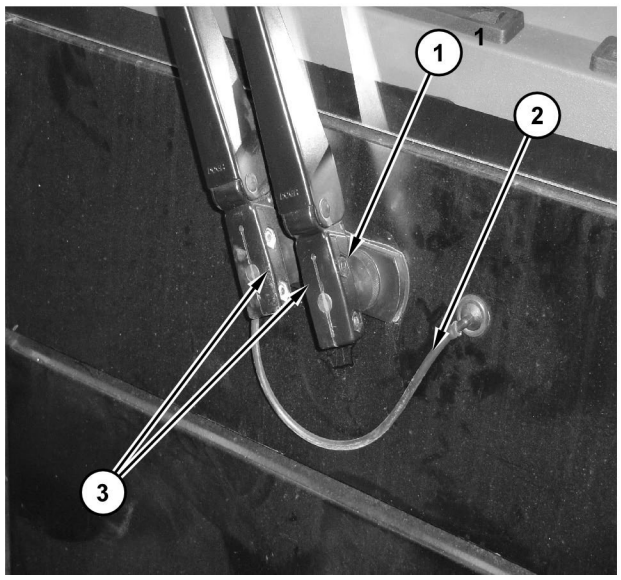


Illustration 943 g01237534

6. Install wiper arm assemblies (3) in the park position.

a. Install bolts (1). Tighten bolts (1) to a torque of 14 ± 2 N·m (10 ± 1 lb ft).

b. Turn the engine start switch to the ON position.

c. Turn the wiper switch to the ON position.

d. Check the path of wiper arm assemblies (3).

e. Turn the wiper switch to the OFF position. Wait until the wiper motor stops moving.

f. Turn the engine start switch to the OFF position.

g. Makeany necessary adjustments.

7. Connect hose (2) to the fitting.

Note: Do not use petroleum lubricants on the hose ends. Do not stretch the hose between connection points.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02478603

Window Wiper and Wiper Motor (Front Quarter Window) - Remove

SMCS Code: 7305-011-FR; 7305-011-MQ

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

Note: Note the position of the wiper blade assembly prior to removal.

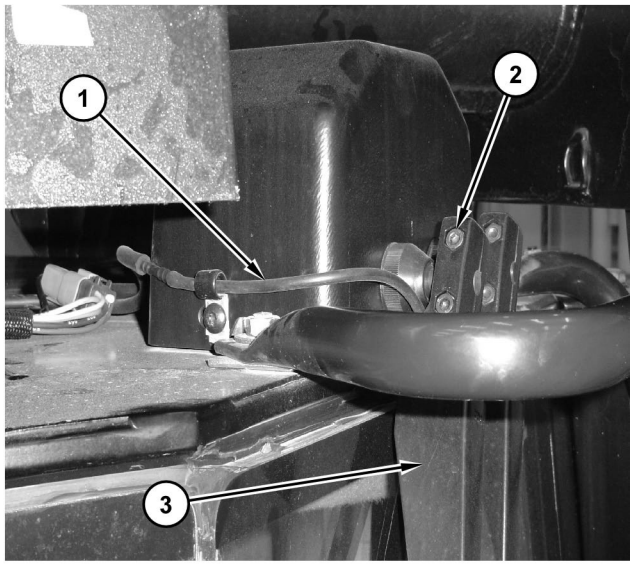


Illustration 944 g01237987

1. Disconnect hose (1). Loosen bolts (2). Remove wiper arm assembly (3).

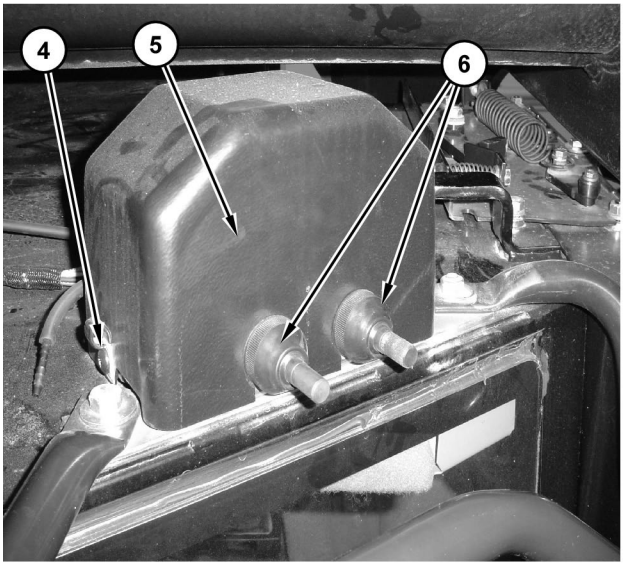


Illustration 945 g01237989

2. Remove screws (4). Remove caps (6). Remove cover (5).

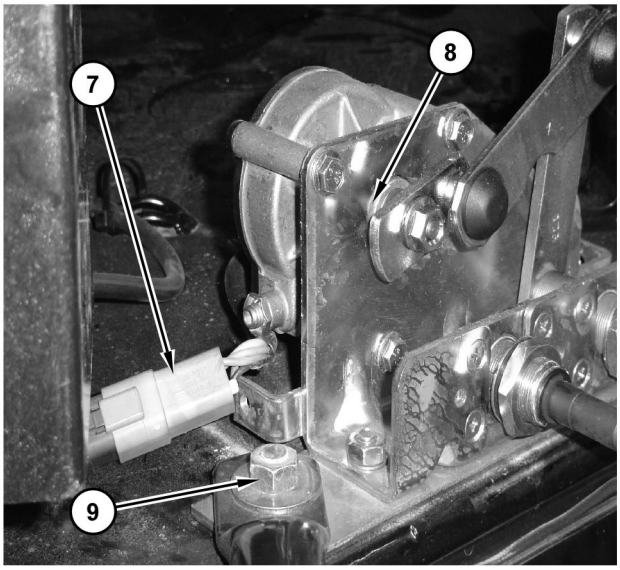


Illustration 946 g01237993

3. Disconnect harness assembly (7). Loosen nuts (9). Remove wiper motor assembly (8).

i02478758

Window Wiper and Wiper Motor (Front Quarter Window) - Install

SMCS Code: 7305-012-FR; 7305-012-MQ

Installation Procedure

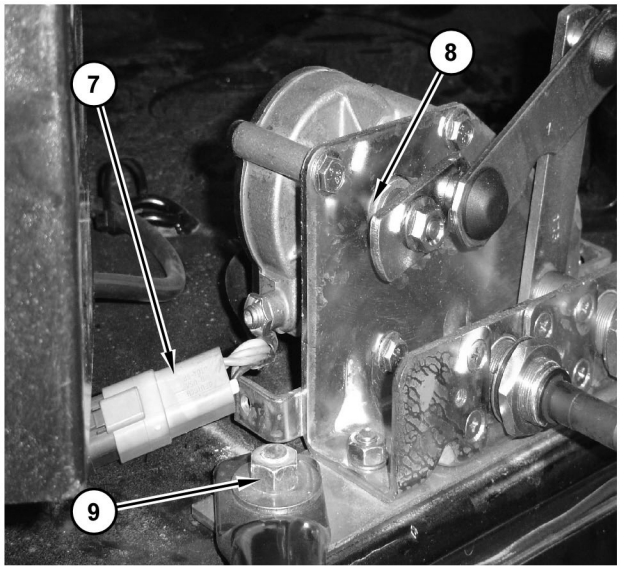


Illustration 947 g01237993

1. Carefully install wiper motor assembly (8). Tighten nuts (9).

2. Connect harness assembly (7).

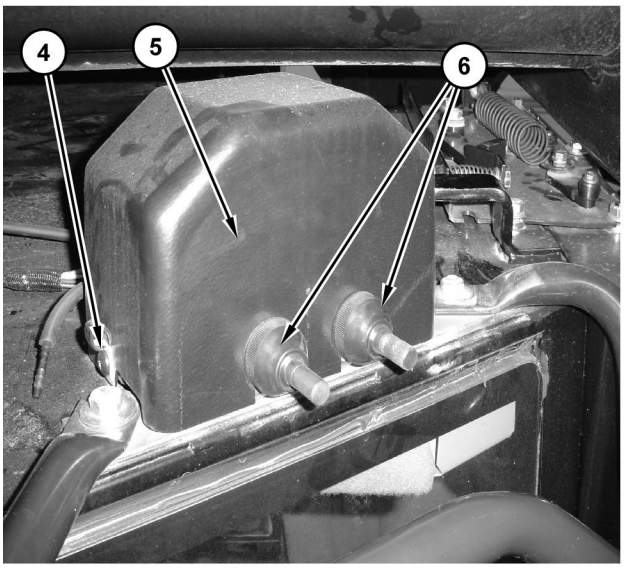


Illustration 948 g01237989

3. Install cover (5). Install caps (6). Install screws (4).

4. Use the following procedure to place the wiper motor in the parked position:

a. Turn the engine start switch to the ON position.

b. Turn the wiper switch to the OFF position. Wait until the wiper motor stops moving. This is the parked position.

c. Turn the engine start switch to the OFF position.

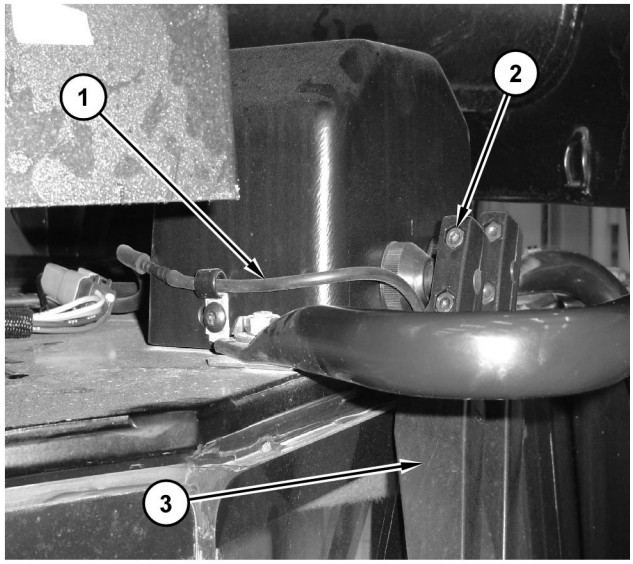


Illustration 949 g01237987

5. Install wiper arm assemblies (3) in the park position.

a. Install bolts (2). Tighten bolts (2) to a torque of 14 ± 2 N·m (10 ± 1 lb ft).

b. Turn the engine start switch to the ON position.

c. Turn the wiper switch to the ON position.

d. Check the path of wiper arm assemblies (3).

e. Turn the wiper switch to the OFF position. Wait until the wiper motor stops moving.

f. Turn the engine start switch to the OFF position.

g. Make any necessary adjustments.

6. Connect hose (1).

Note: Do not use petroleum lubricants on the hose ends. Do not stretch the hose between connection points.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect”.

i02479160

Window Wiper and Wiper Motor (Rear) - Remove

SMCS Code: 7305-011-MQ; 7305-011-RE

Disassembly Procedure

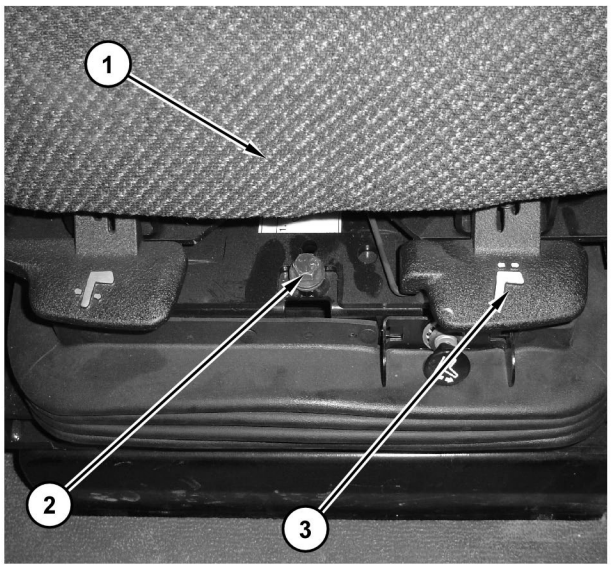


Illustration 950 g01238355

1. Remove bolt (2). Engage lever (3) in order to move seat assembly (1) forward.

Note: DO NOT move seat assembly (1) to the maximum FORWARD position. Seat assembly (1) will disengage from the seat suspension.

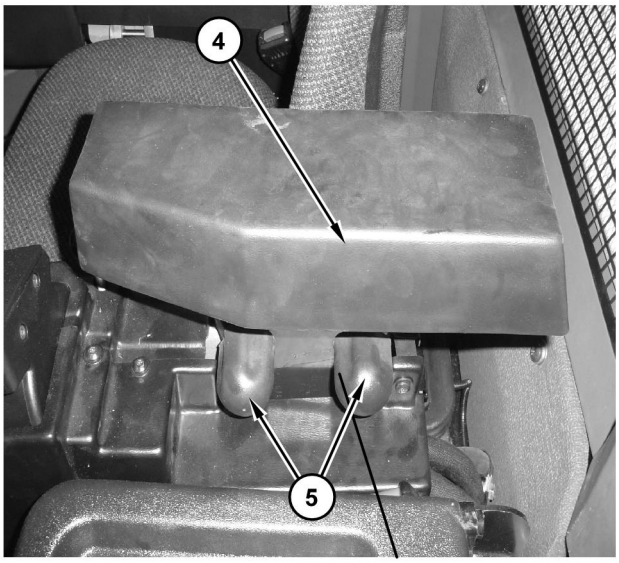


Illustration 951 g01238362

2. Remove knobs (5). Remove armrest assembly (4).

3. Repeat Step 2 for the opposite side.

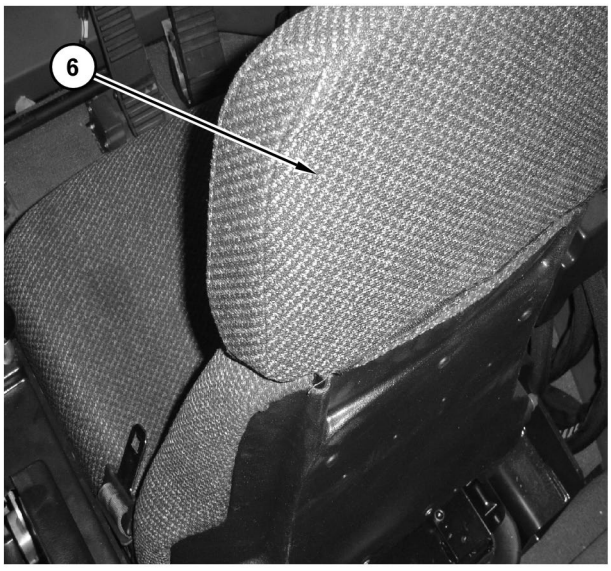


Illustration 952 g01238364

4. Remove headrest (6).

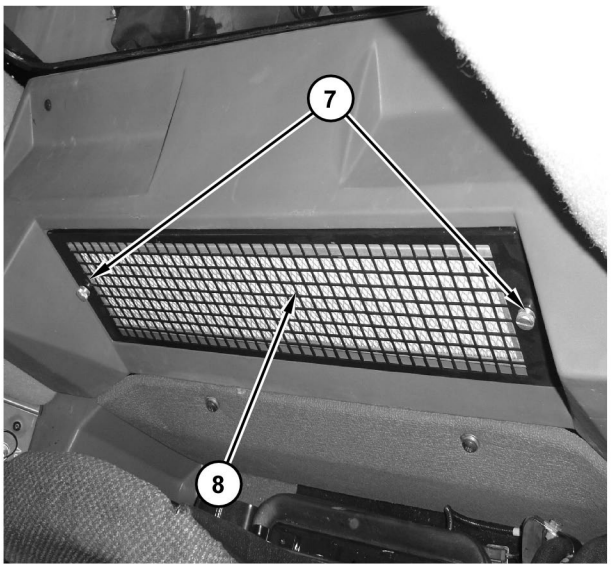


Illustration 953 g01238366

5. Loosen screws (7). Remove cover assembly (8).

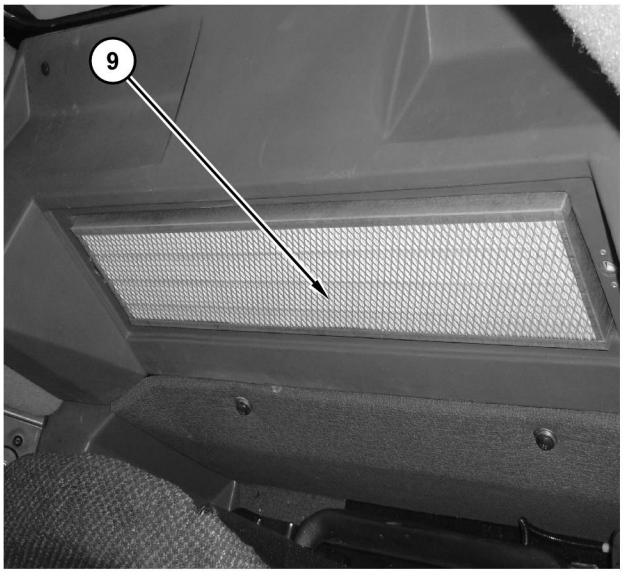


Illustration 954 g01238370

6. Remove filter assembly (9).

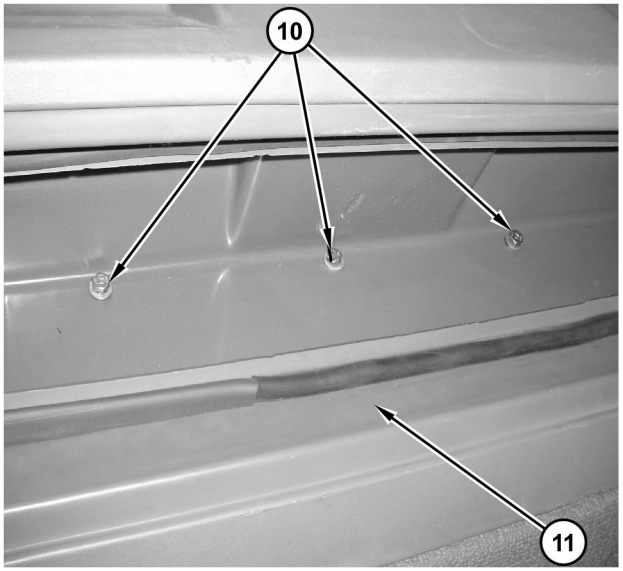


Illustration 955 g01238372

7. Remove bolts (10). Remove rear duct (11).

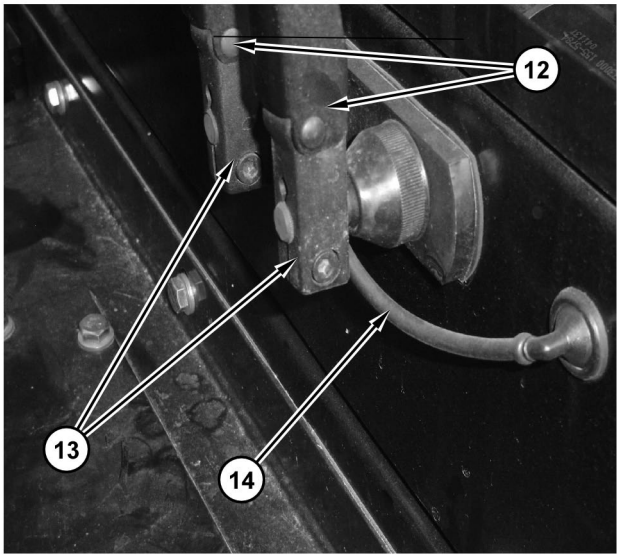


Illustration 956 g01238373

8. Note the position of arm assemblies (12) for assembly purposes.

9. Disconnect hose (14). Loosen bolts (13). Remove arm assemblies (12).

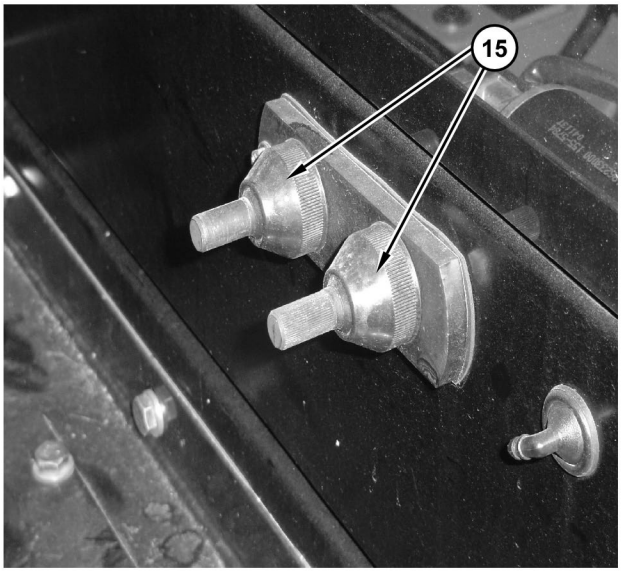


Illustration 957 g01238469

10. Remove caps (15).

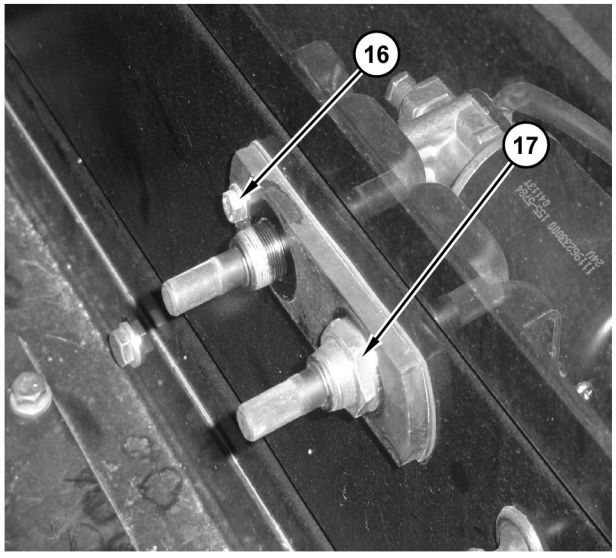


Illustration 958 g01238374

11. Remove bolt (16). Remove nuts (17).

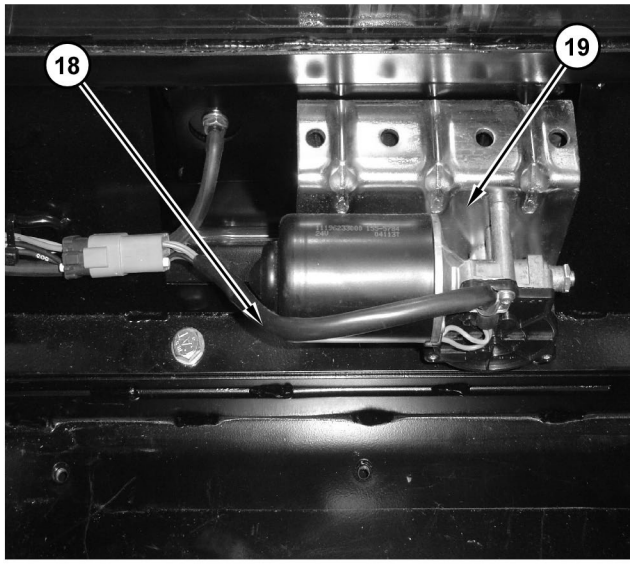


Illustration 959 g01238377

12. Disconnect harness assembly (18). Remove wiper motor assembly (19).

i02479931

Window Wiper and Wiper Motor (Rear) - Install

SMCS Code: 7305-012-RE; 7305-012-MQ

Installation Procedure

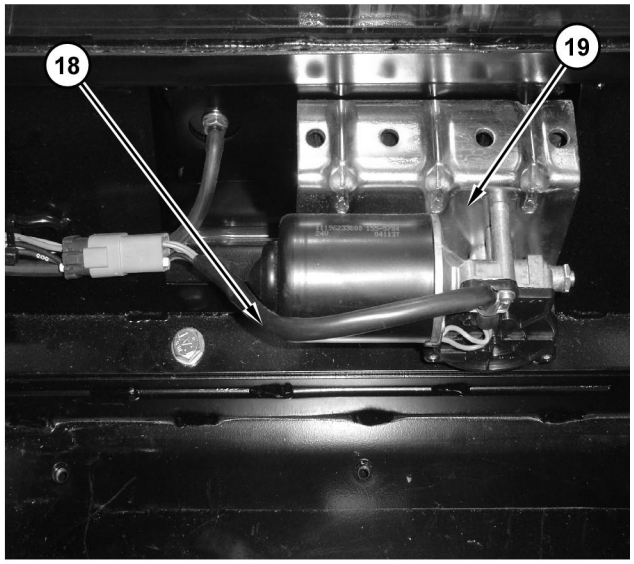


Illustration 960 g01238377

1. Install wiper motor assembly (19). Connect harness assembly (18).

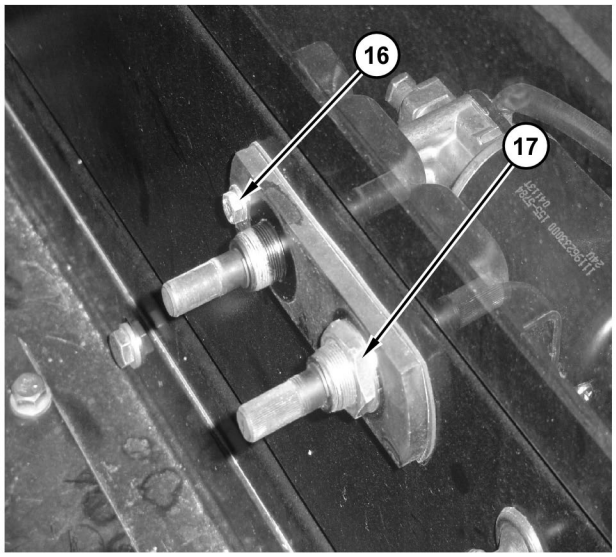


Illustration 961 g01238374

2. Install nuts (17). Install bolt (16).

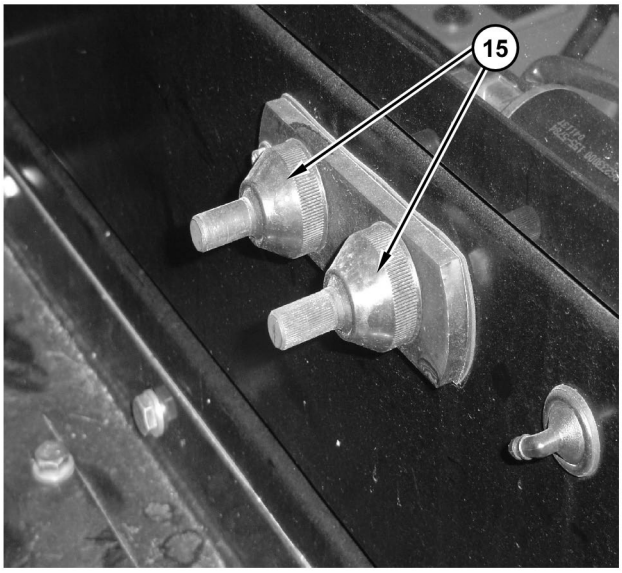


Illustration 962 g01238469

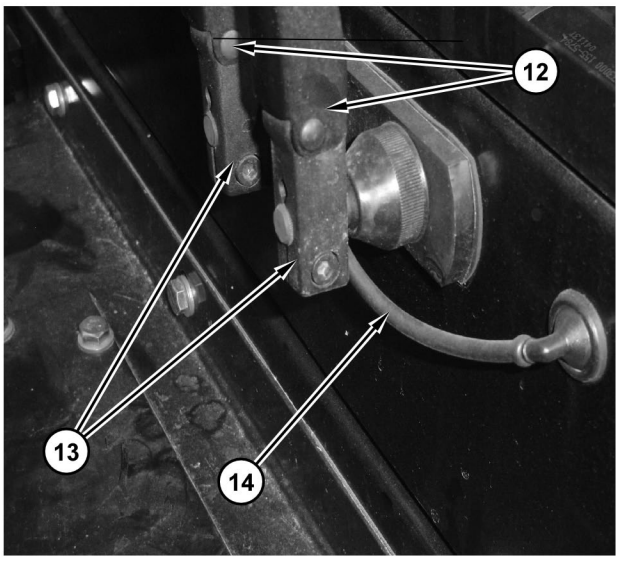


Illustration 963 g01238373

3. Install caps (15).

4. Use the following procedure to place the wiper motor in the parked position:

a. Turn the engine start switch to the ON position.

b. Turn the wiper switch to the OFF position. Wait until the wiper motor stops moving. This is the parked position.

c. Turn the engine start switch to the OFF position.

5. Install arm assemblies (12) in the park position. Install bolts (13). Tighten bolts (13) to a torque of 20 ± 3 N·m (15 ± 2 lb ft). Connect hose (14).

a. Turn the engine start switch to the ON position.

b. Turn the wiper switch to the ON position.

c. Check the path of wiper arm assemblies (3).

d. Turn the wiper switch to the OFF position. Wait until the wiper motor stops moving.

e. Turn the engine start switch to the OFF position.

f. Makeany necessary adjustments.

6. Connect hose (14) to the fitting.

Note: Do not use petroleum lubricants on the hose ends. Do not stretch the hose between connection points.

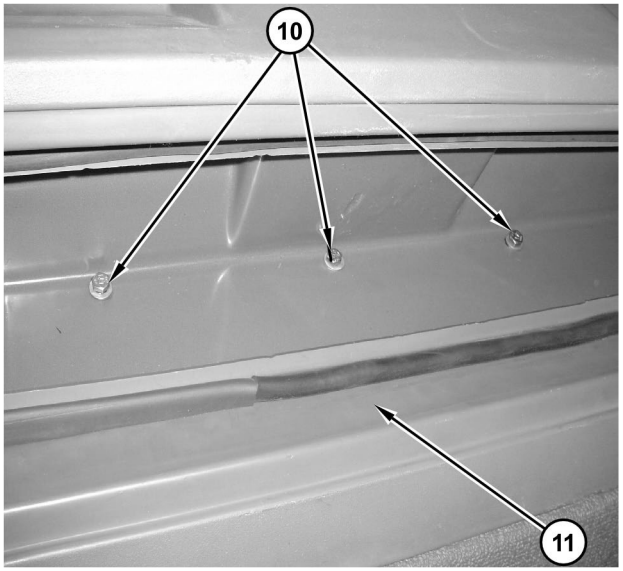


Illustration 964 g01238372

7. Install rear duct (11). Install bolts (10).

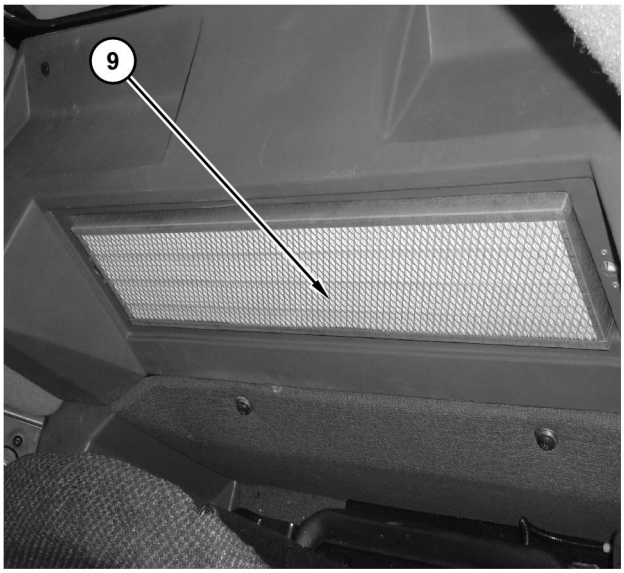


Illustration 965 g01238370

8. Install filter assembly (9).

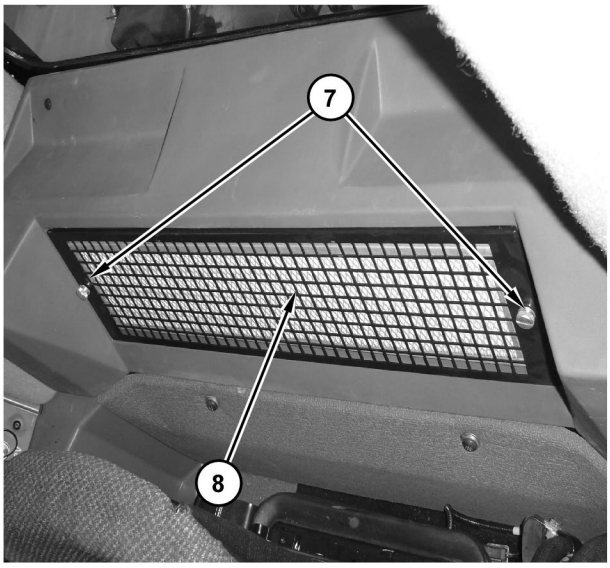


Illustration 966 g01238366

9. Install cover assembly (8). Tighten screws (7).

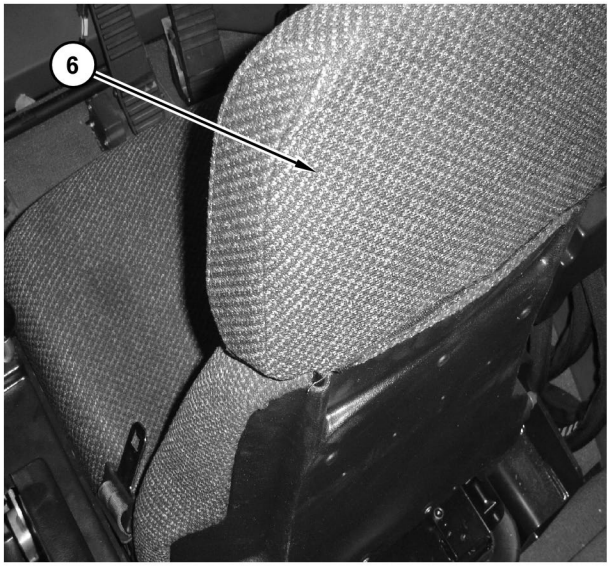


Illustration 967 g01238364

10. Install headrest (6).

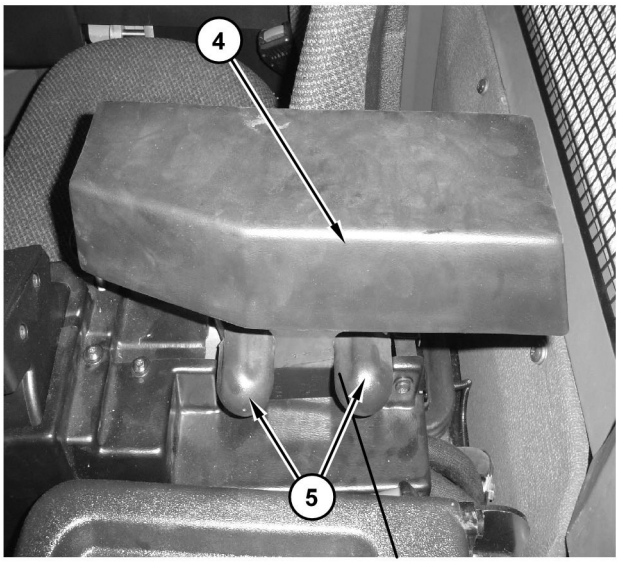


Illustration 968 g01238362

11. Install armrest assembly (4). Install knobs (5).

12. Repeat Step 11 for the opposite side.

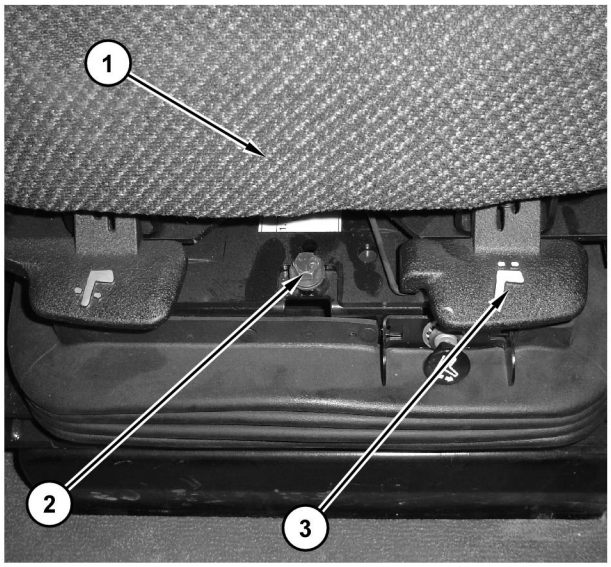


Illustration 969 g01238355

13. Engage lever (3) in order to move seat assembly (1) rearward. Install bolt (3).

i02477599

Seat - Remove

SMCS Code: 7312-011

Removal Procedure

Start By:

a. Connect steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all harness assemblies, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

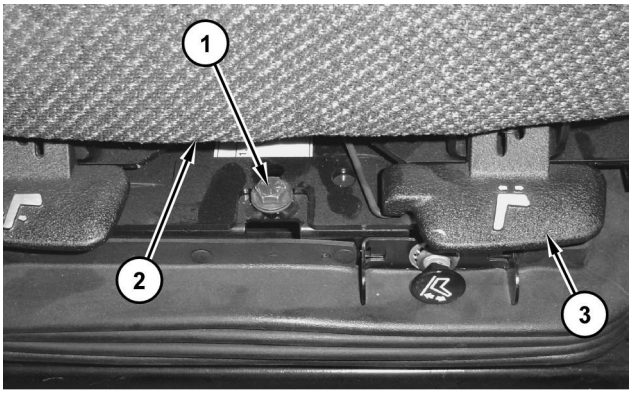


Illustration 970 g01236941

1. Remove bolt (1). Actuate lever (3) in order to slide seat assembly (2) forward. Use two people to remove seat assembly (1). The weight of seat assembly (2) is approximately 34 kg (75 lb).

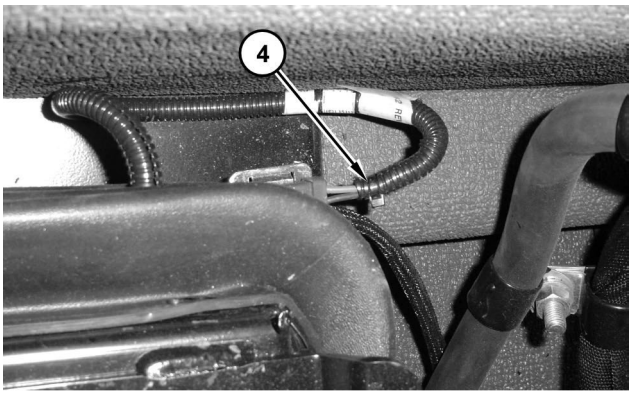


Illustration 971 g01237339

2. Disconnect harness assembly (4).

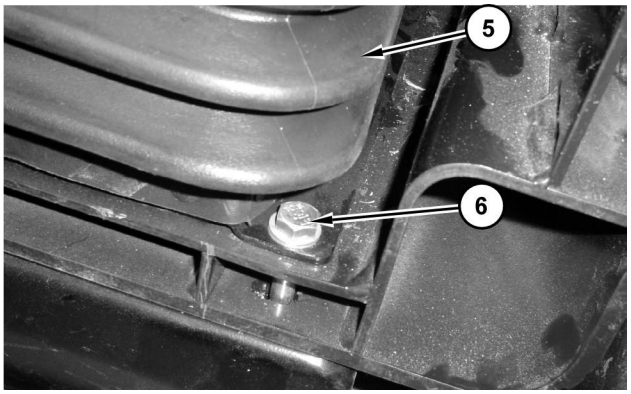


Illustration 972 g01237340

3. Remove bolts (6). Use two people to remove seat suspension assembly (5). The weight of seat suspension assembly (5) is approximately 27 kg (60 lb).

i02477596

Seat - Install

SMCS Code: 7312-012

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

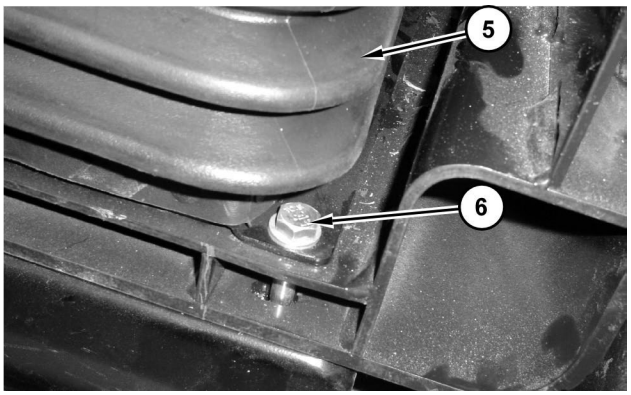


Illustration 973 g01237340

1. Use two people to position seat suspension assembly (5). The weight of seat suspension assembly (5) is approximately 27 kg (60 lb). Install bolts (6).

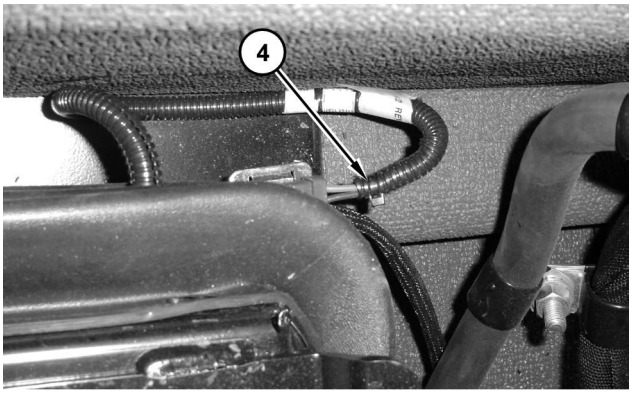


Illustration 974 g01237339

2. Connect harness assembly (4).

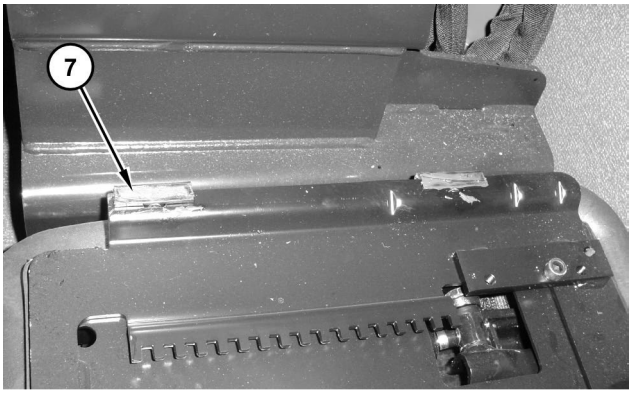


Illustration 975 g01237342

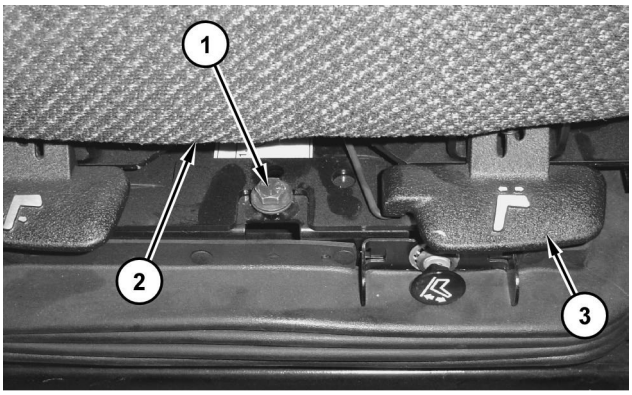


Illustration 976 g01236941

3. Install slider blocks (7). Use two people in order to install seat assembly (1). The weight of seat assembly (1) is approximately 34 kg (75 lb). Actuate lever (3) in order to slide the seat rearward. Install bolt (2).

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly , “Steering Frame Lock - Seperate and Connect”.

i02473315

Air Conditioner and Heater - Remove

SMCS Code: 7304-011; 7320-011

Removal Procedure

Start By:

a. Connect the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect” for the machine that is being serviced.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Effective July 1, 1992 regulations prohibit the venting of any refrigerant into the atmosphere. Refer to Caterpillar publications Service Manuals, SENR3334, SENR5664, and NEDG5065 for the proper procedure, the proper equipment, and the proper tools needed in order to reclaim refrigerant from any Caterpillar equipment.

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Cap all lines, all hoses, and all tubes and plug all lines, all hoses, and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Recover the air conditioner refrigerant from the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.

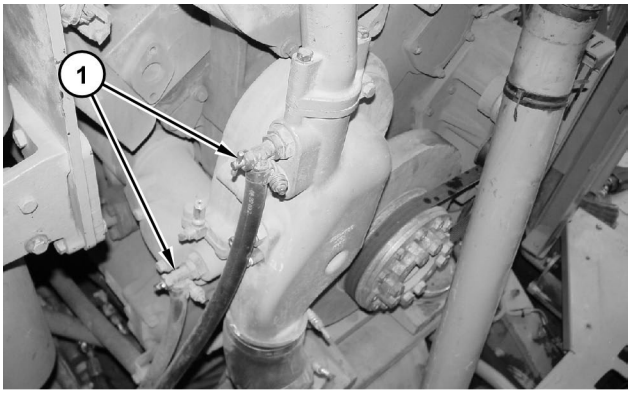


Illustration 977 g01233630

2. Turn heater hose valves (1) to the OFF position.

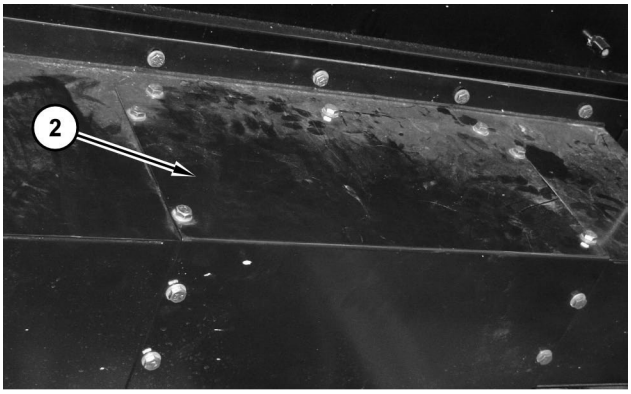


Illustration 978 g01233649

3. Remove cover (2).

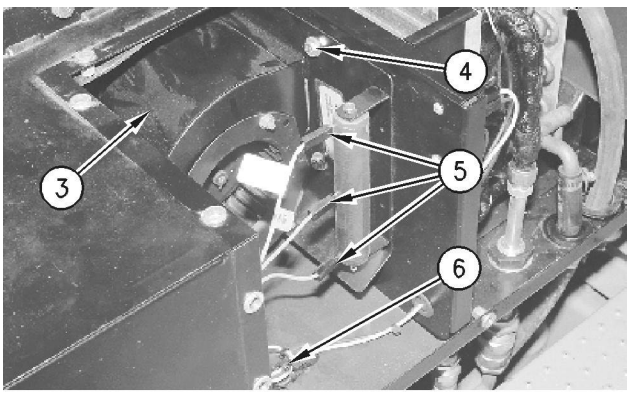


Illustration 979 g00877433

4. Disconnect harness assemblies (5).

5. Disconnect harness assembly (6).

6. Remove three bolts (4).

7. Remove blower assemblies (3).

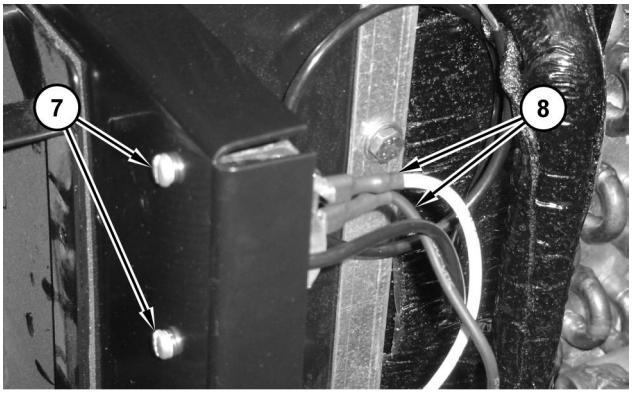


Illustration 980 g01233653

8. Disconnect harness assemblies (8).

9. Remove screws (7).

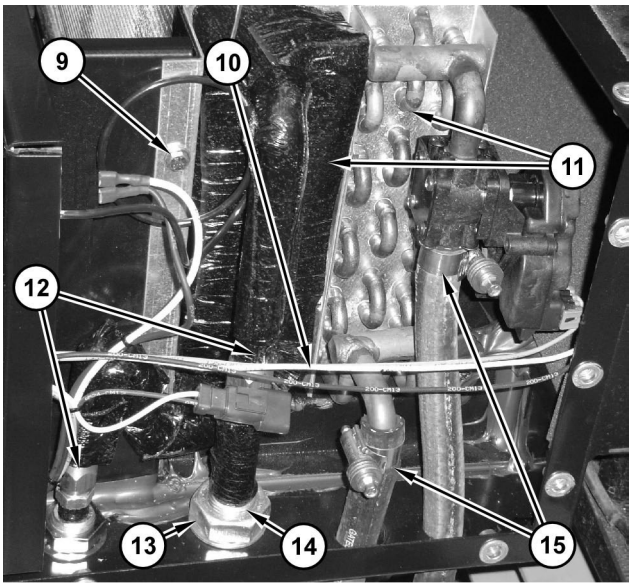


Illustration 981 g01233660

10. Disconnect harness assembly (10).

11. Disconnect heater hoses (15).

12. Disconnect air conditioner hose assemblies (12).

13. Remove nut (13).

14. Position bulkhead fitting (14) out of the way.

15. Remove bolts (9).

16. Remove core assemblies (11).

i02473316

Air Conditioner and Heater - Install

SMCS Code: 7304-012; 7320-012

Installation Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Effective July 1, 1992 regulations prohibit the venting of any refrigerant into the atmosphere. Refer to Caterpillar publications Service Manuals, SENR3334, SENR5664, and NEDG5065 for the proper procedure, the proper equipment, and the proper tools needed in order to reclaim refrigerant from any Caterpillar equipment.

⚠ WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

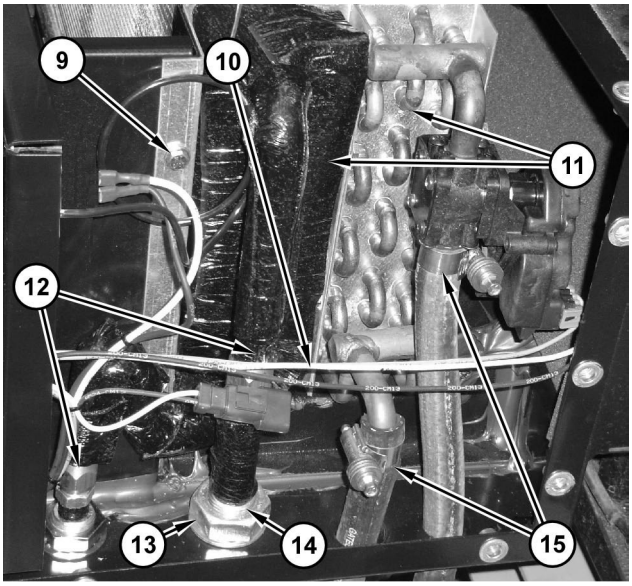


Illustration 982 g01233660

1. Install core assemblies (11).

2. Install bolts (9).

3. Position bulkhead fitting (14) and install nut (13).

4. Connect air conditioner hose assemblies (12).

5. Connect heater hoses (15).

6. Connect harness assembly (10).

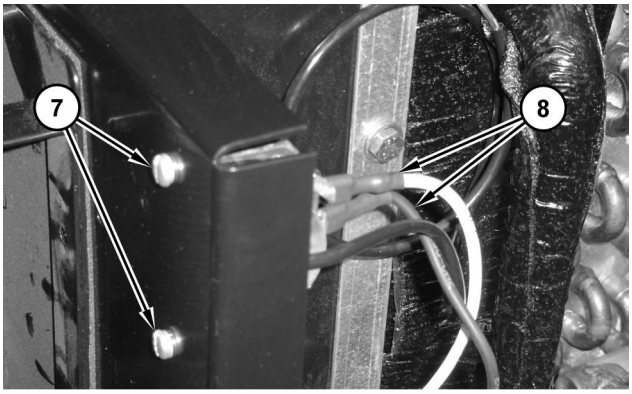


Illustration 983 g01233653

7. Install screws (7).

8. Connect harness assemblies (8).

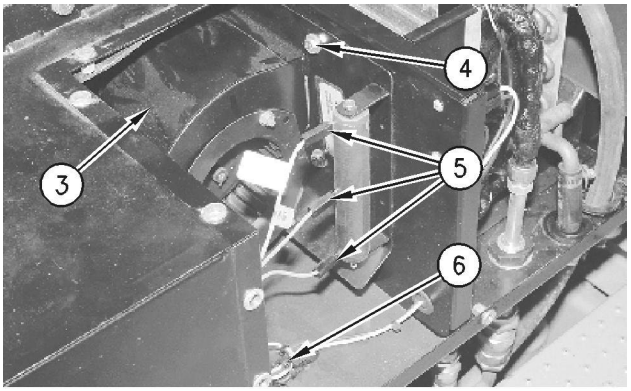


Illustration 984 g00877433

9. Install blower assemblies (3).

10. Install three bolts (4).

11. Connect harness assembly (6).

12. Connect harness assemblies (5).

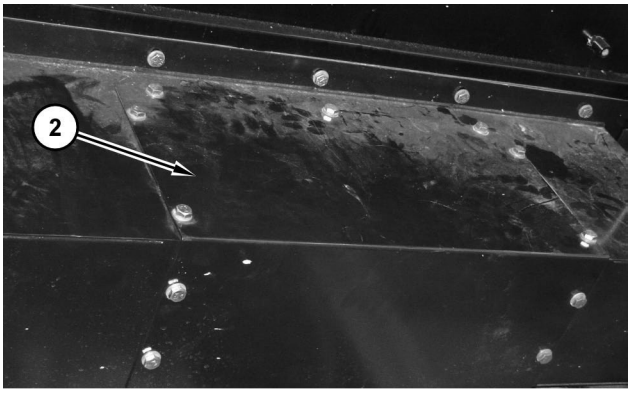


Illustration 985 g01233649

13. Install cover (2).

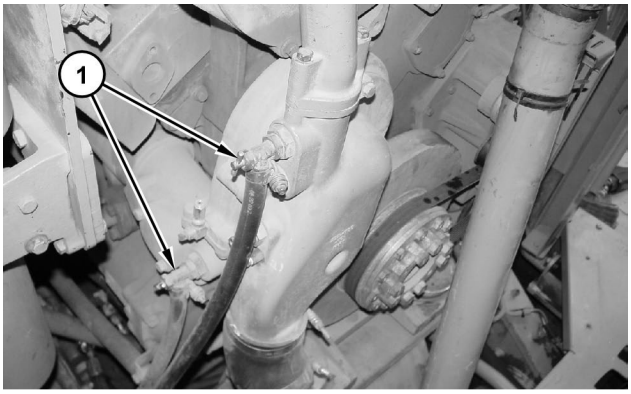


Illustration 986 g01233630

14. Turn heater hose valves (1) to the ON position.

15. Charge the air conditioner system. Refer to Service Manual, SENR5664, “Air Conditioning and Heating Systems with R-134a Refrigerant” for the correct procedure. Refer to Special Publication, NEDG5065, “Air Conditioning Tools” for the correct tools.

End By:

a. Separate the steering frame lock. Refer to Disassembly and Assembly, “Steering Frame Lock - Separate and Connect” for the machine that is being serviced.

i02514976

Front Frame from Rear Frame - Separate

SMCS Code: 7051-076

Separation Procedure

Table 51

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5H-9817	Hydraulic Cylinder	1
	9U-5346	Nut	1
	9U-5344	Puller Stud	1
	6V-4035	Sleeve	1
	3S-6224	Electric Hydraulic Pump Gp	1
B	9U-7536	Lift Stand	2
	277-7200	Electric Hydraulic Pump Gp	1
C	3S-6224	Electric Hydraulic Pump Gp	1
	9U-6814	Puller Stud	1
	124-4640	Sleeve	1
	5P-5212	Plate	1
	6V-0014	Hydraulic Cylinder	1
	9U-6810	Nut	1
D	3S-6224	Electric Hydraulic Pump Gp	1
	9U-6814	Puller Stud	1
	5P-5212	Plate	1
	6V-0014	Hydraulic Cylinder	1
	9U-6810	Nut	1
	124-4641	Sleeve	1
	124-4638	Plate	1
E	3S-6224	Electric Hydraulic Pump Gp	1

(continued)

(Table 51, contd)

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
	9U-6814	Puller Stud	1
	5P-5212	Plate	1
	6V-0014	Hydraulic Cylinder	1
	9U-6810	Nut	1
	124-4641	Sleeve	1
	124-4639	Plate	1

Start By:

a. Remove the push arm and the blade. Refer to Disassembly and Assembly, “Push Arms and Blade - Remove”.

b. Remove the cab. Refer to Disassembly and Assembly, “Cab - Remove”.

c. Remove the center drive shaft. Refer to Disassembly and Assembly, “Drive Shaft (Center) - Remove and Install”.

d. Release the hydraulic system pressure. Refer to Disassembly and Assembly, “System Pressure - Release”.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, PERJ1017, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

At operating temperature, the hydraulic oil tank is hot and under pressure.

Hot oil and components can cause personal injury. Do not allow hot oil or components to contact skin.

Before installation or removal of any hydraulic test equipment, relieve the pressure in the hydraulic tank by slowly loosening the filler cap.

Note: Put identification marks on all lines, on all hoses, on all wires and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This will help to prevent fluid loss and this will help to keep contaminants from entering the system.

1. Drain the hydraulic system into a suitable container for storage or disposal.

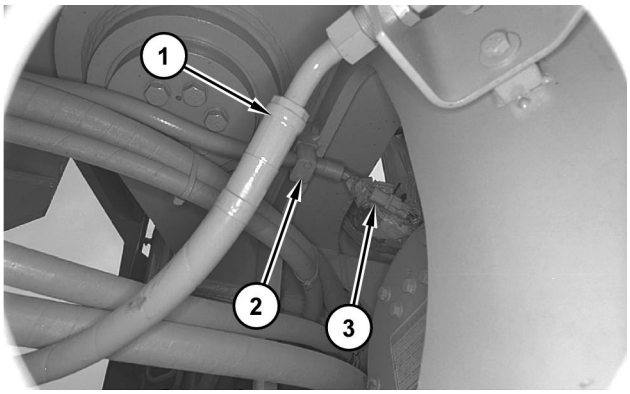


Illustration 987 g01258133

2. Disconnect harness assembly (3) and hose assembly (1). Remove clamp (2).

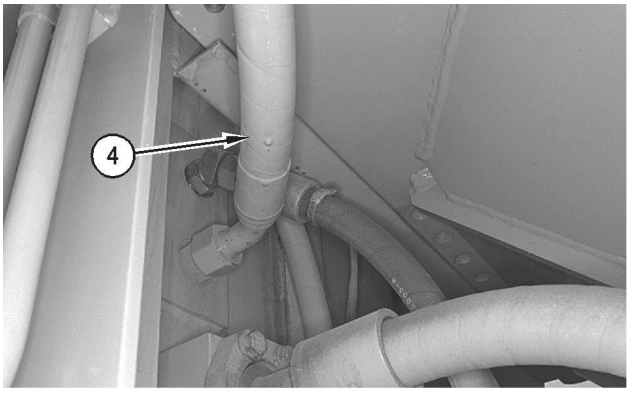


Illustration 988 g00885102

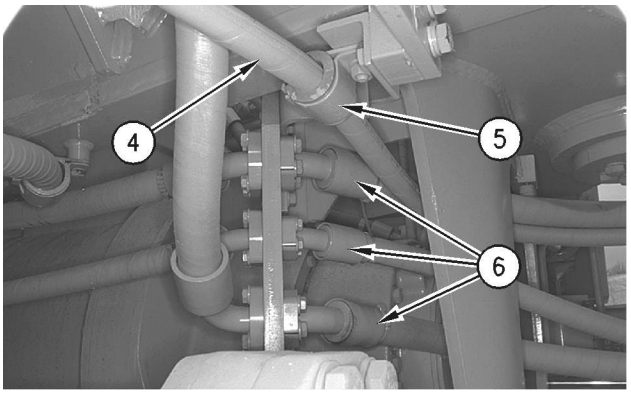


Illustration 989 g00885104

3. Disconnect hose assembly (4) from the implement and the brake hydraulic tank.

4. Remove clamp (5) and disconnect hose assemblies (6).

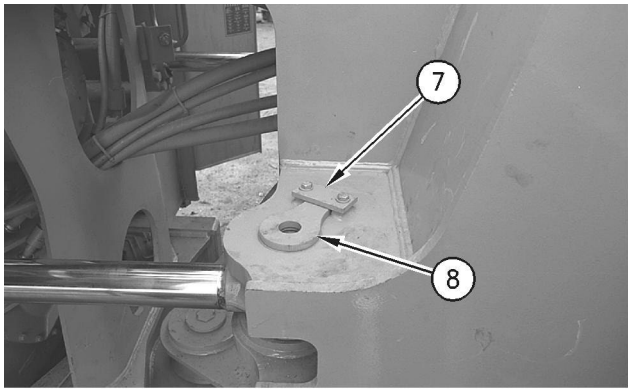


Illustration 990 g00885105

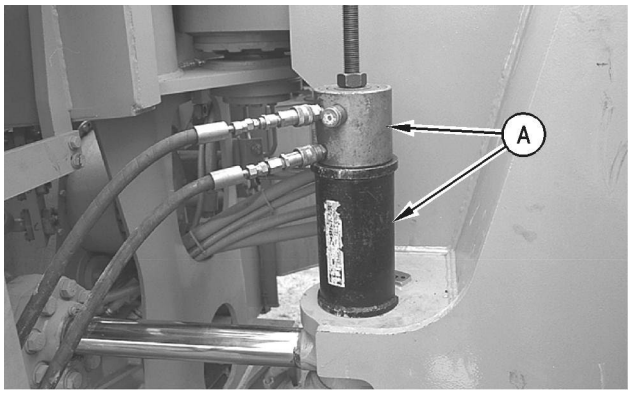


Illustration 991 g00885107

5. Remove retainer (7).

6. Use Tooling (A) in order to remove pin assembly (8). Repeat this Step for the other steering cylinder.



Illustration 992 g00885108

7. Position Tooling (B) and suitable cribbing under the rear frame, as shown.



Illustration 993 g00885109

8. Attach a suitable lifting device to the front frame, as shown. The weight of the front frame at the lifting point is approximately 10000 kg (22000 lb).

9. Position suitable cribbing under the front frame, as shown.

10. Secure a suitable fork lift to the front frame, as shown.

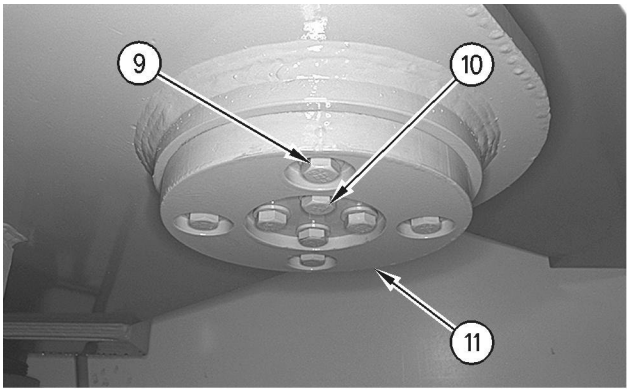


Illustration 994 g00885111

11. Remove bolts (9), bolts (10), and plate (11) from the bottom of the lower hitch.

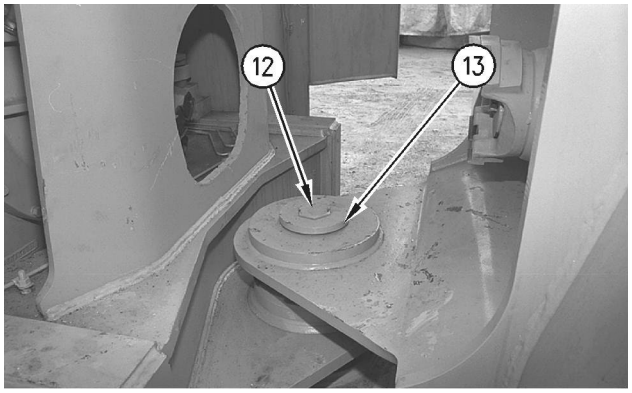


Illustration 995 g00885114

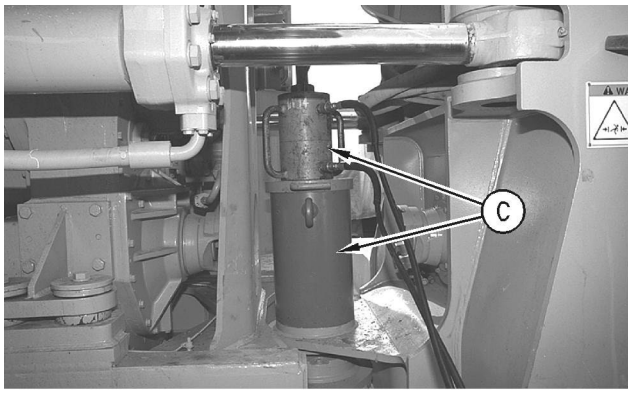


Illustration 996 g00885115

12. Remove cap (12) from pin assembly (13).

13. Use Tooling (C) in order to remove pin assembly (13). The weight of pin assembly (13) is approximately 43 kg (95 lb).

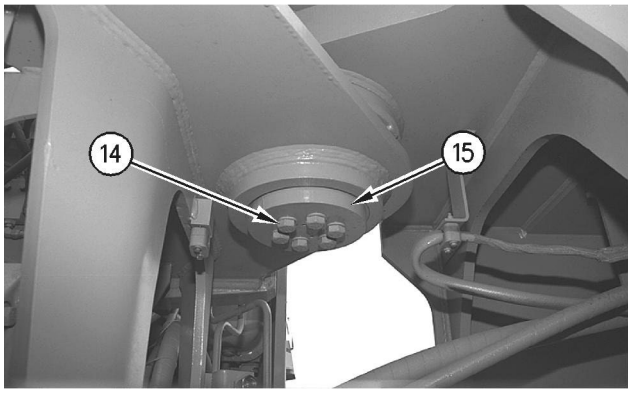


Illustration 997 g00885116

14. Remove bolts (14), plate (15), and the shims from the bottom of the upper hitch.

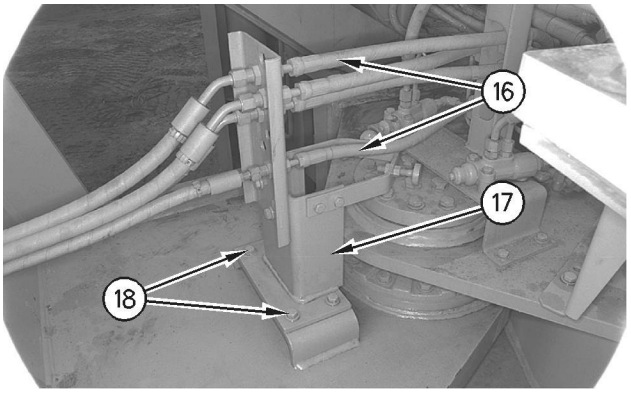


Illustration 998 g00885117

15. Disconnect hose assemblies (16).

16. Remove bolts (18) and reposition bracket assembly (17) to the side.

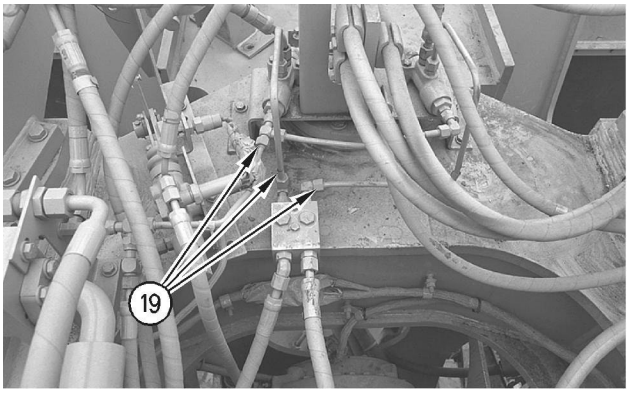


Illustration 999 g00885118

17. Disconnect tube assemblies (19).

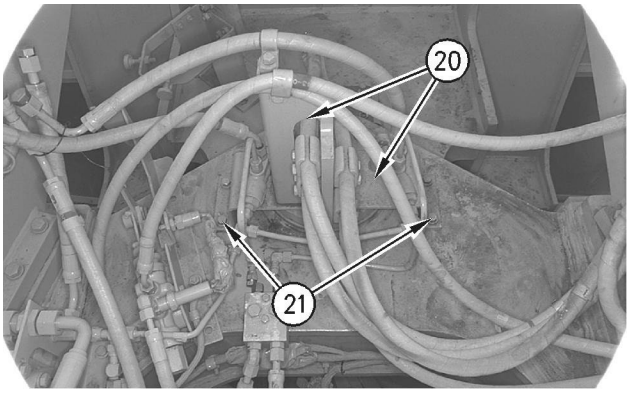


Illustration 1000 g00885119

18. Remove bolts (21) and position the bracket and neutralizing valve (20) to the side.

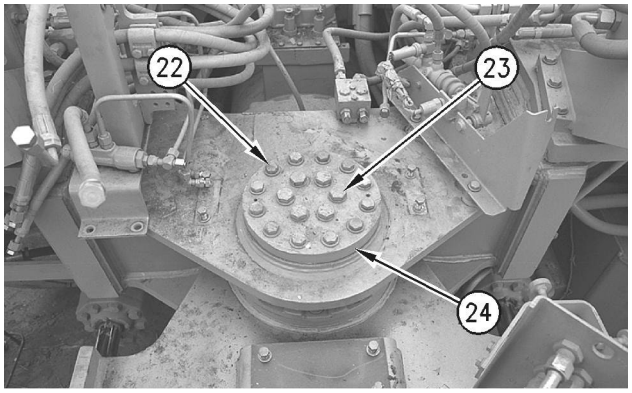


Illustration 1001 g00885120

19. Remove bolts (22), bolts (23), and plate (24).

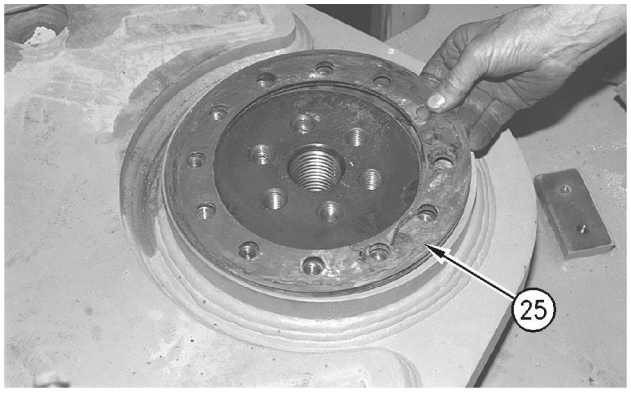


Illustration 1002 g00885121

20. Remove shims (25).

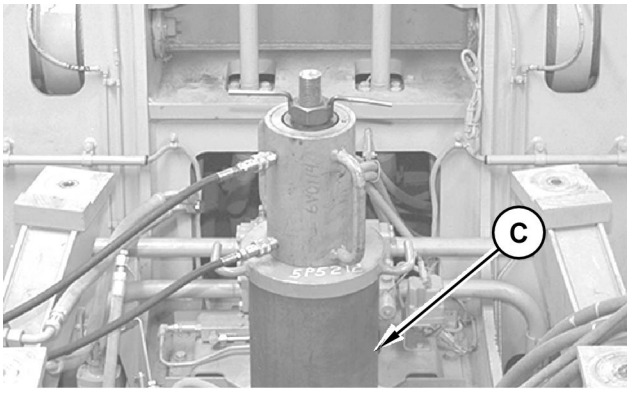


Illustration 1003 g01258140

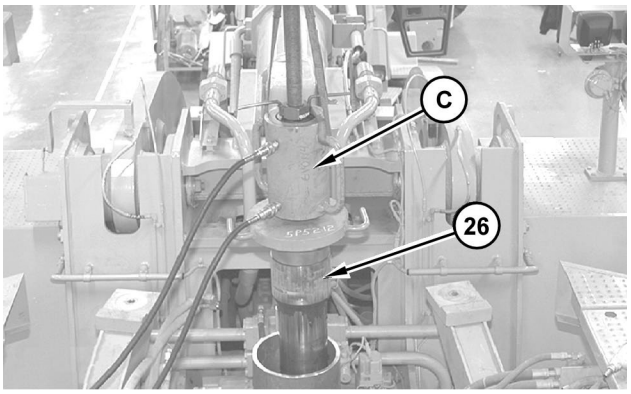


Illustration 1004 g01258142

21. Use Tooling (C) and a suitable lifting device to remove pin assembly (26). The combined weight of Tooling (C) and pin assembly (26) is approximately 159 kg (350 lb). The weight of pin assembly (26) without Tooling (C) is approximately 70 kg (155 lb).



Illustration 1005 g00885126

22. Separate steering frame lock link (27).

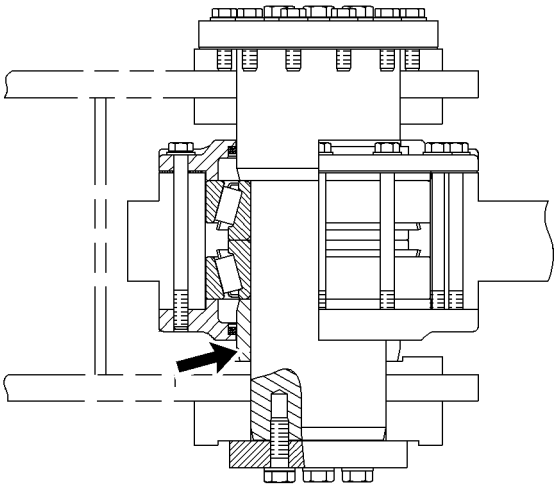


Illustration 1006 g00880020

23. Ensure that the spacer that is located at the bottom of the upper hitch clears the engine end frame at separation.



Illustration 1007 g00885128

24. Use the fork lift to slowly pull the front frame away from the rear frame.

25. Continue to move the front frame until the front frame and the rear frame are separated by a minimum of 610 mm (24 inch).

26. Block the front tires and reposition the suitable cribbing in order to support the front frame.

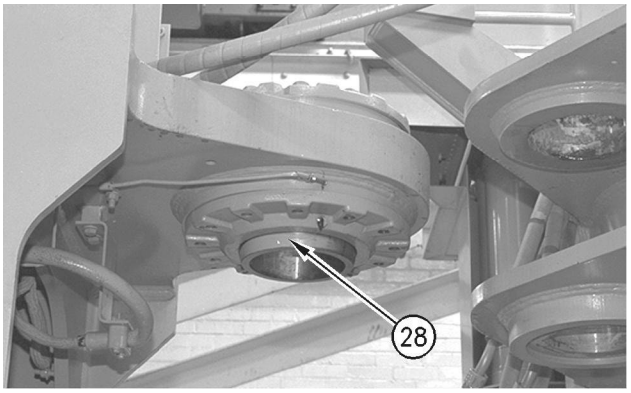


Illustration 1008 g00885129

27. Remove spacer (28) from the upper hitch assembly on the front frame.

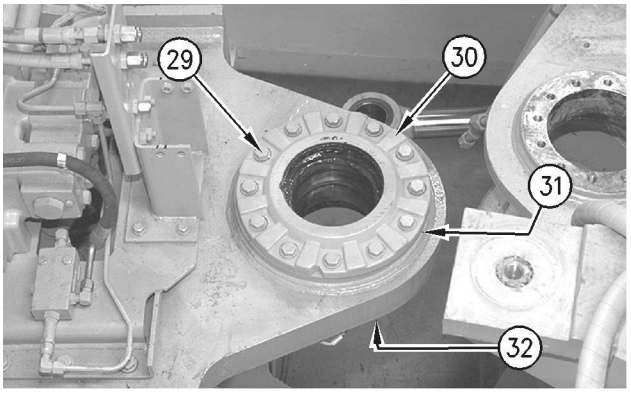


Illustration 1009 g00885130

28. Mark the radial positions of upper cap (34) and lower cap (32).

29. Remove bolts (29), lower cap (32), and upper cap (30).

30. Remove shims (31).

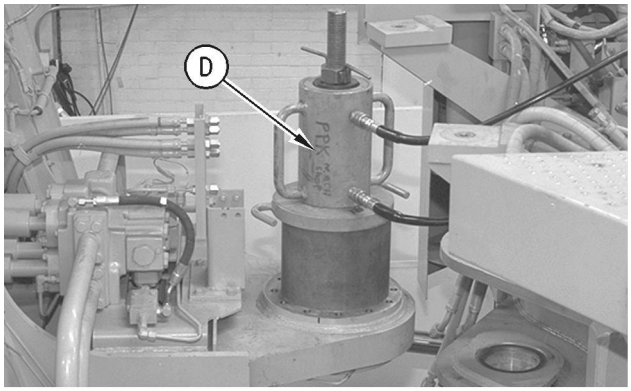


Illustration 1010 g00885131

31. Use Tooling (D) in order to remove the two bearing cups and the cones from the upper hitch.

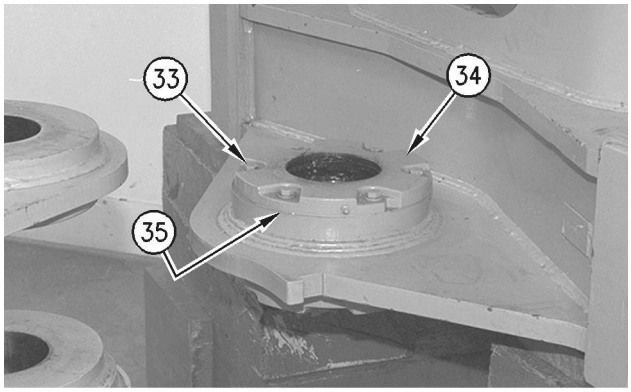


Illustration 1011 g00885132

32. Remove bolts (33) and cap (34) from the lower hitch assembly.

33. Remove shims (35).

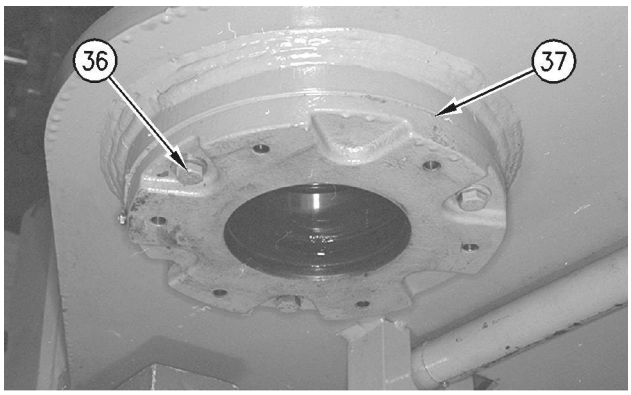


Illustration 1012 g00885133

34. Remove bolts (36) and lower cap (37) from the lower hitch assembly.

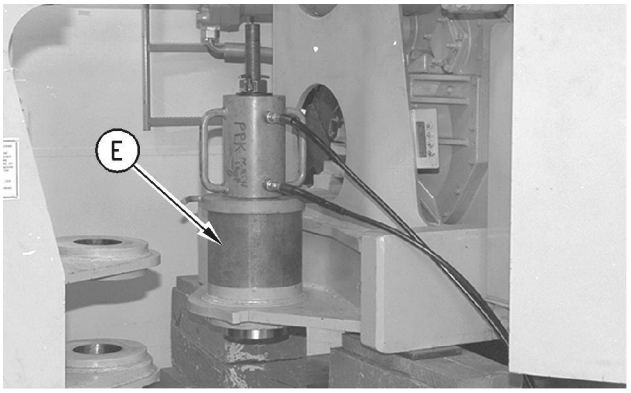


Illustration 1013 g00885134

35. Use Tooling (E) in order to remove the two bearing cups and the cones from the lower hitch.

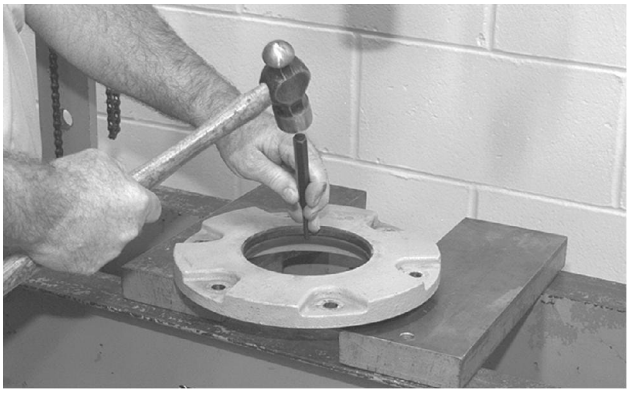


Illustration 1014 g00885135

36. Remove the lip seals from all four of the caps from the upper hitch and the lower hitch.

i07358376

Front Frame to Rear Frame - Connect

SMCS Code: 7051-077

Connection Procedure

Table 52

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0520	Driver Gp	1
B	9U-7536	Lift Stand	2

(continued)

(Table 52, contd)

Required Tools			
Tool	Part Number	Part Description	Qty
	277-7200	Electric Hydraulic Pump Gp	1
C	1D-4572	Bolt	1
	FT-2500	Plate	1
D	1A-7669	Bolt	1
	FT-2499	Plate	1
E	9U-5887	Eyebolt	1
F	9U-7692	Threaded Rod	2
G	6V-2012	Depth Micrometer	1
H	5P-0960	Grease Cartridge	1
J	5P-3931	Anti-Seize Compound	1
K	3E-3880	Eyebolt	2
L	9U-5887	Eyebolt	1

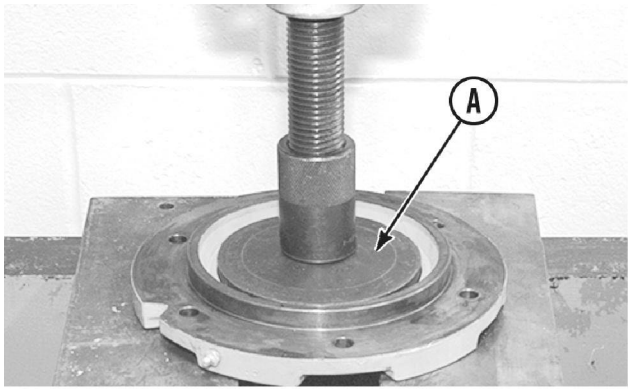


Illustration 1015 g00880855

1. Use Tooling (A) and a suitable press to install the seals into the caps from the upper and the lower hitches.

2. Lubricate the sealing lips with Tooling (H).

3. Coat all of the bores of the front frame with Tooling (J).

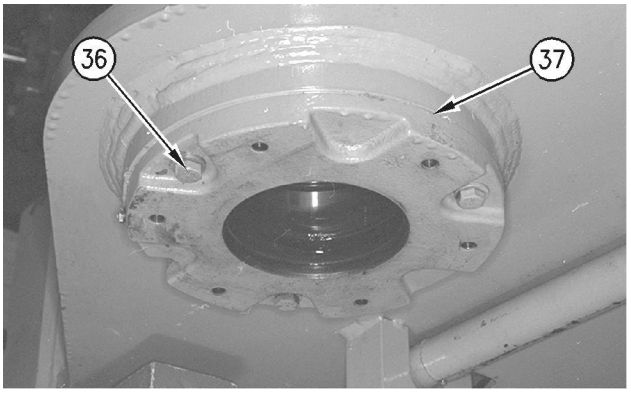


Illustration 1016 g00885133

4. Use three bolts (36) to retain lower cap (37).

5. Tighten bolts (36) to a torque of 100 ± 20 N·m (75 ± 15 lb ft).

6. Lower the temperature of the bearing cup and install the bearing cup in the bore of the lower hitch. Make sure that the bearing cap makes contact with lower cap (37).

7. Lubricate the bearing cones with oil and install the bearing cones into the bearing cup.

8. Lower the temperature of the bearing cup and install the bearing cup in the bearing housing until the bearing cup makes contact with the bearing cones.

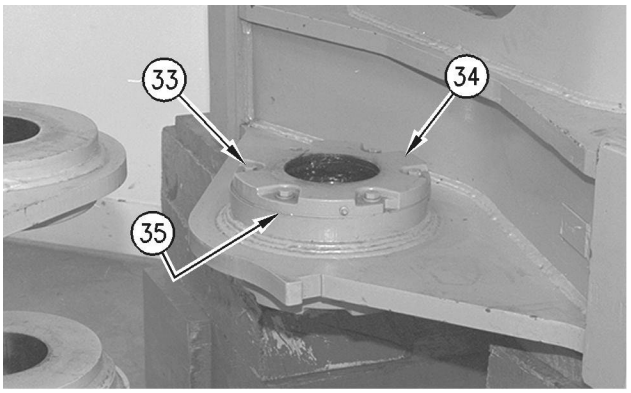


Illustration 1017 g00885132

9. Remove three bolts (33).

10. Install 1.58 mm (0.062 inch) of shim pack (35) under upper cap (34).

11. Secure upper cap (34) and lower cap (37) with three bolts (33) that are spaced at 120 degree intervals.

12. Tighten bolts (33) to a torque of 100 ± 20 N·m (74 ± 15 lb ft).

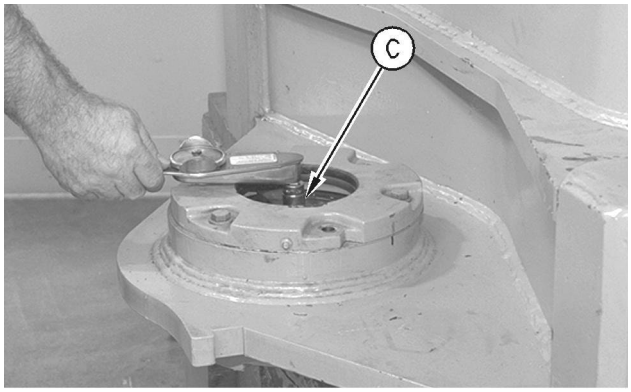


Illustration 1018 g00885355

13. Use Tooling (C) and a torque wrench to determine the rolling torque of the bearing assembly.

14. Add shims or remove shims to obtain a rolling torque between 2.26 N·m (20 lb in) and 7.91 N·m (70 lb in).

15. Install remaining bolts (33). Tighten bolts (33) to a torque of 100 ± 20 N·m (75 ± 15 lb ft).

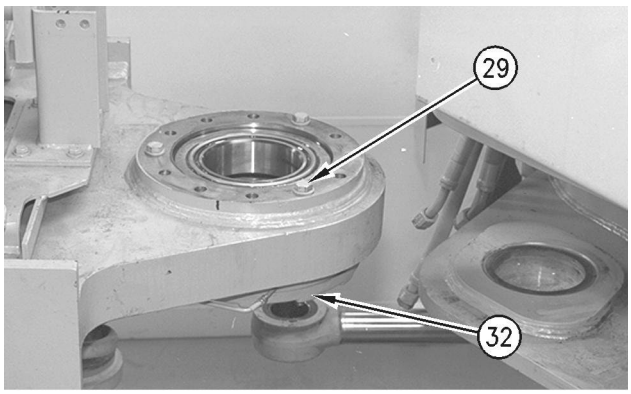


Illustration 1019 g00885360

16. Use three bolts (29) to retain lower cap (32).

17. Lower the temperature of the bearing cup and install the bearing cup in the bore of the lower hitch until the bearing cup makes contact with lower cap (32).

18. Lubricate the bearing cones with oil and install the bearing cones into the bearing cup.

19. Lower the temperature of the bearing cup and install the bearing cup in the bearing housing until the bearing cup makes contact with the bearing cones.

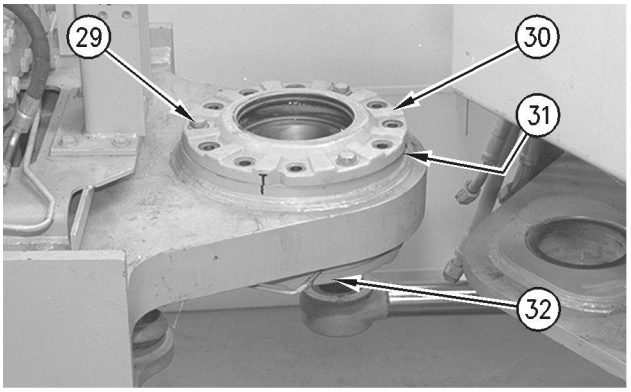


Illustration 1020 g00885361

20. Remove bolts (29).

21. Install 1.85 mm (.073 inch) of shim pack (31) under upper cap (30).

22. Secure upper cap (30) and lower cap (32) with three bolts (29) that are spaced at 120 degree intervals.

23. Tighten bolts (29) to a torque of 300 ± 40 N·m (220 ± 30 lb ft).

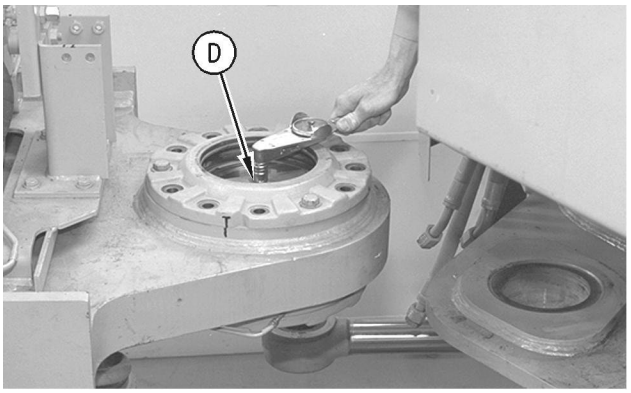


Illustration 1021 g00885368

24. Use Tooling (D) and a torque wrench to determine the rolling torque of the bearing assembly.

25. Add shims or remove shims to obtain a rolling torque between 14.7 N·m (130 lb in) and 32.8 N·m (290 lb in).

26. Install remaining bolts (29). Tighten bolts (29) to a torque of 300 ± 40 N·m (175 ± 30 lb ft).

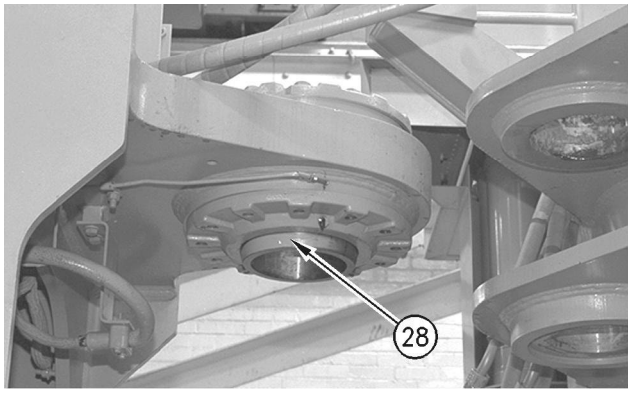


Illustration 1022 g00885377

27. Install spacer (28) into the upper hitch on the front frame.

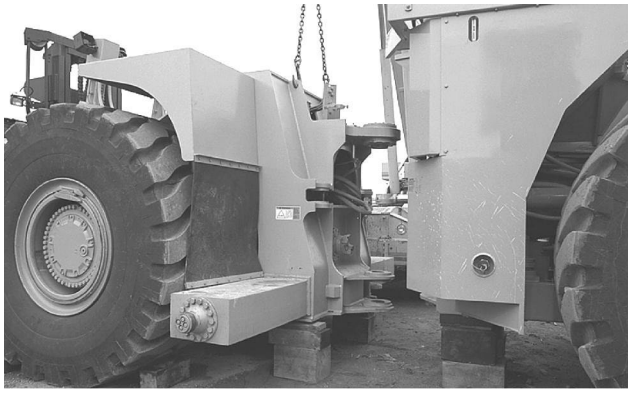


Illustration 1023 g00885379

28. Attach a suitable lifting device to the front frame. The weight of the front frame at the lifting point is approximately 10000 kg (22000 lb) .

29. Raise the front frame to remove the suitable cribbing that was used to support the front frame during the separation procedure.



Illustration 1024 g00885382

30. Use the suitable fork lift to push the front frame toward the rear frame.

Note: Make sure that spacer (28) clears the upper hitch of rear frame.

31. Reposition the suitable blocking under the front frame, as shown.



Illustration 1025 g00885384

32. Use Tooling (B) to make minor adjustments to align the upper and lower hitches.

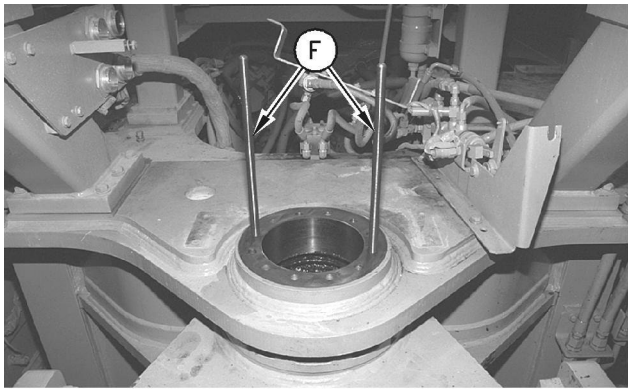


Illustration 1026 g00885385

33. Install Tooling (F).

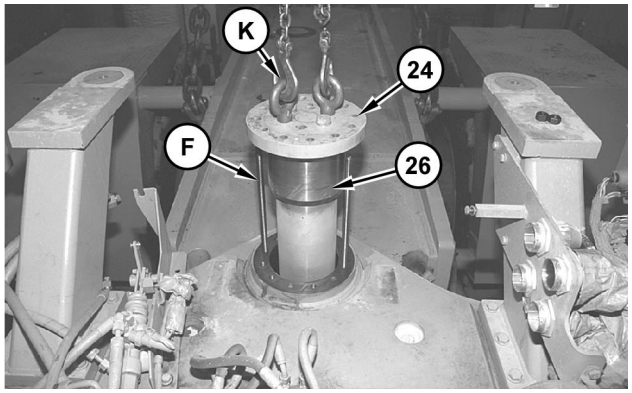


Illustration 1027 g01258181

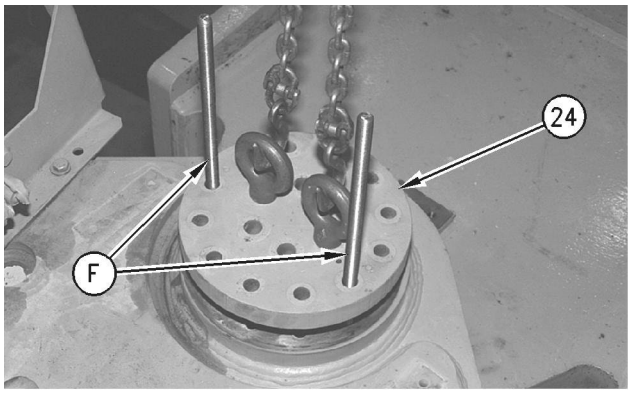


Illustration 1028 g00885388

34. Lower the temperature of pin assembly (26).

35. Attach retainer plate (24) to pin assembly (26) with Tooling (K).

36. Use Tooling (K) and a suitable lifting device to position pin assembly (26) over Tooling (F) and into the pin bore. The weight of pin assembly (26) is approximately 159 kg (350 lb).

Note: Allow pin assembly (26) to warm up for one hour before you adjust the shims.

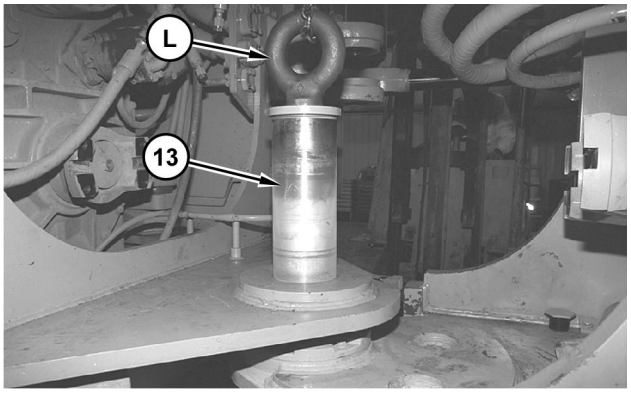


Illustration 1029 g01258183

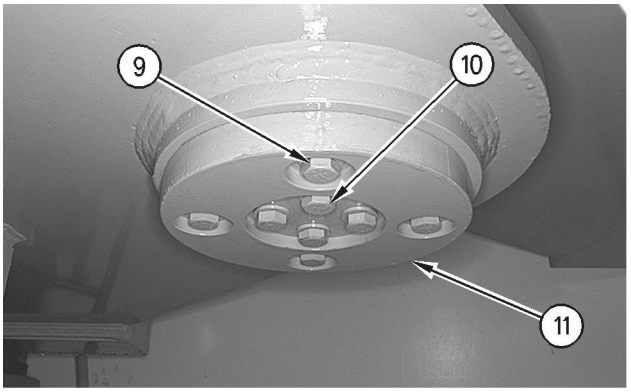


Illustration 1030 g00885406

37. Install lower plate (11) and bolts (9).

38. Lower the temperature of pin assembly (13).

39. Install Tooling (F) into the bottom of pin assembly (13).

40. Use Tooling (L) and a suitable lifting device to install pin assembly (13), be sure that Tooling (F) aligns with the center holes in lower plate (11). The weight of pin assembly (13) is approximately 43 kg (95 lb).

41. Remove Tooling (F) and install bolts (9).

42. Tighten bolts (9) and (10) to a torque of 240 ± 40 N·m (175 ± 30 lb ft).

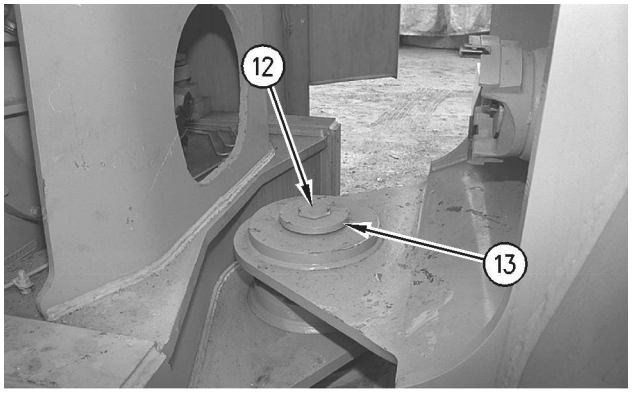


Illustration 1031 g00885409

43. Install cap (12) in pin assembly (13).

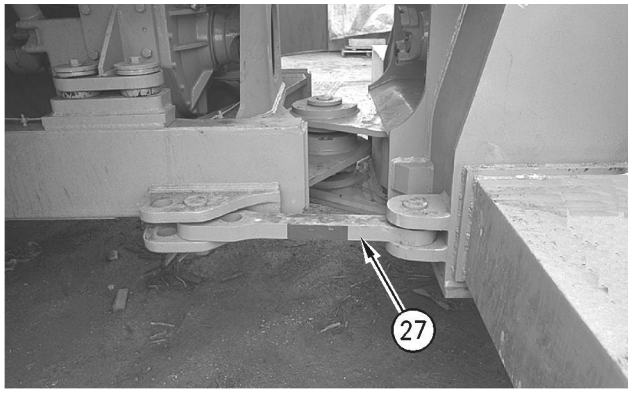


Illustration 1032 g00885413

44. Connect steering frame lock link (27).

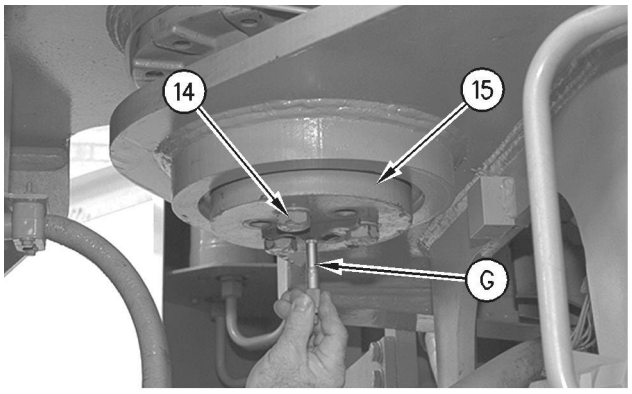


Illustration 1033 g00885416

45. Use three bolts (14) to secure plate (15), as shown.

46. Tighten bolts (14) to a torque of 530 ± 70 N·m (390 ± 52 lb ft).

47. Use Tooling (G) to measure the distance from the bottom surface of plate (15) to the pin. Record this measurement as Dimension (X1). Measure the thickness of plate (15). Record this measurement as Dimension (Y1). Subtract Dimension (Y1) from Dimension (X1) to determine the thickness of the shim pack that is required.

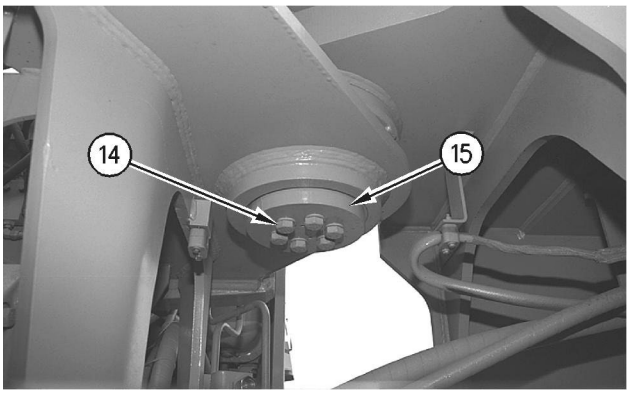


Illustration 1034 g00885116

48. Remove plate (15) and add the correct amount of shims.

49. Install plate (15).

50. Install bolts (14).

51. Tighten bolts (14) to a torque of 530 ± 70 N·m (390 ± 52 lb ft).

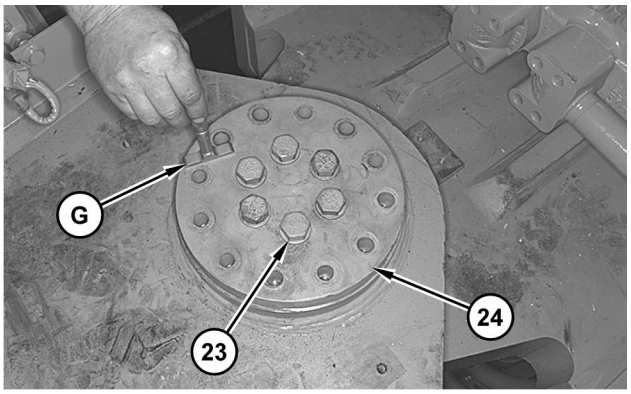


Illustration 1035 g01258187

52. Install plate (24) and bolts (23).

53. Tighten bolts (23) to a torque of 530 ± 70 N·m (390 ± 52 lb ft).

54. Use Tooling (G) to measure the distance from the top of plate (24) to the upper surface of the frame. Record this measurement as Dimension (X2). Measure the thickness of plate (24). Record this measurement as Dimension (Y2). Subtract Dimension (Y2) from Dimension (X2) to determine the thickness of the shim pack that is required.

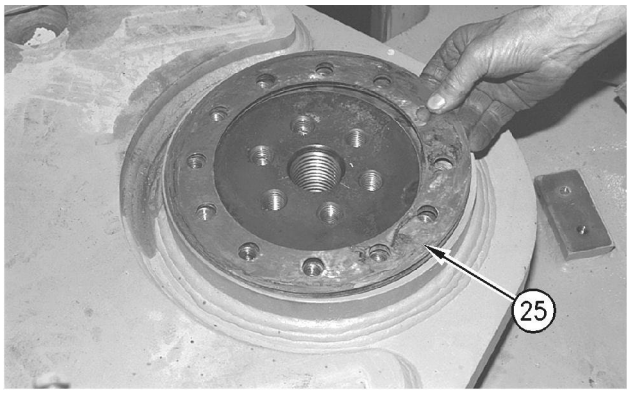


Illustration 1036 g00885121

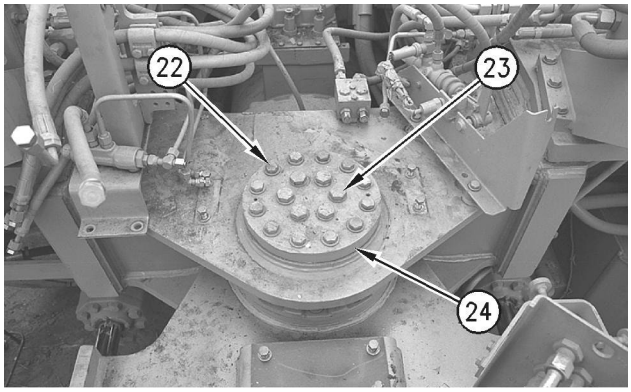


Illustration 1037 g00885120

55. Remove plate (24) and add the correct amount of shims (25).

56. Install plate (24).

57. Install bolts (22) and tighten bolts (22) to a torque of 240 ± 40 N·m (175 ± 30 lb ft).

58. Install bolts (23) and tighten bolts (23) to a torque of 530 ± 70 N·m (390 ± 52 lb ft).

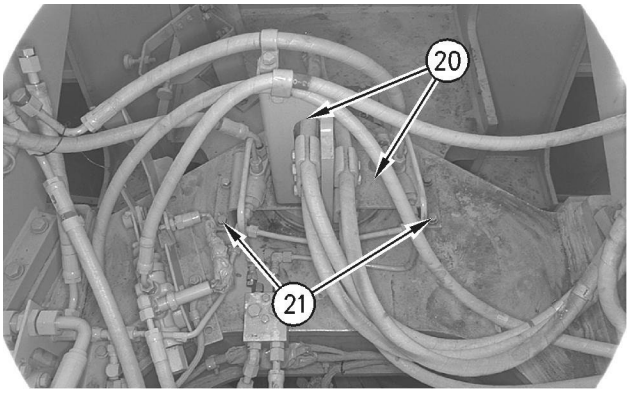


Illustration 1038 g00885119

59. Put the bracket and neutralizing valve assembly (20) in place on the engine end frame.

60. Install bolts (21).

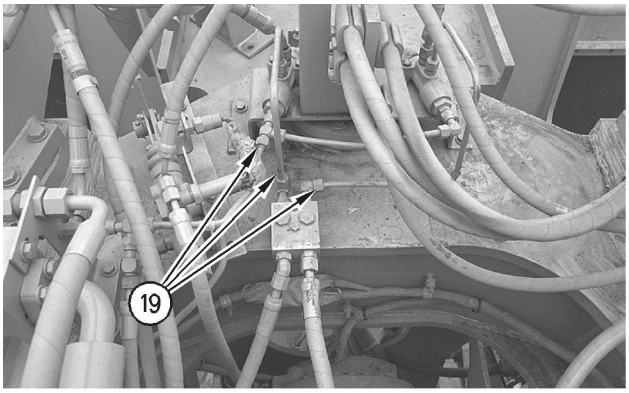


Illustration 1039 g00885118

61. Connect tube assemblies (19).

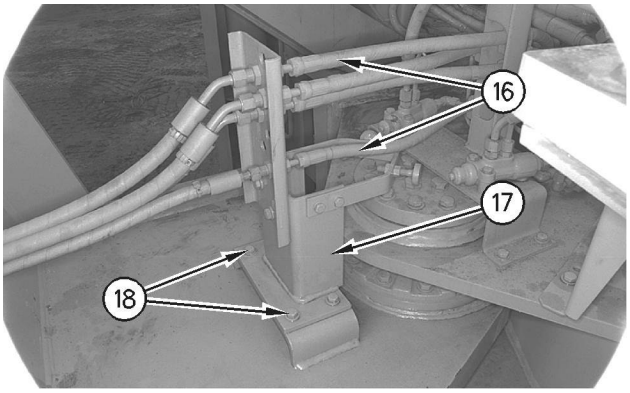


Illustration 1040 g00885117

62. Reposition bracket assembly(17) and install bolts (18).

63. Connect hose assemblies (16).

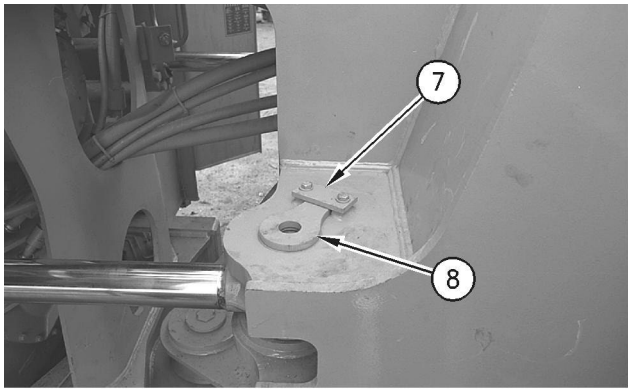


Illustration 1041 g00885105

64. Lubricate pin assembly (8) before installation.

65. Install pin assembly (8) and retainer (7). Repeat this Step for the other steering cylinder.

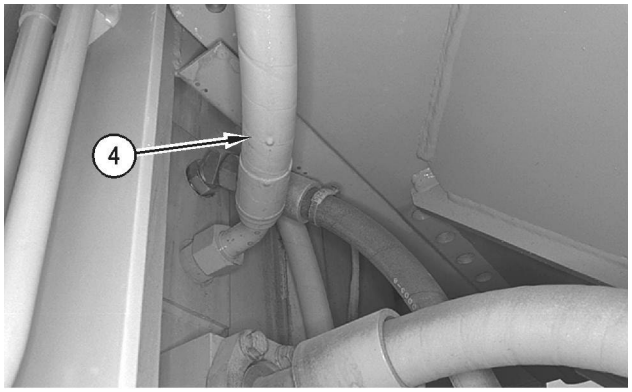


Illustration 1042 g00885102

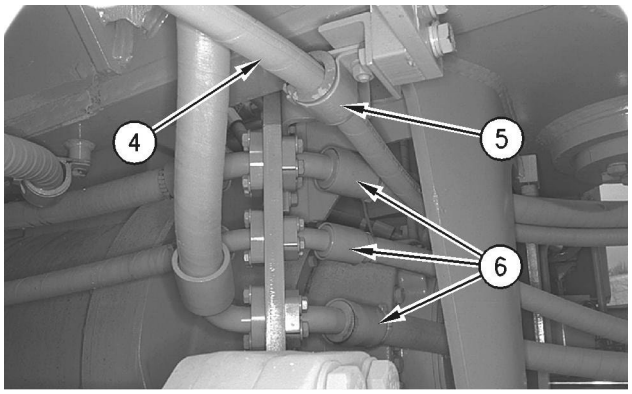


Illustration 1043 g00885104

66. Connect hose assembly (4) to the implement and the brake hydraulic tank.

67. Install clamp (5) and connect hose assemblies (6).

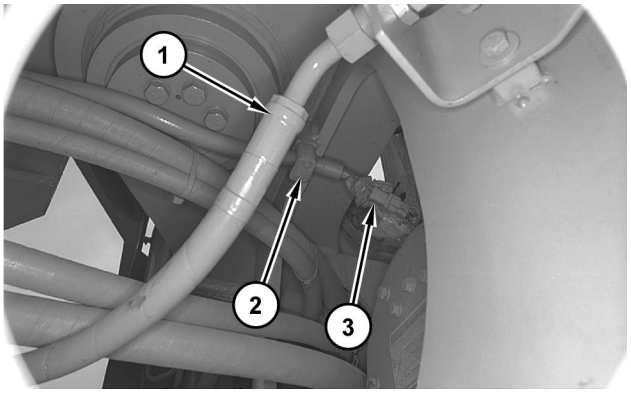


Illustration 1044 g01258133

68. Connect hose assembly (1) and harness assembly (3).

69. Install clamp (2).

70. Fill the hydraulic system with oil. Refer to Operation and Maintenance Manual, “Refill Capacities”.

End By:

a. Install the center drive shaft. Refer to Disassembly and Assembly, “Drive Shaft (Center) - Remove and Install”.

b. Install the cab. Refer to Disassembly and Assembly, “Cab - Install”.

c. Install the push arm and the blade. Refer to Disassembly and Assembly, “Push Arms and Blade - Install”.

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SENR1394-28 (en-us)
August 2020



Systems Operation
Troubleshooting
Testing and Adjusting

Caterpillar Monitoring System

PUBLICATIONS.CAT.COM

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

NOTICE

When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

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General Information

SMCS Code: 7490

Introduction

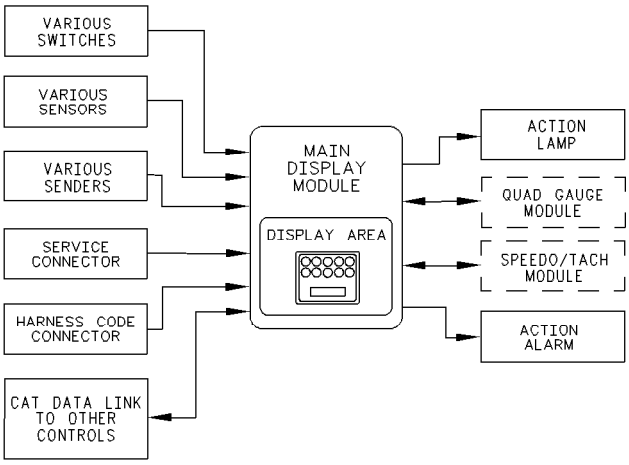


Illustration 1 g00538938

Caterpillar Monitoring System

The quad gauge module and the speedometer/ tachometer module are optional components.

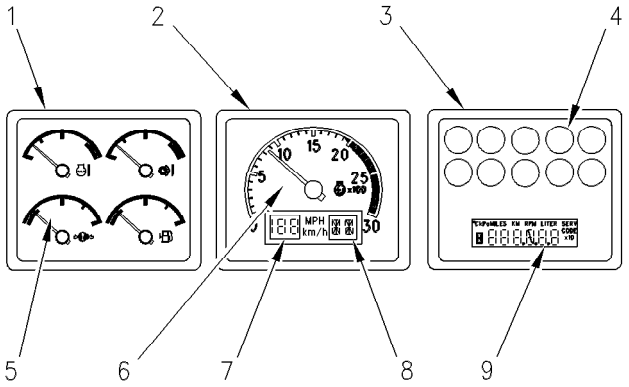


Illustration 2 g00296905

Caterpillar Monitoring System Display Components

(1) Quad gauge module. (2) Speedometer/ tachometer module. (3) Main display module. (4) Alert indicators. (5) Gauges. (6) Tachometer. (7) Speed readout. (8) Transmission gear readout. (9) Display area.

The Caterpillar Monitoring System is an electronic monitoring system that continuously watches machine systems. The system is a flexible modular monitoring system that includes the following devices: a main display module, various switches and sensors, an action lamp and an action alarm. The system may include a speedometer/tachometer module. A different number of quad gauge modules may be included in the system.

The main display module is the brain of the system. This module receives information from the switches, sensors and other electronic controls on the machine via the Cat Data Link. The main display module processes all of the information. The module then activates various outputs. The outputs could be in the display area of the main display module, the quad gauge module, the speedometer/tachometer module, the action lamp, or the action alarm. The display components show the condition of the machine systems. The operator can also obtain system diagnostic information.

The same monitoring system operates on a variety of different machines. All the possible system functions are not performed on every machine. After the main display module has been installed, the module recognizes the machine. The module will perform only the intended functions for that machine. The main display module is required for the monitoring system to operate. The quad gauge module and the speedometer/tachometer module may not be used on some machines. The maximum number of other modules that can be used with the main display module at any one time is four. The modules that can be used are two quad gauge modules and two speedometer/tachometer modules.

Main Display Module

- The ten alert indicators (4) show abnormal conditions in the machine.
- A six digit display area (9) is provided. The display shows the following modes: machine operational hours (service meter), engine speed (tachometer), machine distance (odometer) and diagnostic codes. The information for the speedometer/ tachometer module, and any gauge of the quad gauge module can also be shown as a number on this readout. The display area contains seven unit indicators and a service indicator. The operator selects the information in order to be shown on the display area.
- Seven different unit indicators can be shown in the display area. The unit indicators that can be shown are “°C” , “kPa” , “MILES” , “KM” , “RPM” , “LITERS” and “HOURMETER” symbol. These indicators show the units of measurement for the data on the six digit display area. The indicators are turned ON and OFF in order to correspond with the information on the six digit display area.

- In order to indicate a current fault, a service code indicator is used. The service code indicator is used in service mode and diagnostic scrolling mode.

Speedometer/Tachometer Module

- One tachometer gauge (6) shows the information on the engine speed (RPM).
- One three digit display area (7) shows the information on the ground speed. The speed is displayed in “MPH” and “km/h” .
- Information on the transmission gear and the direction are shown on a two digit gear readout (8).

Quad Gauge Module

- The four gauges (5) show the condition of the machine. The gauges could display oil pressure, fuel level or coolant temperature.

According to the application, the type and the quantity of indicators that are used in the display areas varies. All of the indicators may not be used on all machines. The quantity of quad gauge modules and speedometer/tachometer modules may vary with each machine. An action lamp and an action alarm indicate the severity (warning category) of a problem. To determine the functions that are used on a particular machine, see the corresponding Operation and Maintenance Manual.

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Modes of Operation

SMCS Code: 7490

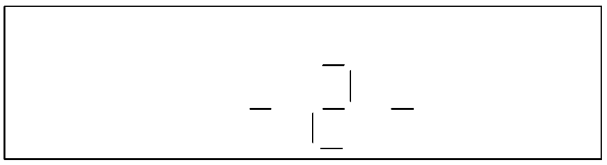


Illustration 3 g01329415

This is a typical example of the Display Area (Mode 2).

The Caterpillar Monitoring System has 13 different possible modes of operation. Five of the modes are operator modes and eight of the modes are service modes. Each mode provides important information regarding the condition of the machine. Each mode also provides information regarding the setup of the monitoring system. All modes are not available on all machines. The system that is installed on the machine determines the modes that are available. All 13 modes are given names and the modes are referenced in this manual. The mode is shown as a number on each display area on the main display module. This number is assigned by the software in the main display module.

The eight service modes can be changed by using the service switch and the clear switch on the main display. Machines that are not equipped with the service switch and the clear switch, the 4C-8195 Control Service Tool can be used in order to change the service modes. The five operator modes are accessible by using the Selector Switch for the operator mode that is located in the operator compartment. The following table shows the available modes. See the Operation and Maintenance Manual of the machine that is being serviced for specific information on the operator mode.

When power is applied, the Caterpillar Monitoring System performs the self test. After the self test is complete the Caterpillar Monitoring System enters the Normal Mode. To enter the other modes, the service and clear inputs are grounded at the same time. This action causes the mode numbers to scroll sequentially on the six-digit display area of the main display module. When ground is removed from the service inputs and the clear inputs, the monitoring system enters the mode which corresponds to the number that is presently shown. The following situation is an example. When you see the mode number “- 1-” on the readout remove the ground. This action causes the monitoring system to enter harness code mode.

Note: The following situation will occur when the key start switch is in the ON position and the service inputs and the clear inputs are grounded. The monitoring system performs the self test when the power is applied. The mode numbers immediately scroll after the self test.

The service inputs and the clear inputs are provided with access by the service connector or the service switch. The service connector or the service switches are located within the operator compartment. Information on the location of the service connector is in the Electrical System Schematic for the machine that is being serviced.

The mode of operation is variable at any time. Grounding the service and clear inputs at the same time initiates the scrolling of the mode numbers. Removing ground causes the monitoring system to enter the operating mode. The mode number that is shown will correspond to the operating mode. When you are scrolling through the modes, mode 0 (normal mode) is not shown on the display area as a number. When you reach mode 0, the display area begins showing the information for mode 0 (normal mode). Some machines show gear display in normal mode. Some machines show the hour meter in normal mode.

Table 1

Operator Modes					
Model	**Service Meter**	**Gear Display**	**Odometer**	**Tachometer**	**Scrolling**
515		0		1	2
525		0		1	2
525B		0		1	2
533	0			1	2
535B		0		1	2
543	0			1	2
545		0		1	2
TK370, TK371	0			1	2
TK380, TK381	0			1	2
814F/F2	0		1	2	3
815F/F2	0		1	2	3
816F/F2	0		1	2	3
824G/H	0		1	2	3
825G/H	0		1	2	3
826G/H	0		1	2	3
834G/H	0		1	2	3
836G/H	0		1	2	3
844	0		1	2	3

(continued)

(Table 1, contd)

Operator Modes					
Model	**Service Meter**	**Gear Display**	**Odometer**	**Tachometer**	**Scrolling**
844H	0		1	2	3
938F		0	1	2	3
IT38F		0	1	2	3
950G	0		1	2	3
960F		0	1	2	3
962G	0		1	2	3
IT62G	0		1	2	3
966G	0		1	2	3
970F		0	1	2	3
972G	0		1	2	3
980G	0		1	2	3
988G/H	0		1	2	3
990	0		1	2	3
990H	0		1	2	3
R1300G	0		1	2	3
R1600G	0		1	2	3
R1700G	0		1	2	3
R2900G	0		1	2	3
R3000H	0		1	2	3
824GII/H					
825GII/H					
826GII/H					
950FII		0	1	2	3
950GII/H					
962GII/H					
966F II		0	1	2	3
966GII/H					
972GII/H					
980GII/H					

Table 2

Service Modes						
Model	**Operator Mode**	**Harness Code(1)**	**Numeric Readout**	**Service**	**Tattle**	**Dig. Tattle**
515	0	1	2	3	4	
525	0	1	2	3	4	
525B	0	1	2	3	4	
533	0	1	2	3	4	

(continued)

(Table 2, contd)

Service Modes						
Model	**Operator Mode**	**Harness Code(1)**	**Numeric Readout**	**Service**	**Tattle**	**Dig. Tattle**
535B	0	1	2	3	4	
543	0	1	2	3	4	
545	0	1	2	3	4	
TK370, TK371	0	1	2	3	4	
TK380, TK381	0	1	2	3	4	
814F/F2	0	1	2	3		4
815F/F2	0	1	2	3		4
816F/F2	0	1	2	3		4
824G	0	1	2	3	4	
825G	0	1	2	3	4	
826G	0	1	2	3	4	
824G Series II/H	0	1	2	3		4
825G Series II/H	0	1	2	3		4
826G Series II/H	0	1	2	3		4
834G/H	0	1	2	3		4
836G/H	0	1	2	3		4
844	0	1	2	3		4
844H	0	1	2	3		4
938F	0	1	2	3	4	
IT38F	0	1	2	3	4	
950F Series II	0	1	2	3	4	
950GII/H	0	1	2	3		4
950G	0	1	2	3	4	
960F	0	1	2	3	4	
962GII/H	0	1	2	3		4
962G	0	1	2	3	4	
IT62G	0	1	2	3	4	
966F Series II	0	1	2	3	4	
966GII/H	0	1	2	3		4
966G	0	1	2	3	4	
970F	0	1	2	3	4	
972GII/H	0	1	2	3		4
972G	0	1	2	3	4	
980GII/H	0	1	2	3		4
980G	0	1	2	3	4	
988G/H	0	1	2	3		4
990	0	1	2	3		4
990H	0	1	2	3		4

(1) Some codes such as 63 or 64 appear in CAT ET as Hexadecimal Numbers compare codes to the readout of the EMS before servicing the machine.

Table 3

Service Modes						
Model	**Units**	**Setup**	**CAL 1**	**CAL 2**	**CAL 3**	**Test Mode**
515						
525						
525B			5			
533						
535B			5			
543						
545			5			
TK370, TK371						
TK380, TK381						
814F/F2	5	6	7			
815F/F2	5	6	7			
816F/F2	5	6	7			
824G	5		6	7	8	
825G	5		6	7	8	
826G	5		6	7	8	
824G Series II/H	5	6		7		
825G Series II/H	5	6		7		
826G Series II/H	5	6		7		
834G/H	5		6	7	8	
836G/H	5		6	7	8	
844	5			7	6	
844H	5			7	6	
938F	5	6	7			
IT38F	5	6	7			
950F Series II	5					
950GII/H	5		6	7	8	9
950G	5		6	7	8	
960F	5					
962GII/H	5		6	7	8	9
962G	5		6	7	8	
IT62G	5		6	7	8	
966F Series II	5					
966GII/H	5		6	7	8	9
966G	5		6	7	8	
970F	5					
972GII/H	5		6	7	8	9
972G	5		6	7	8	

(continued)

(Table 3, contd)

Service Modes						
Model	**Units**	**Setup**	**CAL 1**	**CAL 2**	**CAL 3**	**Test Mode**
980GII/H	5		6	7	8	9
980G	5		6			
988G/H	5	6		7	8	
990	5			7	6	
990H	5			7	6	

Table 4

Service Modes									
Model	**Operator Mode**	**Harness Code**	**Numeric Readout**	**Service**	**Tattle**	**Units**	**Cal 1**	**Cal 3**	**Maintenance**
R1300G	0	1	2	3	4	5	6		
R1300G Series II	0	1	2	3	4	5	6	8	
R1600G	0	1	2	3	4	5			7
R1700G	0	1	2	3	4	5			7
R1700G **S/N:** SBR	0	1	2	3	4	5	6		7
R2900G	0	1	2	3	4	5	6		7
R3000G	0	1	2	3	4	5	6		7

i02375506

Normal Mode

SMCS Code: 7490

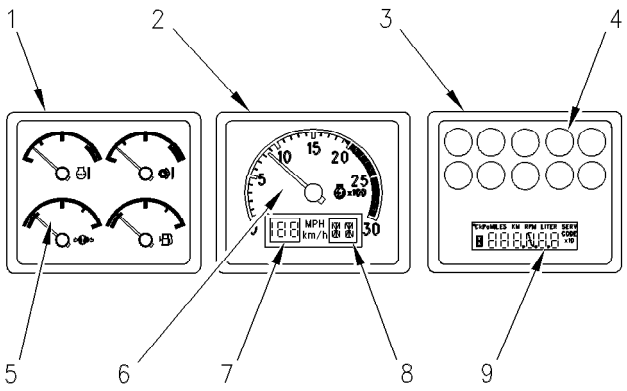


Illustration 4 g00296905

Caterpillar Monitoring System Display Components

(1) Quad gauge module. (2) Speedometer/ tachometer module. (3) Main display module. (4) Alert indicators. (5) Gauges. (6) Tachometer. (7) Ground speed readout. (8) Transmission gear readout. (9) Display area.

Normal mode is used during normal machine operation. When you are in normal mode, the Caterpillar Monitoring System performs the following operations.

- A monitoring system that is operating properly will perform a self test whenever the keyswitch is turned to the ON position. The outputs also operate for a brief instant. See Testing and Adjusting, “System Self Test ”.
- The main display module continuously watches machine systems. If the gauges are available, the gauges in the quad gauge module show a value in a normal range. Ground speed readout (7) is shown as a numeric value and the transmission gear readout (8) on the module shows numeric values. The value for a condition may also be shown in the display area.
- The main display can show a problem with the machine. The main display module continuously monitors machine systems. When an abnormal condition (problem) exists, the corresponding alert indicator (4) FLASHES. As the severity of the problem increases, the action lamp FLASHES and the action alarm SOUNDS. See Systems Operation, “Warning Operation”.

Note: The main display module may notify the operator when a diagnostic code exists in other electronic systems. This is done in different ways. The following example is of a diagnostic code that occurs in the engine electronic system. The service code indicator will show “SERV CODE” and the alert indicator for “check engine” FLASHES. See the Operation And Maintenance Manual for the machine that is being serviced for more specific information on the machine.

Operator Modes

The six digit display area (9) is used to show various conditions of the machine system to the operator (Operator Modes). Operator modes that are available to the operator are dependent to the monitoring system that is installed on the machine. The table above lists the operator modes by the machine.

The default condition is shown on the six digit display area when the main display module enters normal mode. This condition is normally the service meter. See Systems Operation, “Service Meter Mode” for more information.

The six digit display area scrolls through the available operator modes when the operator switch input is grounded. Opening the switch input will stop the scrolling on the currently shown mode. Mode numbers are not displayed when operator modes are scrolling.

See the topic with the corresponding name on the following pages for a more detailed explanation of each mode.

Optional Machine Conditions

The display area may be used to show other information on the condition of the machine. For example, the display area may be used as a gear readout when the speedometer/tachometer module is not used. The following situation occurs in order to function as a gear readout. The six digit display area changes from the default condition to the gear readout when the parking brake is DISENGAGED. The symbol for the service meter turns OFF and the information on the transmission gear is shown on the six digit display area.

The display area may also be used when ether is being injected with a flashing “E” . A flashing “P” in the display area may be used when the engine is being prelubed. The following display modes are also available: the load count, the engine oil pressure and the charge pressure. See the table for the Monitoring System Mode on the Electrical System Schematic in order to determine the mode number for the corresponding machine.

i01144632

Service Meter Mode

SMCS Code: 7490

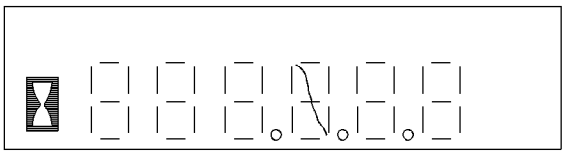


Illustration 5 g00298101

Display Area

The main display module keeps track of the total number of engine hours. The total machine operating hours are shown on the six digit display area when you are in service meter mode. The symbol for the service meter is ON in order to indicate when the display is functioning as a service meter. The value is continuously updated when the engine is operating.

The main display module monitors the following electrical inputs in order to determine when the machine's engine is operating: the engine speed, terminal for alternator “R” and the engine oil pressure. Additional inputs may be used on some machines. The main display module starts the service meter for the machine when one of these inputs is in the normal range.

Gear Display

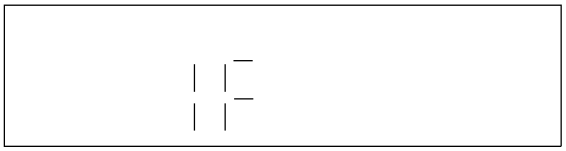


Illustration 6 g00542265

Example Of Display Area

In addition, the gear can be displayed in this mode. When the parking brake is engaged the total machine operating hours are shown on the display. When the machine is not equipped with a speedometer/ tachometer module, the gear can be displayed in this mode. The gear will be displayed when the parking brake is disengaged.

i02280841

Odometer Mode

SMCS Code: 7490

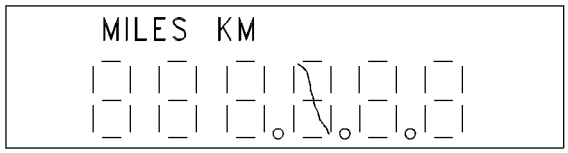


Illustration 7 g00298418

Display Area

The total distance for the machine is displayed on the six digit display area when the main display module is in odometer mode. The indicator for the units shows “MILES” or “KM” . This depends on the setting for units of measure of the main display module. The main display module receives information from the transmission output speed sensor from the transmission electronic control module. This is done by using the Cat Data Link. The unit of measure can be set by using the units mode. See Systems Operation, “Units Mode” for more information.

i02280842

Tachometer Mode

SMCS Code: 7490

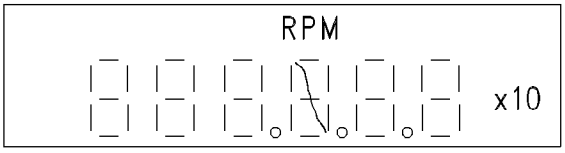


Illustration 8 g00298698

Display Area

The engine RPM is shown on the six digit display area when the main display module is in tachometer mode. The indicator for the units shows “RPM” . The main display module can calculate engine speed with a frequency sensor. The main display module may also receive information from a frequency sensor from another electronic control module. This can be done by way of the Cat Data Link.

i03405100

Scrolling Mode

SMCS Code: 7490

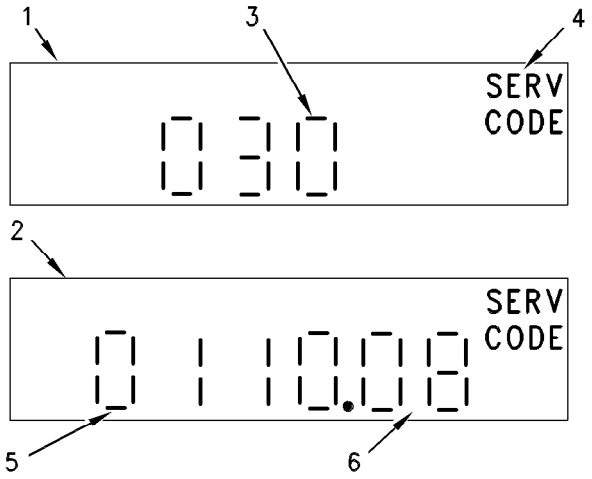


Illustration 9 g00495188

(1) First display. (2) Second display. (3) Module identifier (MID). (4) Service code indicator “SERV CODE” . (5) Component identifier (CID). (6) Failure mode identifier (FMI).

Scrolling mode allows service personnel or an operator to see diagnostic codes that were stored by the main display module. The diagnostic code in this mode can not be cleared. The diagnostic code can also not be placed on hold.

The diagnostic codes momentarily scroll on the display area upon entering the scrolling mode. The MID is shown first as each diagnostic code is shown for about one second. The corresponding CID and the corresponding FMI is shown second for about two seconds. “End” appears when the last diagnostic code has been shown. The diagnostic codes are then shown. The display shows “- - -” when the main display module has no diagnostic codes.

The “SERV CODE” functions as a diagnostic present indicator in scrolling mode. The diagnostic that has caused a diagnostic code to be shown currently is present when “SERV CODE” is ON. “SERV CODE” is OFF when the fault is not present, but the fault has previously occurred.

i05940166

Harness Code Mode

SMCS Code: 7490

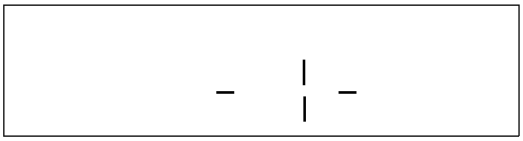


Illustration 10 g00298918

Display area

Harness code mode is mode 1. The machine code is shown on the six-digit display area when the main display module is in harness code mode. The machine code must correspond with the monitoring system that is installed on the machine sales model. See the following table for Machine Codes. The machine code is a two-digit representation of the harness code. An incorrect harness code is one that does not match the machine. Incorrect operation of the monitoring system will be caused by an erroneous harness code. Excessive diagnostic codes could be recorded as a result of this situation.

Table 5

Machine Codes	
Sales Model	**Machine Code**
938F	02
IT38F	03
938F (Fuel Tank)	04
950G (Secondary Steering)	07
962G (Secondary Steering)	08
950G (Secondary Steering Axle Oil Temperature)	13
962G (Secondary Steering Axle Oil Temperature)	14
950G (Secondary Steering)	15
962G (Secondary Steering)	16
IT62G	17
966G (Secondary Steering)	18
972G (Secondary Steering)	19
966G (Secondary Steering Axle Oil Temperature)	20
972G (Secondary Steering Axle Oil Temperature)	21

(continued)

(Table 5, contd)

Machine Codes	
Sales Model	**Machine Code**
950G (1)	28
834G/H	41
834G Scoop	35
834H Scoop	42
R1600G (3) (2)	28
R1700G(2)	29
836G/H	46
962G (1)	29
R1300G	30
966G (1)	30
R2900G (3) (2)	31
972G (1)	31
988G (Logger Standard Transmission)	31
980G (1)	32
IT62G (1)	33
962G (2)	34
IT62G (2)	35
950G	38
950F	39
960F	40
962G	41
966G	42
966F	43
972G	44
970F	45
980G	46
824G/H	34
988G/H	47
988G Bulk handler High Rot	7
988G Bulk handler High Rot. Steel Mill	9
988G High Rot. Short Boom	56
988H 3.88 Boom	15
988H 4.25 Boom	40
988H Block Handler	48
988H Bulk Loader	3
988H Logger CTL (3 valve standard)	54

(continued)

(Table 5, contd)

Machine Codes	
Sales Model	**Machine Code**
825G (3)	72
825H (3)	73
826G/H	36
980G (Water/Glycol)(4)	50
525 **S/N:** 1DN1–374	51
988G (Short Boom Bucket)	55
988G (Standard Lift)	47
988G Steel Mill (PSC)	36
814F	54
814F2 (3)	65
815F	57
815F2	66
816F	58
816F2 (3)	67
814F Emissions Update	53
815F Emissions Update	55
816F Emissions Update	56
545	58
988G (Logger Block Handler Transmission)	59
515 and 525 **S/N:** 1DN375–UP	60
988G (Block Handler Transmission)	61
525B	61
535B	62
824G Series II/824H (3)	63
825G Series II/825H (3)	63
826G Series II/826H (3)	63
533 (3)	63
543 (3)	63
TK370, TK371 (3)	63
TK380, TK381 (3)	63
950GSeries II/H (3)	63
962GSeries II/H (3)	63
966GSeries II/H (3)	63

(continued)

(Table 5, contd)

Machine Codes	
Sales Model	**Machine Code**
972GSeries II/H (3)	63
990 (3)	80
844 (3)	81
990H (3)	82
844H (3)	83
980G/H Series II(3)	99

(1) Machines that are equipped with the Integrated Brake Control System
(2) Machines that are equipped with Dual Horsepower
(3) A physical harness code plug is not present. Uses a “soft” harness code embedded in software.
(4) Special Custom Applications

i01121863

Numeric Readout Mode

SMCS Code: 7490

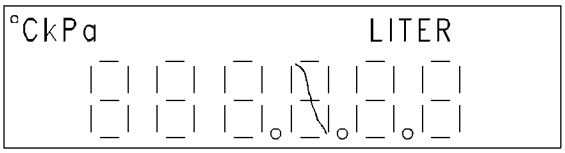


Illustration 11 g00299479

Display Area

Numeric readout mode is always mode 2. Numeric readout mode assists the service personnel with the troubleshooting of the sensor inputs. The inputs supply information for the gauges in the quad gauge modules. Numeric readout mode more accurately shows the same information that is shown on the gauges in normal mode. The system identifier and numeric value for the system scrolls on the six digit display area. The system identifier identifies the system that is currently shown on the six digit display area. See table 6 for “System Identification” and illustration 12 in order to match the system identifier to the appropriate gauge.

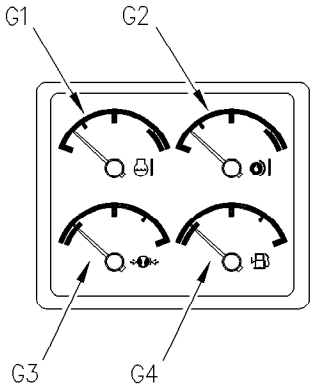


Illustration 12 g00537627

Quad gauge modules

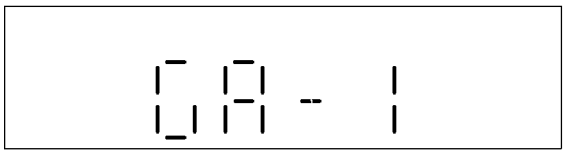


Illustration 13 g00299481

This is an illustration of the display area on the Main Display Module that is showing an example of a system identifier.

Table 6

System Identification	
System Identifier	**Gauge (System)**
GA-1	1
GA-2	2
GA-3	3
GA-4	4

Table 7

Units	
Condition	**Units of Measurement**
Temperature	°C
Pressure	kPa
Voltage	0.1 volts
Level	% full

In addition to the table and the illustration, only the gauge for the system that is shown on the six digit display area is operational. All other gauges in the quad gauge modules are shut off. The gauge needles will move to the far left position.

When you enter the numeric readout mode, the six digit display area is showing information for system GA-1. The display momentarily shows the system identifier. The display then shows the value for the corresponding system on the six digit display area. Grounding the service input causes all the systems to scroll on the display. This will show the system identifiers. Removing ground from the service input stops the scrolling, when the desired system is shown. The six digit display area continues to show the system identifier momentarily. The six digit display area then shows the value of the system. The system is now shown on hold. While the system is on hold, the numeric value of the system is continuously updated.

i08106563

Service Mode

SMCS Code: 7490

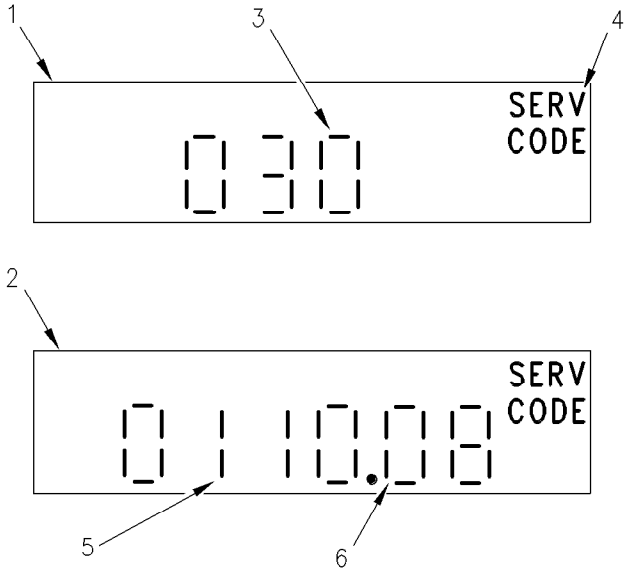


Illustration 14 g00427558

Diagnostic Example

(1) First display. (2) Second display. (3) Module identifier (MID). (4) Service code indicator (SERV CODE). (5) Component identifier (CID). (6) Failure Mode identifier (FMI).

Service mode is mode 3 on all machines except shovels. The service mode for shovels is mode 2. The main display module detects faults that occur with sensor inputs, sender inputs, and main display module outputs while the main display module is in normal mode. The signal is at the contact of the main display module. A diagnostic code is detected when the signal is outside a valid range. The main display module then records the diagnostic code. The diagnostic code remains stored for future reference when the CID FMI is not present.

The main display module detects diagnostic codes and the main display module diagnoses problems in the following circuits:

- Display output modules
- Action alarm output
- Action lamp output
- Sensor inputs
- Harness code

Note: The main display module does not detect a diagnostic code for the switch inputs.

Service personnel can see the diagnostic codes and service personnel can troubleshoot the diagnostic codes when the main display module has detected a CID FMI. All detected problems are shown in the display area as a diagnostic code. The diagnostic codes can be placed on hold and the diagnostic codes can be cleared while the main display module is in service mode.

Note: Diagnostic codes from other machine systems under electronic control are shown in the display area of the main display module when the main display module is in Service Mode. The Cat Data Link allows the transfer of diagnostic information from other electronic control modules to the main display module. This diagnostic information is then shown when the main display module is in service mode. The diagnostic code for faults from other electronic control modules has a MID that is unique to the control. These diagnostic codes can scroll similarly to the diagnostic codes from the Caterpillar Monitoring System. See the following description of Module Identifier (MID).

The diagnostics of the Caterpillar Monitoring System are available to assist with the troubleshooting of diagnostic codes when the main display module is placed in service mode. A diagnostic code is used to specify each CID FMI. The diagnostic code is made up of three identifiers (MID, CID and FMI). These identifiers are shown in the display area. The display area continuously changes between the following identifiers when the diagnostic code is on hold:

Module Identifier (MID) – The MID is a three-digit code that is shown on the display area. The MID is shown for approximately one second before the diagnostic code that is shown in the same area. The electronic control module that has diagnosed the problem is logged by the MID. The following examples are of some MID.

Caterpillar Monitoring System 030
Engine Control (ADEM) 036
Hydrostatic Electronic Control System 079
Machine Control System. 039

See the table for the Module Identifier (MID) on the Electrical System Schematic for the machine that is being serviced for the most complete list. To troubleshoot diagnostic codes, use the service manual for the control that detected the CID FMI.

Component Identifier (CID) – The components that are faulty are noted by the CID. These components are examples: transmission oil temperature sensor, speed sensor, action lamp and boost pressure sensor. The CID is a four digit code that is shown on the six digit display area. The CID and the FMI are shown together after the MID has been displayed. See the table for “Diagnostic Codes For The Caterpillar Monitoring System” in the Troubleshooting, “Diagnostic Code List”. This will show a list of component identifiers for the main display module.

Failure Mode Identifier (FMI) – The FMI tells the type of failure that has occurred. The following situations are examples: voltage above normal, current below normal and abnormal frequency. The FMI is a two digit code that is shown on the six digit display area. The CID and the FMI are shown after the MID is displayed. The CID and the FMI are separated by a decimal point “.” . See the table for “Detected Faults” in Troubleshooting, “Diagnostic Code List”. This table will show a list of failure mode identifiers for the main display module.

When the main display module enters the service mode, the MID, the CID, and the FMI are shown. At this time, the diagnostic code that is shown is on hold. The display area continuously changes between the following identifiers when the diagnostic code is on hold: MID, CID and FMI. This is maintained as long as the service and clear inputs remain open. Troubleshooting is performed while the diagnostic code is on hold.

Note: The display shows “- - -” when the main display module has no diagnostic codes.

All diagnostic codes are shown one at a time in the display area when the diagnostic codes are scrolling. Grounding the service input causes the display to scroll when the main display module is in service mode. This will momentarily show the MID. The display will show the CID and the FMI that corresponds. Removing ground from the service input stops the scrolling when the diagnostic code that is desired is shown. The diagnostic code that is shown is now on hold.

Note: The diagnostic codes from other electronic control modules can be shown on the display. Use the same procedure in order to place the diagnostic codes on hold.

Troubleshooting Intermittent Diagnostic Codes

Diagnostics are provided in order to assist service personnel during troubleshooting of intermittent problems. The service code indicator (SERV CODE) is shown when the diagnostic code is present. This can aid in troubleshooting of an intermittent CID FMI. Gently shaking the harness connectors will aid the checking of intermittent diagnostic codes. The service code indicator changes from “SERV CODE” that is OFF to “SERV CODE” that is ON. This will occur when the CID FMI changes status. The action alarm SOUNDS briefly during the change of status when the diagnostic code is on hold for a CID FMI. These diagnostics signal the service personnel while inspections are performed. These diagnostics assist in troubleshooting intermittent problems by one service person.

A diagnostic code is removed from the memory of the main display module when the diagnostic code has been cleared. When a CID FMI is corrected, it is necessary to remove the corresponding diagnostic code from the memory of the main display module. In order to remove the diagnostic code from the memory, place the diagnostic code on hold and ground the clear input. The memory of the main display module saves a diagnostic code until the code is cleared. The main display module does not allow clearing of a diagnostic code that corresponds to a CID FMI which is present.

Note: The diagnostic codes from other electronic control modules can be cleared by using the main display module.

Note: Cat ® Electronic Technician (Cat ® ET) service tool. can also be used to clear events.

Machines that are not equipped with the service switch and the clear switch, the 4C-8195 Control Service Tool can be used to change the service modes.

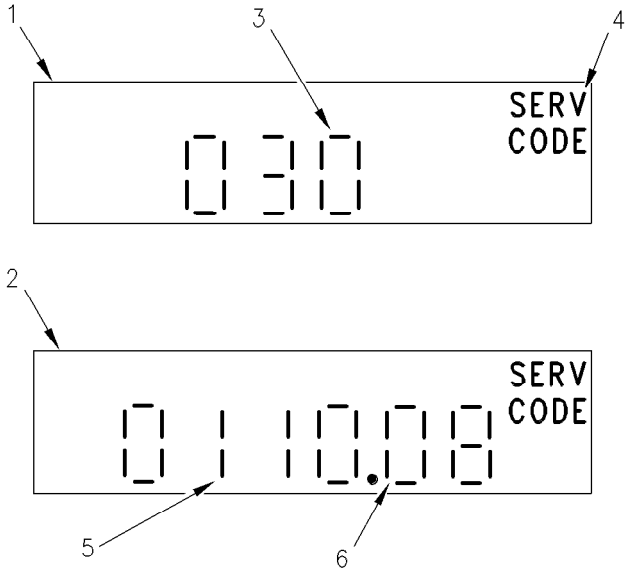


Illustration 15 g00427558

Diagnostic Example

(1) First display. (2) Second display. (3) Module identifier (MID). (4) Service code indicator (SERV CODE). (5) Component identifier (CID). (6) Failure Mode identifier (FMI).

Note: Illustration 15 shows the display from current production machines. The CID is now displayed as four digits. A decimal point “.” has replaced the “F” in the display. The “F” was used to separate the CID from the FMI. An example of the display is shown in illustration 16 .

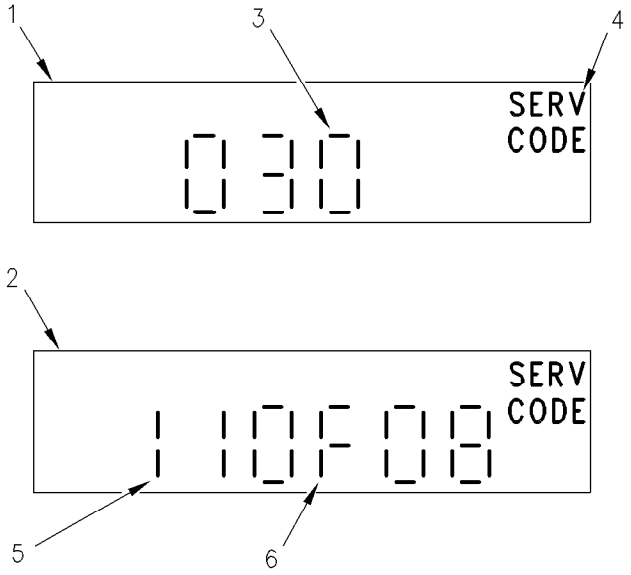


Illustration 16 g00300658

Diagnostic Example

(1) First display. (2) Second display. (3) Module identifier (MID). (4) Service code indicator (SERV CODE). (5) Component identifier (CID). (6) Failure mode identifier (FMI).

Brief Explanation

Illustration 15 shows a main display module that is currently receiving a signal. This signal is from the transmission oil temperature sensor and the signal is out of range.

Detailed Explanation

MID (3) – “030” . This code concerns the Caterpillar Monitoring System. The Caterpillar Monitoring System service manual should be used to troubleshoot the diagnostic code. If the MID that was shown was “081” , the diagnostic code would concern the power train electronic control. The service module for the power train electronic control should be used to troubleshoot the diagnostic code.

CID (5) – “0110” . This code means that a problem has occurred in the sensor circuit for the engine coolant temperature of MID “030” . See the table “Diagnostic Codes For Caterpillar Monitoring System” in Troubleshooting, “Diagnostic Code List”. This will show a list of the component identifiers for the Caterpillar Monitoring System.

FMI (6) – “08” . This identifier means that a signal of abnormal frequency, pulse width or period is being received concerning CID “0110” . See the table “Diagnostic Codes For Caterpillar Monitoring System” in Troubleshooting, “Diagnostic Code List”. This table will show a list of failure mode identifiers for the Caterpillar Monitoring System.

Service code indicator (4) is ON in Illustration 14 . When the main display module is in service mode, the service code indicator (4) functions as a fault present indicator. Therefore, the CID “0110” diagnostic code is present. The service code indicator changes from ON to OFF when the CID “0110” diagnostic code changes status. Also, the action alarm sounds when the CID “0110” diagnostic code changes status. This action will take place while the main display module is in service mode.

i02280849

Tattletale Mode

SMCS Code: 7490

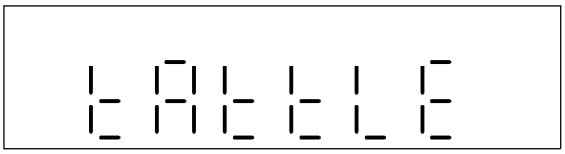


Illustration 17 g00301362

Display Area

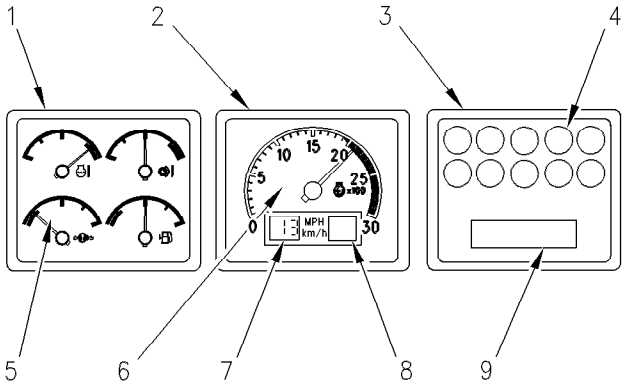


Illustration 18 g00559808

Caterpillar Monitoring System Display Components

(1) Quad gauge module. (2) Speedometer/ tachometer module. (3) Main display module. (4) Alert indicators. (5) Gauges. (6) Tachometer. (7) Speed readout. (8) Transmission gear readout. (9) Display area.

Tattletale Mode is a tool for management and maintenance. The history of the machine can be recorded by this mode. The main display module records the extreme value for each condition of the machine that is monitored. The values come from sensor inputs, switch inputs and the Cat Data Link. The values in tattletale mode are updated whenever a value occurs with more importance than the previous value. These values are ignored for a short period of time after each start-up. This allows the machine systems to stabilize before the recording of information.

Gauges (5) show the highest reading or lowest reading that has been attained by the corresponding machine system. The gauges show the highest reading for systems with increasing abnormal values. The gauges also show the lowest reading for systems with decreasing abnormal values. The gauge alternates between the highest reading and lowest reading. This will occur for the gauges that are double ended.

Tachometer (6) and speed readout (7) show the highest reading that has been obtained.

Alert indicators (4) turn on when an abnormal condition has existed.

Information from the tattletale is retained until the information is cleared. Grounding the clear input erases the information. After clearing, all information is reset to a nominal value and the recording of new extreme values begins.

Note: The date, time or duration of the extreme value that has occurred is not recorded.

Example

This example explains the information that is shown in the illustration for the Tattletale Mode.

- Gauge (5) for the engine coolant temperature has a pointer that indicates a value above the normal temperature range. Therefore, a high abnormal value has existed in this system.
- Gauge (5) for the brake air pressure has a pointer that indicates a value below the normal pressure range. Therefore, a low abnormal value has existed in this system.
- Gauge (5) for the brake oil temperature has a pointer that indicates a value in the normal range. Therefore, no abnormal value has existed in these systems.
- Gauge (5) for the fuel level has a pointer that indicates a level of 50%. Therefore, the lowest amount of fuel that has existed is 50%.
- The pointer on tachometer (6) indicates a maximum value (2100 RPM). Therefore, an engine speed of 2100 rpm has existed.
- Speed readout (7) shows “13 MPH” . Therefore, 13 MPH is the highest ground speed that has been attained.
- Alert indicator (4) is ON. Therefore, an abnormal condition has existed in this system.
- All other alert indicators (4) are OFF. Therefore, no abnormal values have existed in these systems.

Note: No information from the tattletale mode is stored for the highest transmission gear or lowest transmission gear that has been selected.

i01112499

Units Mode

SMCS Code: 7490

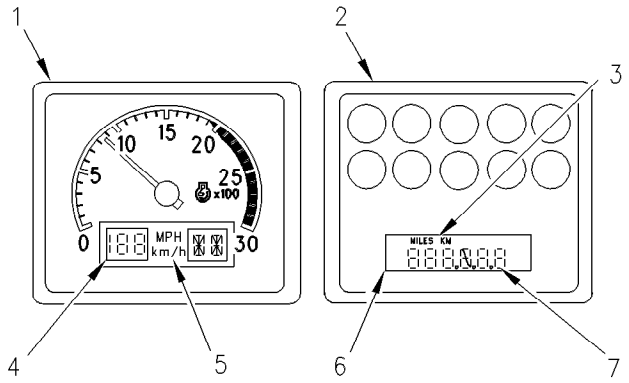


Illustration 19 g00301504

Caterpillar Monitoring System

(1) Speedometer/tachometer module. (2) Main display module. (3) Odometer units. (4) Speed readout. (5) Speedometer units. (6) Display area. (7) Six digit display area.

The units mode is mode 5. The units mode is used to toggle the displays of the monitoring system between US and Metric units of measure. When the main display module enters units mode, six digit display area (7) shows the current setting. The display reads “US” when the mode is set to US units. The display reads “SI” when the mode is set to Metric units.

When the units mode is set to US units, the main display module shows “MILES” on display area (6) when the main display module is in odometer mode. The display for the speedometer/tachometer module shows “MPH” . The display area (6) shows “KM” when the main display module is set to Metric units. The display for the speedometer/tachometer module shows “km/h” .

In order to toggle the units, ground the clear input while the service input is open. The units continuously toggle when the clear input is grounded. Opening both of the inputs will set the main display module to the currently displayed setting.

i01421214

Setup Mode

SMCS Code: 7490

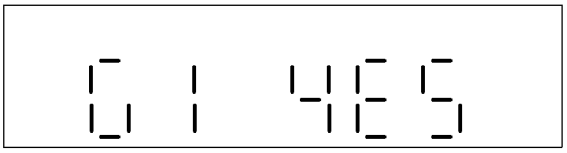


Illustration 20 g00301743

Display Area

Setup mode is used to tell the main display module of changes in display modules. The main display module is initially setup when the module is installed on the machine. In order to be able to communicate with the main display module, the attachment display modules are sensed by the initial setup. A diagnostic code is logged when the main display module can not communicate with a display module. When a new attachment display module is added to the Caterpillar Monitoring System, the main display module needs to be setup in order to communicate with the new module.

When the main display module enters the setup mode, the six digit display area shows an indicator for the module (“G1” , “G2” , “t1” , and “t2”). The display area also shows the state of each module (“YES” or “NO”). The main display module knows the display modules that are standard for the machine. The main display module also knows the modules that can be added to the machine. Only the indicator for the module(s) that may be added is shown. For example, if no gauge modules are standard, the first indicator for the module that is shown is “G1” . The “G1” also indicates that a gauge module may be added. If one gauge module is standard and another gauge module may be added, “G2” is shown. Speedometer/ tachometer modules that may be added are shown in the same manner except with a “t” prefix.

The “G” indicates the quad gauge module. The “t” indicates the speedometer/tachometer module. The “YES” indicates to the main display module, when the corresponding module is connected. The “NO” is shown on the main display module, when the corresponding module is not connected. Grounding the clear input causes the display to toggle between “YES” and “NO” . Opening the clear input stops the display on the current display “YES” or “NO” . When “YES” is selected, the main display module tries to communicate over the display data link with the display module that is indicated. If the display module does not respond, the main display module records a service code. If “NO” is selected, the main display module does not try to communicate with the display module.

i01972380

Calibration Mode

SMCS Code: 7490

Calibration mode is used on some machines in order to perform special functions of calibration. The operation of the calibration mode will vary depending on the machine and the system that is being calibrated. The Service Manual Module for the controls that require the calibration mode should be used to determine the operation.

Calibration mode is mode 6. This mode will allow the transmission pressure sensor input to be overridden. This will allow the brakes to be released when the machine is serviced or repaired.

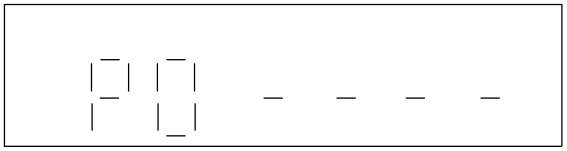


Illustration 21 g00775009

Example Of Display Area

The transmission pressure sensor is not installed.

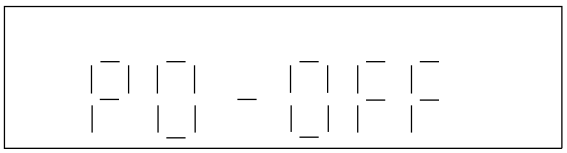


Illustration 22 g00775016

Example Of Display Area

The transmission pressure sensor is not overridden.

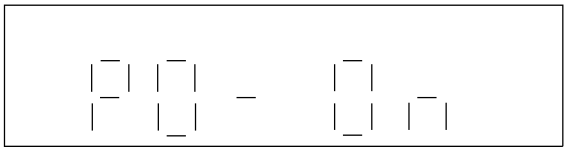


Illustration 23 g00775028

Example Of Display Area

The transmission pressure sensor is overridden.

i01973867

Maintenance Mode

SMCS Code: 7490

The maintenance mode is mode 7. This mode will verify if the maintenance mode alert indicator is on. The maintenance mode will also verify that the maintenance mode alert indicator is off. When the clear switch is pressed, the Caterpillar Monitoring System ECM will instruct the engine ECM to turn off the maintenance alert indicator.

i06181716

Warning Operation

SMCS Code: 7490

Table 8

WARNING OPERATION					
	Warning Indications (1)				
Warning Category	Alert Indicator Flashes (3)	Action Lamp Flashes	Action Alarm Sounds	Required Operator Action	Possible Result (2)
1	X			No immediate action required. The system needs attention soon.	No harmful or damaging effects.
2	X	X		Change machine operation or perform maintenance to the system.	Severe damage to components.
2-S	X	X	X (4)	Immediately change the machine operation.	Severe damage to machine components.
3	X	X	X (5)	None. Engine will immediately perform a safe shutdown.	Operator injury or severe damage to components.

(1) The warning indications which are active, are marked with an “X” .
(2) This is the possible result if no operator action is taken.
(3) At a 10 Hz rate.
(4) The alarm is on continuously.
(5) Pulsating alarm.

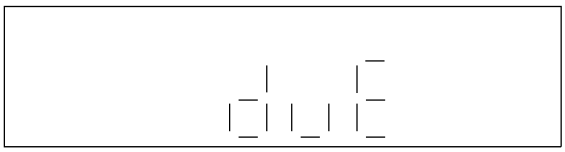


Illustration 24 g00773222

Example Of Display Area

The maintenance mode alert indicator is on.

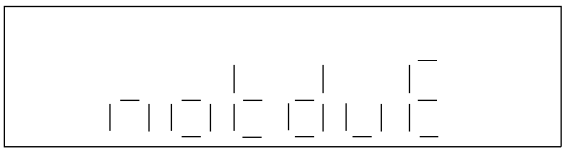


Illustration 25 g00773226

Example Of Display Area

The maintenance mode alert indicator is off.

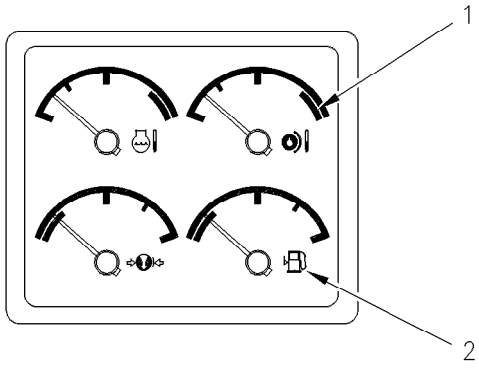


Illustration 26 g00302063

Quad Gauge Module

(1) Gauge warning area.
(2) Pictograph symbol.

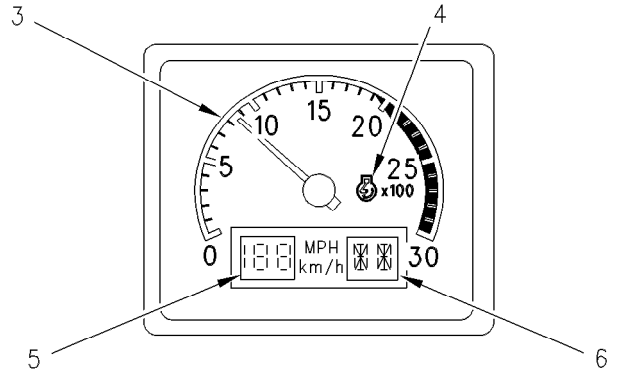


Illustration 27 g00427600

Speedometer/Tachometer Module

(3) Tachometer.
(4) Pictograph symbol.
(5) Ground speed readout.
(6) Transmission gear readout.

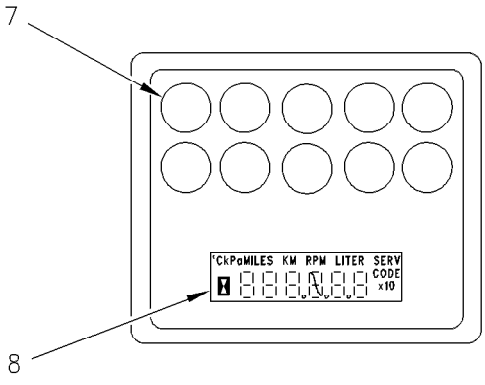


Illustration 28 g00302085

Main Display Module

(7) Alert indicator.
(8) Display area.

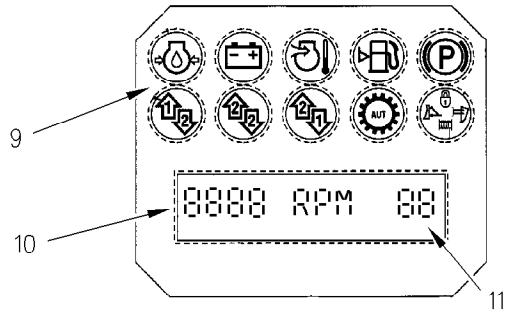


Illustration 29 g00815500

Lamp/Gear Module

(9) Pictograph symbols.
(10) Tachometer.
(11) Transmission gear readout and direction.

The Caterpillar Monitoring System notifies the operator of an immediate problem with a machine system or an impending problem with a machine system. Warning operation begins, when the main display module receives a problem signal. The problem signal reflects an abnormal condition of the machine . Warning operation also begins, when the main display module detects a problem with the control system. Switches, sensors and other electronic control modules on the machine provide signals to the main display module. The problem signals are the following conditions:

- An open switch. When a condition exceeds the trip point of the switch, the switch opens.
- A sensor signal exceeds the limits. The main display module determines the limits.
- Another condition is an abnormal condition that is detected by another electronic control module. The abnormal condition is then communicated over the Cat Data Link to the main display module.

The main display module analyzes the problem signals. In order to notify the operator of a warning, the display components on the main display module activate the appropriate warning indication. The following warning indications will notify the operator:

- The alert indicator FLASHES approximately nine times per second.
- The action lamp FLASHES for one second and the action lamp is OFF for two seconds.
- The action alarm SOUNDS for one second and the action alarm is OFF for two seconds.
- The action alarm SOUNDS continuously when the highest warning level is 2-S.

Note: In order to activate warning indications, more than one input is required. The main display module decides when the warning indications are activated.

Problems from the machine system are classified into three warning categories. The categories are based on the severity of the problem. The categories also dictate the required response of the operator. Warning category 1 represents the least severe problem and warning category 3 represents the most severe problem. The warning categories are identified for the operator according to the combination of warning indications that are active. See the table for Warning Operation.

Note: See the Operation And Maintenance Manual for complete information on the Warning Operation.

i05609344

Alert Indicator Description

SMCS Code: 7490

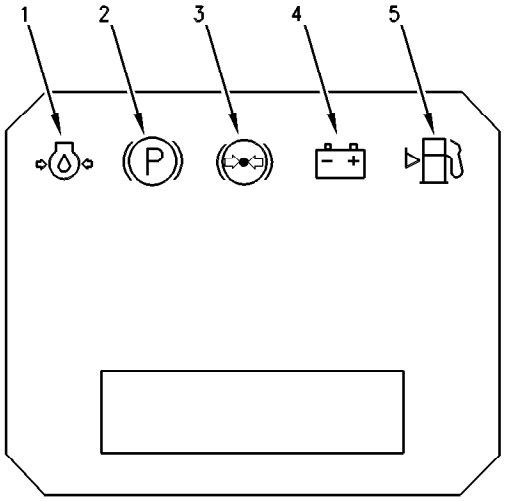


Illustration 30 g00591954

Alert Indicators for 814F, 815F, and 816F

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Fuel Level.

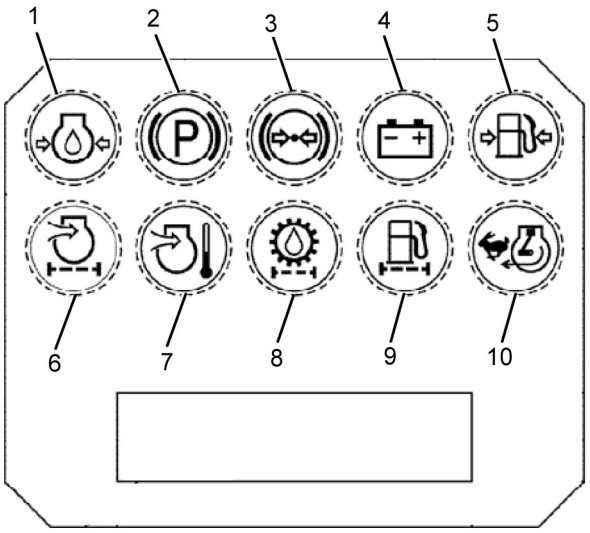


Illustration 31 g01329473

Alert Indicators for 814F Series II, 815F Series II, and 816F Series II

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Fuel Pressure. (6) Air Filter Restriction

(7) High Inlet Air Temperature. (8) Transmission Oil Filter Restriction. (9) Fuel Filter Restriction.

(10) Engine Overspeed

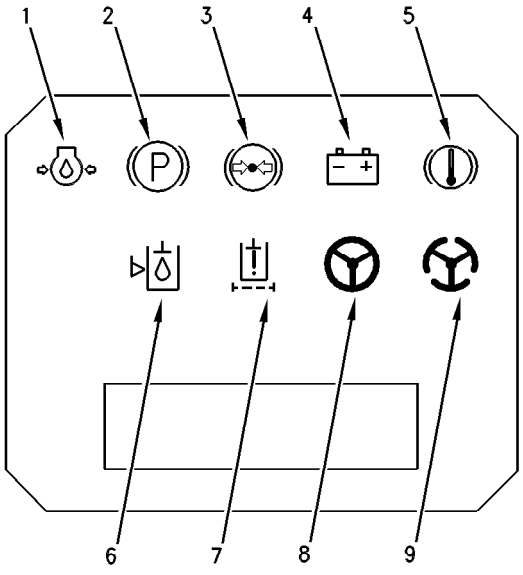


Illustration 32 g00591938

Alert Indicators for 824G, 825G, 950G, 962G, 966G, 972G, 980G, and IT62G

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Axle Oil Pressure. (6) Hydraulic Oil Level. (7) Hydraulic Oil Filter. (8) Primary Steering. (9) Secondary Steering.

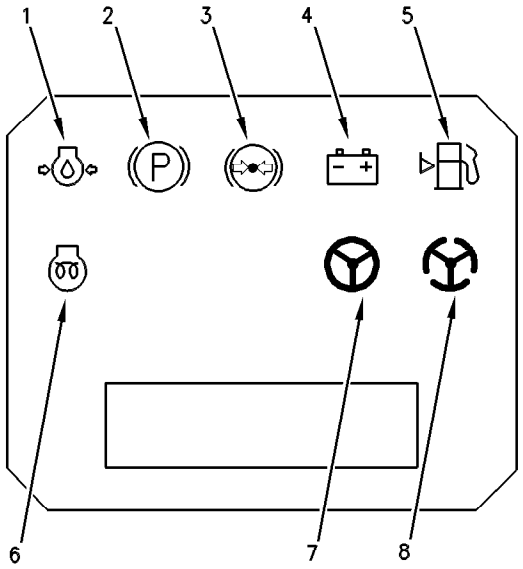


Illustration 33 g00591934

Alert Indicators for 938F and IT38F

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Fuel Level. (6) Air Inlet Heater. (7) Primary Steering. (8) Secondary Steering.

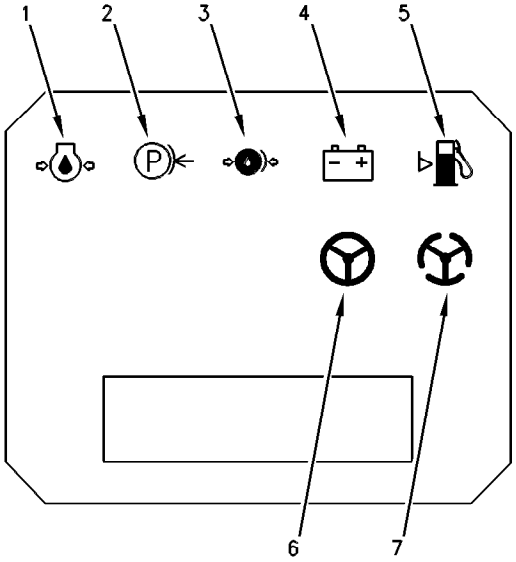


Illustration 34 g00591951

Alert Indicators for 950G, 962G, 980G, IT62G, 824G, 825G, and 826G

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Fuel Level. (6) Primary Steering. (7) Secondary Steering.

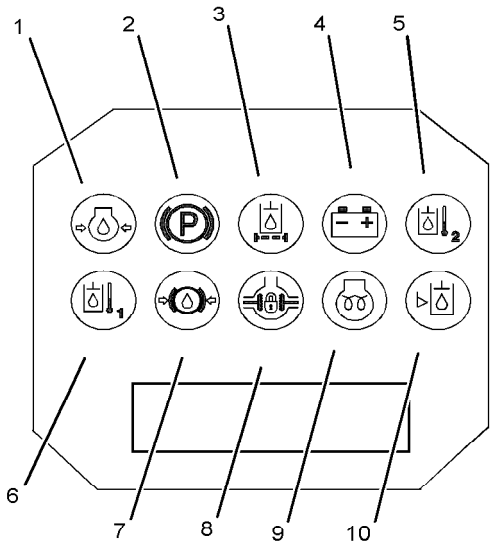


Illustration 35 g01010383

Alert Indicators for 533, 543, TK370, TK371, TK380, and TK381

(1) Engine Oil Pressure. (2) Parking Brake. (3) Hydraulic Oil Filter. (4) Charging System. (5) Hydraulic Oil Temperature 2. (6) Hydraulic Oil Temperature 1. (7) Brake Oil Pressure. (8) Differential Lock. (9) Air Inlet Heater. (10) Hydraulic Oil Level.

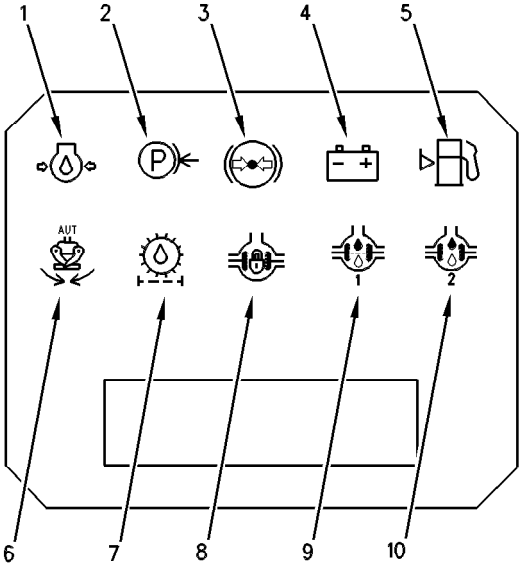


Illustration 36 g00591952

Alert Indicators for 515 and 525

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Fuel Level. (6) Automatic Grapple. (7) Transmission Oil Filter. (8) Differential Lock. (9) Front Differential Oil Filter. (10) Rear Differential Oil Filter.

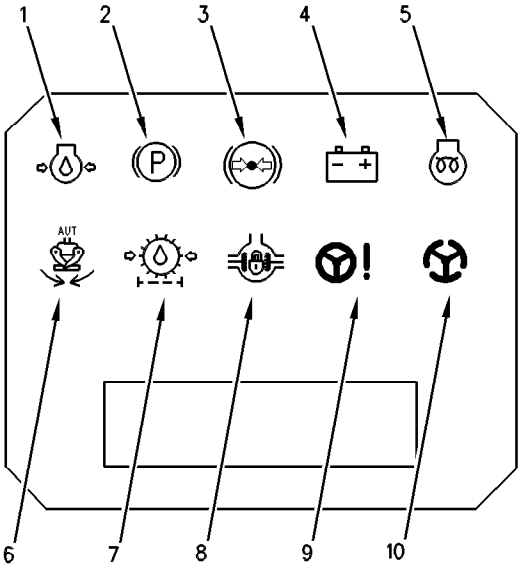


Illustration 37 g00598584

Alert Indicators for 545, 525B, and 535B

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Air Inlet Heater. (6) Automatic Grapple. (7) Transmission Oil Filter. (8) Differential Lock. (9) Primary Steering. (10) Secondary Steering.

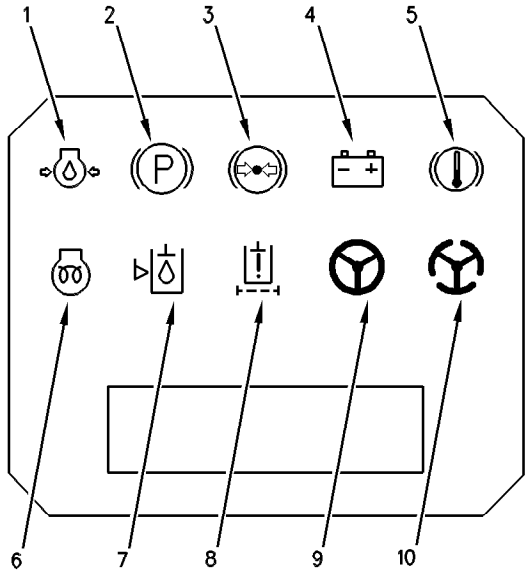


Illustration 38 g00591931

Alert Indicators for 950G, 962G, 966G, 972G, and IT62G

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Axle Oil Temperature. (6) Air Inlet Heater. (7) Hydraulic Oil Level. (8) Hydraulic Oil Filter. (9) Primary Steering. (10) Secondary Steering.

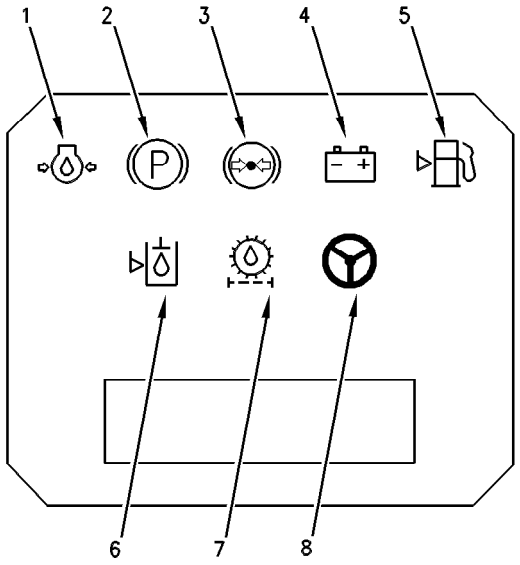


Illustration 39 g00591956

Alert Indicators for 950G, 962G, 980G, IT62G, 824G, 825G, and 826G

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Fuel Level. (6) Hydraulic Oil Level. (7) Transmission Oil Filter. (8) Primary Steering.

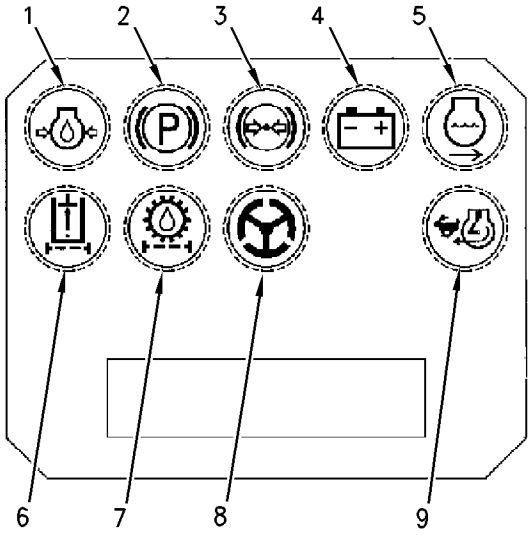


Illustration 41 g00735075

Alert Indicators for 836G

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Engine Coolant Flow. (6) Hydraulic Oil Filter. (7) Transmission Oil Filter Restriction. (8) Secondary Steering. (9) Engine Overspeed.

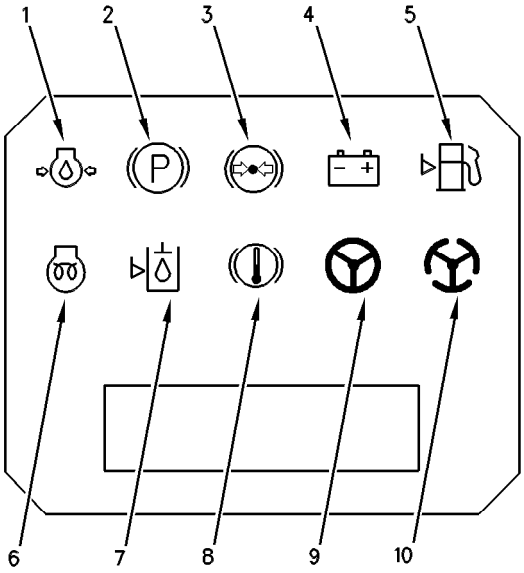


Illustration 40 g00591960

Alert Indicators for 950F Series II, 960F, 966F Series II, and 970F

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Fuel Level. (6) Air Inlet Heater. (7) Hydraulic Oil Level. (8) Axle Oil Temperature. (9) Primary Steering. (10) Secondary Steering.

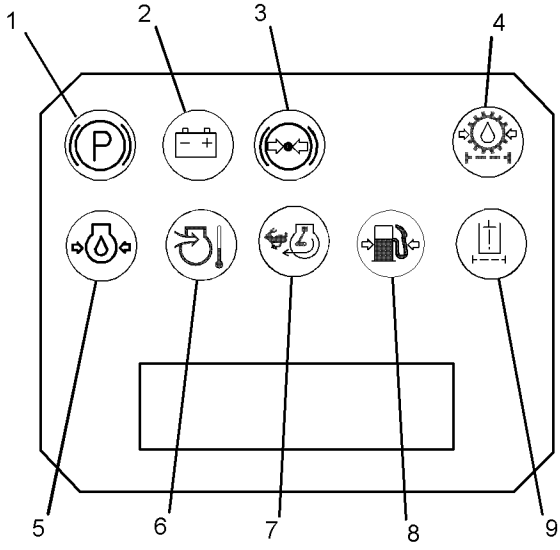


Illustration 42 g01142646

Alert Indicators for 836H

(1)Parking Brake. (2) Electrical System Voltage. (3) Brake Oil Pressure. (4) Transmission Filter. (5) Engine Oil Pressure. (6) Inlet Manifold Air Temperature. (7) Engine Overspeed. (8) Fuel Pressure. (9) Hydraulic Filter.

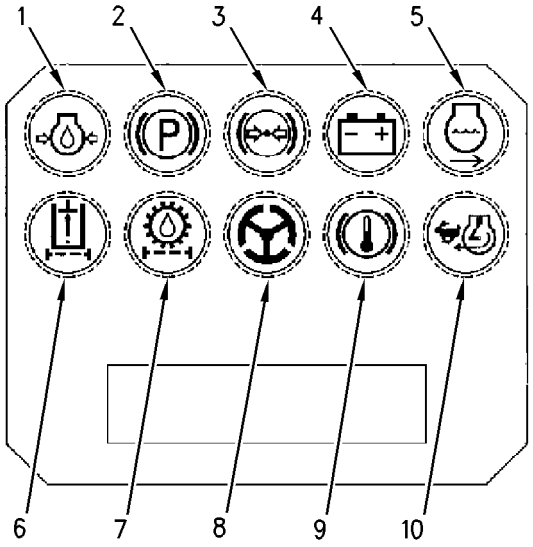


Illustration 43 g00735082

Alert Indicators for 834G and 988G

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Low Engine Coolant Flow. (6) Hydraulic Oil Filter. (7) Transmission Oil Filter Restriction. (8) Secondary Steering. (9) Axle Oil Temperature. (10) Engine Overspeed.

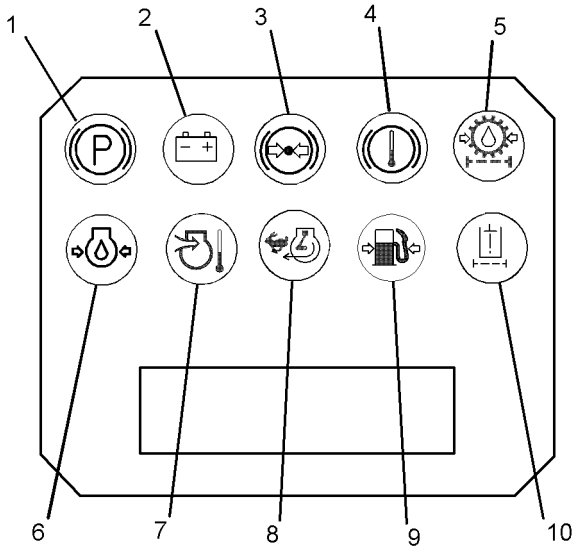


Illustration 44 g01142659

Alert Indicators for 834H and 988H

(1)Parking Brake. (2) Electrical System Voltage. (3) Brake Oil Pressure. (4) Axle Temperature.(5) Transmission Filter. (6) Engine Oil Pressure. (7) Inlet Manifold Air Temperature. (8) Engine Overspeed. (9) Fuel Pressure. (10) Hydraulic Filter.

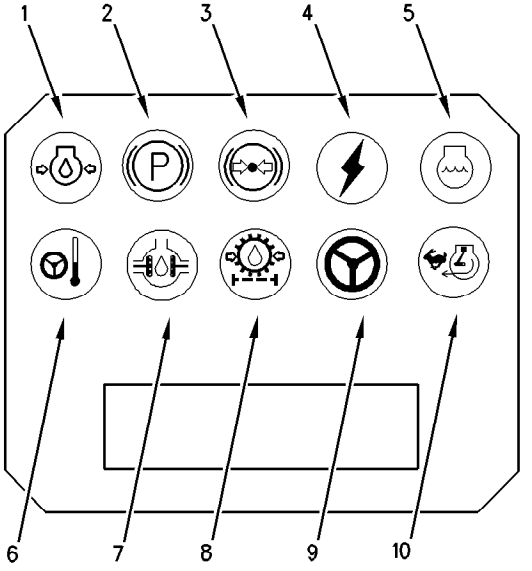


Illustration 45 g00866696

Alert Indicators for 844, and 990

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Coolant Flow. (6) Steering Oil Temperature. (7) Axle Oil Temperature. (8) Transmission Filter. (9) Steering Pressure. (10) Engine Overspeed.

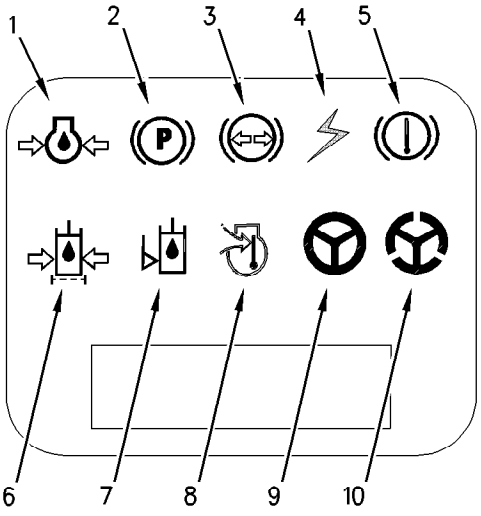


Illustration 46 g00880569

Alert Indicators for 950G/HSeries II, 962G/HSeries II, 966G/HSeries II, and 972G/H Series II

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Front and Rear Axle Oil Temperature. (6)Implement Filter. (7) Hydraulic Oil Level. (8) High Inlet Manifold Temperature. (9) Primary Steering. (10) Secondary Steering.

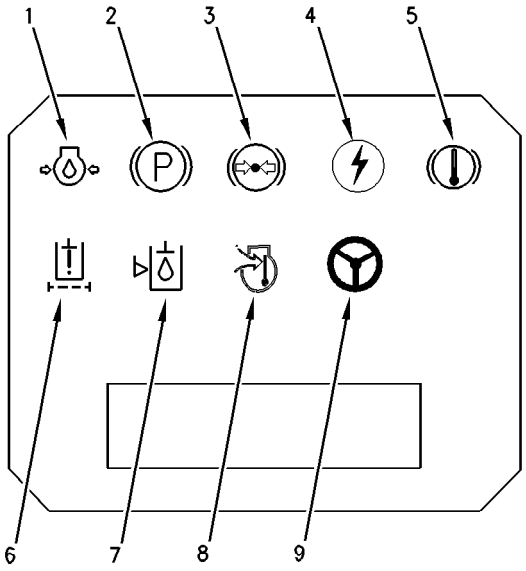


Illustration 47 g00880577

Alert Indicators for 980G/H Series II

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Oil Pressure. (4) Charging System. (5) Front and Rear Axle Oil Temperature. (6) Hydraulic Filter. (7) Hydraulic Oil Level. (8) High Inlet Manifold Temperature. (9) Primary Steering.

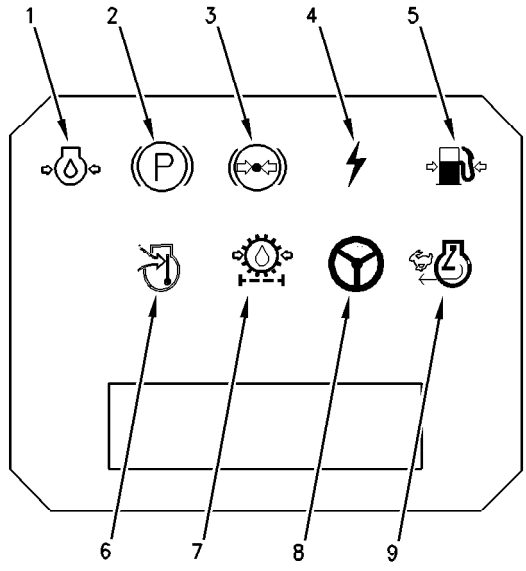


Illustration 48 g00880580

Alert Indicators for 824G/HSeries II, 825G/HSeries II, 826G/H Series II

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Accumulator Oil Pressure. (4) Charging System. (5) Fuel Pressure. (6) High Inlet Air Temperature. (7) Transmission Filter Status. (8) Primary Steering. (9) Engine Overspeed.

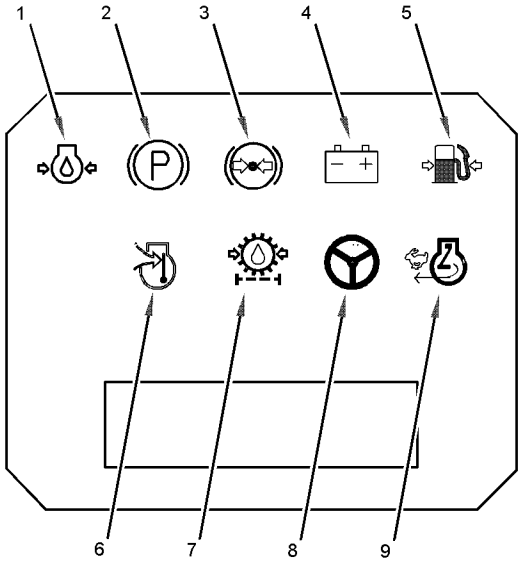


Illustration 49 g01142630

Alert Indicators for 824H, 825H, 826H

(1) Engine Oil Pressure. (2) Parking Brake. (3) Brake Pressure. (4) Charging System. (5) Fuel Pressure. (6) High Inlet Air Temperature. (7) Transmission Filter Status. (8) Primary Steering. (9) Engine Overspeed.

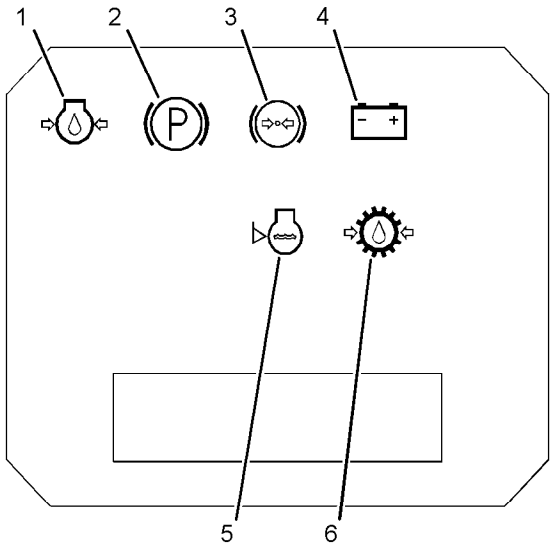


Illustration 50 g01020803

Alert Indicators for R1300G

(1) Engine Oil Pressure
(2) Parking Brake
(3) Brake Oil Pressure
(4) Charging System
(5) Engine Coolant Level
(6) Transmission Oil Pressure (If Equipped)

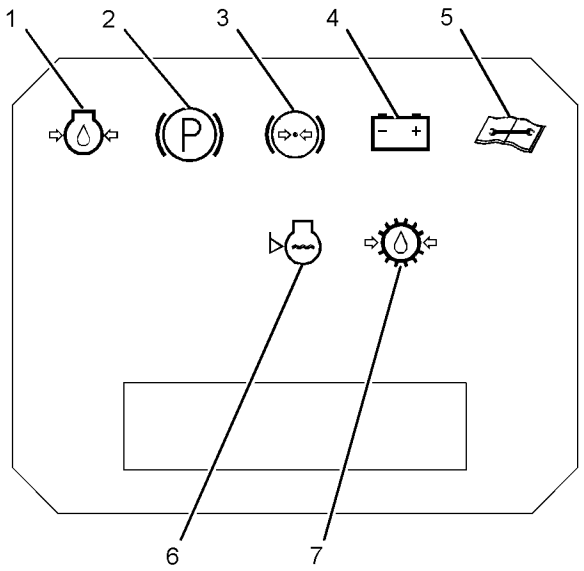


Illustration 51 g01223600

Alert Indicators for R1300G Series II (S/N: RSL1–Up)

(1) Engine Oil Pressure
(2) Parking Brake
(3) Brake Oil Pressure
(4) Charging System
(5) Maintenance Required/Fuel Pressure
(6) Engine Coolant Level
(7) Transmission Oil Pressure

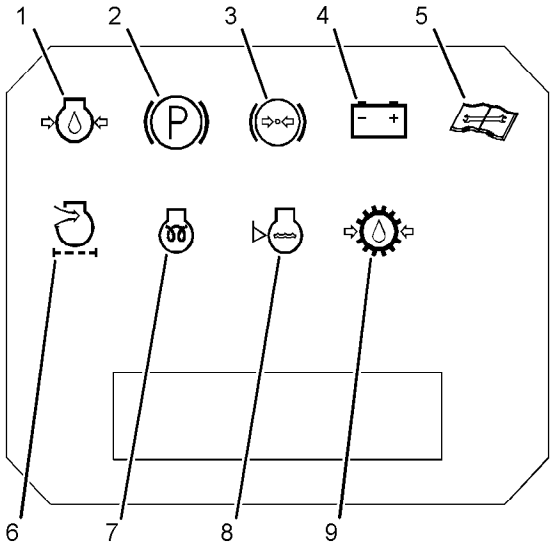


Illustration 52 g01020804

Alert Indicators for R1600G

(1) Engine Oil Pressure
(2) Parking Brake
(3) Brake Oil Pressure
(4) Charging System
(5) Maintenance Required
(6) Air Filter Restriction
(7) Air Intake Heater (If Equipped)
(8) Engine Coolant Level
(9) Transmission Oil Pressure (If Equipped)

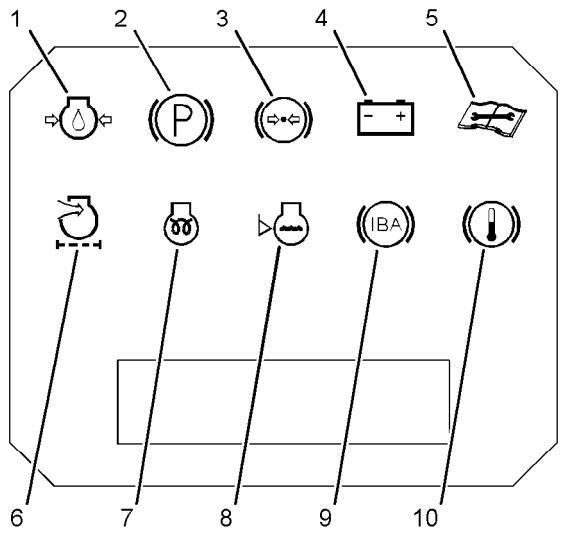


Illustration 53 g01020805

Alert Indicators for R1700G (S/N: 8XZ1–Up)

(1) Engine Oil Pressure
(2) Parking Brake
(3) Brake Oil Pressure
(4) Charging System
(5) Maintenance Required
(6) Air Filter Restriction
(7) Air Intake Heater
(8) Engine Coolant Level
(9) Impending Brake Application (IBA)
(10) Axle Oil Temperature/Pressure

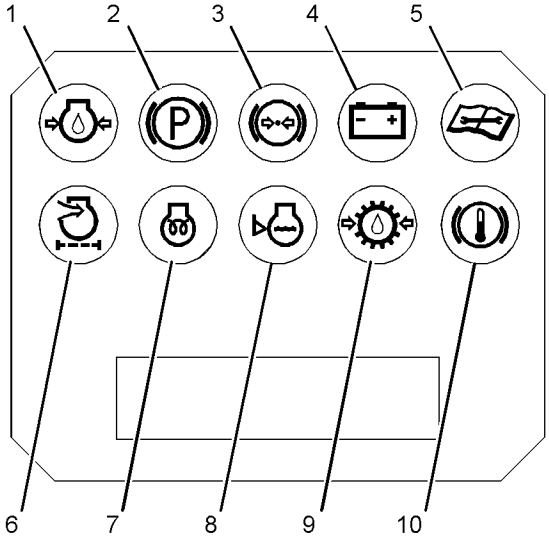


Illustration 54 g01224068

Alert Indicators for R1700G Series II (S/N: SBR1–Up)

(1) Engine Oil Pressure
(2) Parking Brake
(3) Brake Oil Pressure
(4) Charging System
(5) Maintenance Required/Fuel Pressure
(6) Air Filter Restriction
(7) Air Intake Heater
(8) Engine Coolant Level
(9) Transmission Oil Pressure
(10) Axle Oil Temperature/Pressure

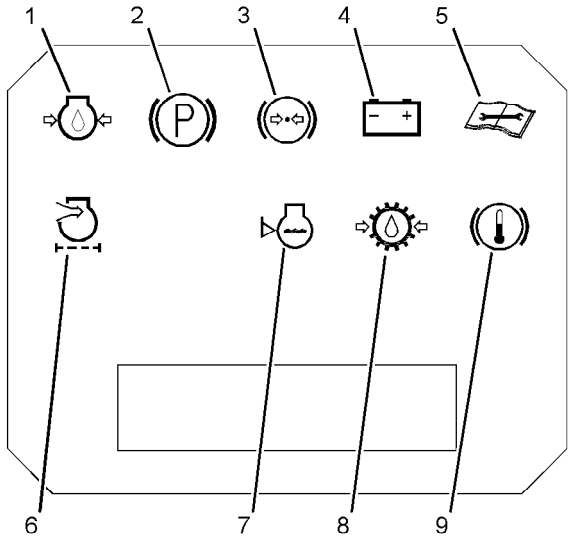


Illustration 55 g01020806

Alert Indicators for R2900G

(1) Engine Oil Pressure
(2) Parking Brake
(3) Brake Oil Pressure
(4) Charging System
(5) Maintenance Required/Fuel Pressure
(6) Air Filter Restriction
(7) Engine Coolant Level
(8) Transmission Oil Pressure
(9) Axle Oil Temperature/Pressure

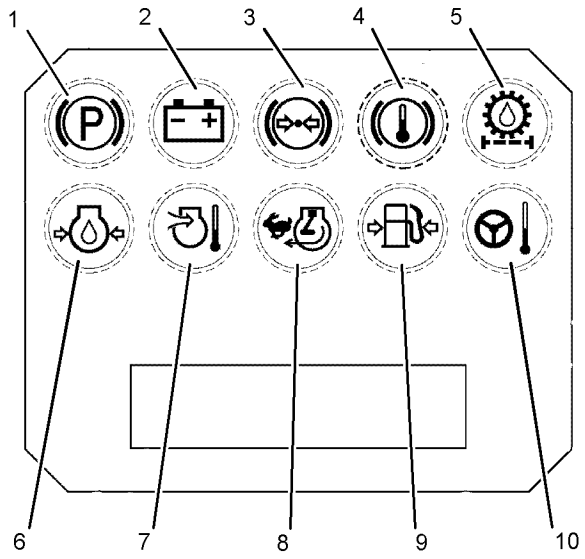


Illustration 56 g01254338

Alert Indicators for 844H and 990H

(1) Parking Brake
(2) Charging System
(3) Brake Oil Pressure
(4) Axle Oil Temperature/Pressure
(5) Transmission Oil Filter Restriction
(6) Engine Oil Pressure
(7) High Inlet Air Temperature
(8) Engine Overspeed
(9) Fuel Pressure
(10) Steering Oil Temperature

Engine Oil Pressure – This light indicates that the engine oil pressure is low. This signal is received by the Caterpillar Monitoring System from the engine ECM via the Cat Data Link. The indicator lights when the switch voltage is high or the switch voltage is floating.

Parking Brake Engaged – The light indicates that the parking brake is engaged. Parking brake status is received over the data link. The information is used to modify the warning level of this indicator. If the machine is in neutral, only the indicator lights. However, if the machine is in a forward gear or a reverse gear, the action lamp and the action alarm also activates.

Brake Oil Pressure – The light indicates that the brake oil pressure is low. The pressure is received from the brake oil pressure switch. If this alert indicator flashes, stop the machine immediately, engage the parking brake, and investigate the cause of the fault.



Hydraulic Oil Filter – The alert indicator indicates a plugged hydraulic oil filter. Change the hydraulic oil filter. If this alert indicator flashes during operation, stop the machine immediately and engage the parking brake. Stop the engine and investigate the cause of the fault.



Electrical System – There is a malfunction in the electrical system. The system voltage is too high for normal machine operation or the system voltage is too low for normal machine operation.



Charging System Status – The light indicates that battery voltage is outside the range of 24.8 to 29.5 VDC. While the engine is running, the light also turns on when the alternator frequency is below 90 Hz. The action lamp and the action alarm will also activate when the battery voltage rises above 32 VDC.



Hydraulic Oil Temperature 1 – The hydraulic oil temperature is above 32 °C (90 °F). Change the operation of the machine. If the temperature remains high, stop the machine and investigate the cause of the fault.



Case Drain Temperature – The temperature of the case drain is above 32 °C (90 °F). Change the operation of the machine. If the temperature remains high, stop the machine. Investigate the cause of the fault.



Coolant Flow – The alert indicator indicates no coolant flow in the engine. If this alert indicator flashes, stop the machine immediately and engage the parking brake. Stop the engine and investigate the cause of the fault.



Low Engine Coolant Flow – The light indicates that the engine coolant is not flowing. The status is determined by the engine ECM and the signal is sent to the Caterpillar Monitoring System via the Cat Data Link.



Engine Overspeed – The light indicates that the engine is overspeeding. A Level 1 warning is initiated when the engine speed reaches 2400 RPM. This warning turns off when the engine speed returns to 2350 RPM. A Level 2 warning is initiated when the engine speed reaches 2500 RPM. This warning turns off when the engine speed returns to 2400 RPM.



Transmission Oil Filter Restriction – The light indicates that the transmission oil filter is restricted. Under normal operation, the indicator will illuminate and the system will bypass oil until the oil gets up to normal operating temperature. The light will illuminate when the differential pressure is greater than 250 kPa (36 psi).



Transmission Filter Status – The transmission oil filter is clogged. If this alert indicator flashes during operation, then stop the machine immediately and engage the parking brake. Stop the engine and investigate the cause of the fault.



High Inlet Air Temperature – The air inlet temperature is too high. If the alert indicator comes on, change operating techniques or park the machine in order to allow the air cooler to cool down. If the situation continues, consult your Caterpillar dealer.



Air Inlet Heater – This light indicates whether the heater is on or off. If the light is flashing, the heater is on.



Low Fuel Level – This light indicates low fuel level.



Fuel Pressure – Low fuel pressure. If this alert indicator flashes during operation, then stop the machine immediately and engage the parking brake. Stop the engine and investigate the cause of the fault. Check the following for any disruption in fuel flow: fuel filter, fuel lines, fuel filter base, and fuel tank.



Steering System Status – This light indicates that the primary steering pressure is low. The pressure is received from the primary steering pressure switch.



Secondary Steering – The light indicates that the secondary steering motor has pressure and the system is functioning properly.



Steering Oil Temperature – This alert indicator indicates excessive steering oil temperature. If this alert indicator flashes, reduce the load on the system. If the alert indicator continues to flash after 5 minutes, stop the machine and investigate the cause of the fault.



Axle Oil Temperature – This alert indicator indicates excessive axle oil temperature. If this alert indicator flashes, reduce the load on the system. If the alert indicator continues to flash after 5 minutes, stop the machine. Investigate the cause of the fault.



Axle Oil Temperature – The light indicates that the axle oil temperature is too high. The pressure is received from the switch.



Hydraulic Oil Level – The light indicates that the hydraulic oil level is low. The level is received from the hydraulic oil level switch.



Hydraulic Oil Filter – The light indicates that the hydraulic oil filter is plugged and the bypass valve is open.



Automatic Grapple – The light indicates that the automatic CLOSE feature of the grapple arms is activated.



Differential Lock – The light indicates that the differential lock is activated.



Front Differential Oil Filter – The light indicates that there is a restriction in the front differential oil filter.



Rear Differential Oil Filter – The light indicates that there is a restriction in the rear differential oil filter.



Maintenance Required – This alert indicator will be on constantly when the machine requires maintenance. The alert indicator can be reset and the maintenance interval can be altered. A laptop computer with Electronic Technician (ET) is required. The status is determined by the engine ECM and the signal is sent to the Caterpillar Monitoring System via the Cat Data Link.



Fuel Pressure – This alert indicator will flash if the fuel filter is blocked. Service the fuel filter when this indicator flashes during operation.



Air Filter Restriction – The light indicates that the air filter is restricted. The status is determined by the engine ECM and the signal is sent to the Caterpillar Monitoring System via the Cat Data Link.



Engine Coolant Level – The light indicates that the engine coolant level is low. The status is determined by the engine ECM and the signal is sent to the Caterpillar Monitoring System via the Cat Data Link.



Impending Brake Application (IBA) – The light indicates that the machine has low transmission oil pressure. This light warns the operator that the parking brake will automatically engage if there is a decrease in pressure. The signal is received from the transmission oil pressure switch.



Transmission Oil Pressure – The light indicates that the machine has low transmission oil pressure. The signal is received from the transmission oil pressure sensor or the switch.

i01112705

Component Description

SMCS Code: 7490

The same Caterpillar Monitoring System operates on a variety of different machines. The monitoring system is a flexible, modular system that includes the main display module and optional display modules (speedometer/tachometer module and quad gauge module). The main display module is used in all applications. The type and the quantity of display modules that are used depends on the machine. All of the following electrical components are not present on every machine. The main display module recognizes the machine and the components that are present. For the location of the electrical components, see the Electrical System Schematic in the Service Manual for the machine.

i02280978

Main Display Module

SMCS Code: 7490

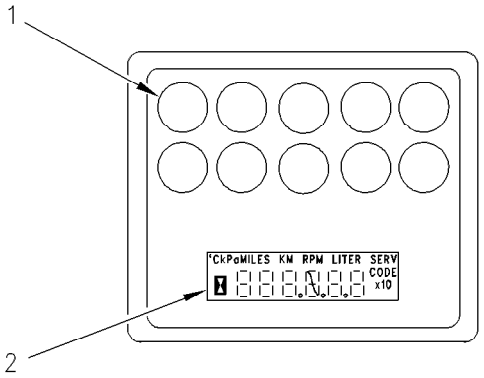


Illustration 57 g00297407

Main Display Module

(1) Alert Indicators. (2) Display area.

The main display module continuously monitors all machine systems. The main display module makes decisions that are based upon the input from the machine systems or other electronic control modules. The main display module sends information to other electronic controls on the machine. The input and output of this information takes place over the Cat Data Link. The outputs on the main display module notify the operator and the service person of the status of the machine systems. The following outputs are on the Caterpillar Monitoring System: the quad gauge, the speedometer/tachometer module, the main display module, the action lamp and the action alarm. A connector with 40 contacts is located on the rear of the module. This connector connects the necessary harness wiring to the inputs and outputs. For a complete description of the connector, see Testing And Adjusting, “Connector Contact Description of Main Display Module”.

Inputs/Outputs

Cat Data Link

The Cat Data Link (connector contacts 5 and 14) is used to communicate with other electronic control modules on the machine. The Cat Data Link is bidirectional. This allows the modules to input the information. Also, the modules can output the information. This permits sharing of information such as engine oil pressure, harness codes and diagnostics.

Display Data Link

The display data link (connector contacts 15, 25 and 35) provides the electrical signals in order to operate the speedometer/tachometer module and the quad guage module. These display modules provide information about the machine systems to the operator. Each module and each display indicator is identified by an identifier or an address. Data is continuously output from the main display module to the other display modules. The module that is addressed returns the data to the main display module. This confirms the receipt of the data.

Inputs

The operation and the status of the machine is transferred from the inputs to the main display module. Three types of inputs exist: switch type input, sensor type input and sender type input. Switches and harness wiring provide a ground or an open signal to the switch inputs. Sensors provide a changing signal to the sensor inputs of the main display module. Senders provide a changing resistance to the sender inputs of the main display module.

Some inputs are multipurpose (switch, sensor or sender). The following examples are of multipurpose inputs: connector contacts 7, 17, 27 and 37 may be either switch inputs or PWM sensor inputs, connector contacts 9 and 18 may be either switch inputs or 0-240 ohm sender inputs and connector contacts 8, 10, 28 and 38 may be switch inputs, PWM sensor inputs or 70-800 ohm sender inputs. These inputs are programmed at the time of installation in order to define the components that are monitored. In order to determine the inputs on the main display module that are programmed, see the Electrical System Schematic in the Service Manual.

Switch Inputs - Uncommitted

The uncommitted switch inputs (connector contacts 11, 19, 20, 21, 29, 32, 39, and 40) provide the information that is used in order to operate the ten alert indicators. The alert indicators are part of the outputs on the main display module. These switch inputs may be programmed at the time of installation to work independently. The switch inputs may be programmed with other switch inputs and/or sensor inputs. The switch inputs will operate an alarm indicator and the input will determine the appropriate warning category (1,2 or 3). During normal operation, these switch inputs are closed to ground. The grounded inputs tell the main display module that the conditions of the system are normal and no alert indicators should be ON. These inputs receive information from the following switches that are located within the machine systems: pressure, temperature, flow, level and mechanical.

Other inputs for the main display module may be programmed at the time of installation in order to function as uncommitted switch inputs. For more information, see the topics “Sensor Inputs - PWM”, “Sender Input - 0- 240 Ohm” and “Sender Input - 70-800 Ohm”.

Any one of the switch inputs may be programmed to operate from an operator switch that is used to operate the display area on the main display module. For the location of this switch input, see the wiring diagram for the machine. For information on the operation of this switch, see System Operation, “Normal Mode”.

Note: The alert indicators may also be programmed to operate from sensor inputs. One of the ten alert indicators is normally dedicated to the charging system. The system uses the input for the battery power and the input for the alternator terminal “R” .

Switch Inputs - Programming

The operation of the main display module is determined by the programming switch inputs (connector pins 3, 6, 12, 16, 22 and 31). The main display module operates in a manner that corresponds to the open state or the grounded state of the programming switch inputs. These inputs receive information from a permanent connection or a harness code connector within the harness wiring. The inputs for the programming switch consist of the information from the harness code.

The inputs from the harness code switch tell the main display module the machine model. Information of the model is necessary because of the differences in the machines. Information from the machine is necessary for the main display module to make decisions.

Switch Inputs - Service

The inputs from the service switches (connector contacts 23 and 33) control the setup, the mode of operation, and certain diagnostic functions. Grounding the service input (connector contact 23) and the clear input (connector contact 33) at the same time will initiate a change in the monitoring system mode of operation. Removing ground from these two inputs locks the main display module in the selected mode. Other diagnostic functions are also performed when the service inputs are grounded and/or opened at the proper time. For more information, see System Operation, “Modes Of Operation”.

Sensor Inputs - PWM

Each PWM sensor input (connector contacts 7, 17, 27 and 37) may be programmed in order to operate as either a sensor input or a switch input.

A PWM signal is present when the sensor input is programmed to operate as a PWM sensor input. A PWM signal represents the condition of a machine system. As the condition of the machine changes, the duty cycle of the signal changes. The duty cycle is the percentage of time that the signal is ON compared to the time the signal is OFF. The frequency of the signal is constant. The following examples are conditions that are monitored: temperature, pressure and level. The main display module measures the duty cycle of the output for the PWM sensor. The information is then sent to the quad gauge in order to be shown on one of the gauges.

Note: See “Switch Inputs - Uncommitted” for input operation when the PWM sensor input is programmed to operate as a switch input. Use the Electrical System Schematic of the machine that is being serviced in order to determine the inputs that are programmed.

Note: The input from the PWM sensor may be programmed to operate a gauge or an alarm indicator. The sensor can also be programmed to operate both a gauge and an alarm indicator.

Sensor Input - Frequency

At each frequency sensor input (connector contacts 26, 30 and 36), an AC signal is present. The signal represents the speed of a machine system. Frequency sensors for engine speed and machine speed provide an AC signal to the main display module. The main display module measures the frequency (Hz) of the AC signals. The information is then sent to the speedometer/tachometer module.

At the input for the alternator terminal “R” (connector contact 30), the terminal “R” of the alternator provides an AC signal to the main display module. The main display module determines the speed of the alternator by measuring the frequency (Hz) of the AC signal. The alternator R terminal helps determine the condition of the electrical charging system. Harness wiring directly connects the alternator terminal “R” to the sensor input for the alternator “R” . The information on the alternator terminal “R” is used with other inputs (engine oil pressure, engine speed, etc) in order to determine when the engine is running.

Sender Input - 0- 240 Ohm

Each 0-240 ohm sender input (connector contacts 9 and 18) may be programmed in order to operate as either a sender input or a switch input.

A sender input measures a resistance value in order to determine the condition of the system. A resistive fuel level sender (or a component with a similar output signal) provides this information. The output resistance of the fuel level sender corresponds to the depth of fuel within the tank. The main display module measures the resistance value. The information is then sent to the quad gauge in order to be shown on one of the gauges.

Note: See “Switch Inputs - Uncommitted” for input operation when the 0-240 ohm sender input is programmed to operate as a switch input. Use the Electrical System Schematic of the machine that is being serviced in order to determine the inputs that are programmed.

Note: The 0-240 ohm sender input may be programmed to operate a gauge or an alarm indicator. The sensor can also be programmed to operate both a gauge and an alarm indicator.

Sender Input - 70-800 Ohm

Each 70-800 ohm sender input (connector contacts 8, 10, 28 and 38) may be programmed in order to operate as a sender input, a PWM sensor input or a switch input.

The 70-800 ohm sender input measures a resistance value in order to read the condition of the system. The temperature sender (or a component with a similar output signal) provides this information. The output resistance of the temperature sender corresponds to the temperature of the fluid that is being measured. Oil, coolant and hydraulic temperature are examples of fluid temperatures that are measured. The main display module measures the resistance value. The information is then sent to the quad gauge in order to be shown on one of the gauges.

Note: The 70-800 ohm sender input may be programmed to operate a gauge or an alarm indicator. The sensor can also be programmed to operate both a gauge and an alarm indicator.

Note: See “Switch Inputs - Uncommitted” for input operation when the 70-800 ohm sender input is programmed to operate as a PWM sensor input. Use the Electrical System Schematic of the machine that is being serviced in order to determine the inputs that are programmed.

Note: See “Switch Inputs - Uncommitted” for input operation when the 70-800 ohm sender input is programmed to operate as a switch input. Use the Electrical System Schematic of the machine that is being serviced in order to determine the inputs that are programmed.

Input - Voltage

The input for battery voltage (connector contact 1 and 2) provides the main display module with power. The voltage input is also used by the main display module to monitor the machine electrical system. This information from the voltage helps determine the condition of the electrical system.

When an alert indicator is used in order to indicate the voltage of the machine system, the battery signal is combined with the signal for the terminal “R” within the main display module. When an electrical system fault occurs, there are two possible warning categories. The category is set by the type of fault.

Category 1 – The frequency for the terminal “R” from the alternator is less than 90 Hz or the system voltage is greater than 29.5 volts for at least 2 seconds. The system voltage is less than 24.8 volts for a least 2 seconds.

Category 3 – The system voltage is less than 23.0 volts for at least 2 seconds or the system voltage is greater than 32.0 volts for at least 2 seconds.

Outputs

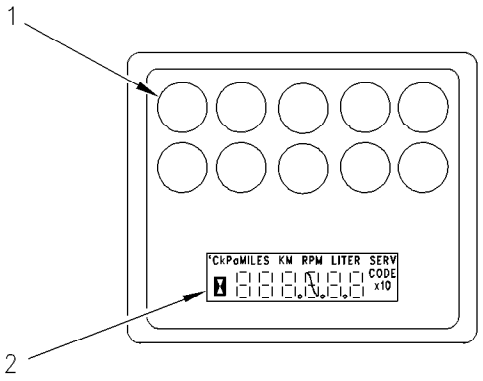


Illustration 58 g00297407

Main Display Module

(1) Alert Indicators. (2) Display area.

The outputs of the Caterpillar Monitoring System notify the operator of the status of the machine systems. The main display module provides electrical power for the other display modules and the sensors.

The following outputs are on the Caterpillar Monitoring System: the display for the main display module, the display data link, the alert indicators, the action lamp, the action alarm, the sensor power supply and the power supply for the main display module.

The outputs on the main display module are the alert indicators (1) and the display area (2).

The alert indicators notify the operator of abnormal conditions with the machine. The main display module uses the status of the uncommitted switch inputs, sender inputs and/or sensor inputs in order to determine when an abnormal condition is present. The main display module then FLASHES the appropriate alert indicator. The symbol of the FLASHING alert indicator identifies the responsible machine system. When an alert indicator FLASHES, an abnormal condition exists. For more information, see System Operation, “Warning Operation”.

Note: The main display module may use a combination of inputs in order to determine abnormal conditions. For example, engine oil pressure and engine rpm may be used to enable the alert indicator for the machine electrical system. The alert indicator for the machine electrical system will FLASH if an abnormal condition exists on the input for the terminal “R” or the input for +battery.

The display area has various symbols that show the condition of the machine systems. The symbols also show information for service and setup. The type of information that is shown on the display depends on the operating mode. For more information about the display area, see System Operation, “Modes of Operation”.

Action Lamp

When a serious abnormal condition exists, the main display module activates the output for the action lamp (connector contact 13) and the action lamp FLASHES. For more information, see System Operation, “Warning Operation”.

Action Alarm

When a critical abnormal condition exists, the main display module activates the output for the action alarm (connector contact 4) and the action alarm SOUNDS. For more information, see System Operation, “Warning Operation”.

Power Supply Output - Sensor

The output for the sensor power supply (connector contact 24) provides 8 DCV for the PWM sensors that are connected to the inputs of the main display module.

Power Supply Output - Display Modules

The output for the power supply to the display module (connector contact 34) provides 9 DCV for the display modules. The quad gauge module and the speedometer/tachometer module cannot function without this power output.

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Display Components

SMCS Code: 7450

The following table shows the contact description for all the display components.

Table 9

Contact Description Of Display Components Connector		
No.	**Function**	**Type**
1	+9 DCV	Input
2	Ground	Ground
3	Display Clock	Input
4	Display Data	Input
5	Display Load	Input
6	Harness Code	Open(1)

(1) Used to give two display components of the same type a unique component number. This is needed so the main display module can send unique information to each identical component. Since all monitoring system configurations included in this manual have at most one module, this input should be open.

The display components receive information from the main display module. The information that is shown notifies the operator and the service person of the status of the machine systems. The components are the quad gauge module and the speedometer/ tachometer module.

i06893011

Quad Gauge Module

SMCS Code: 7450

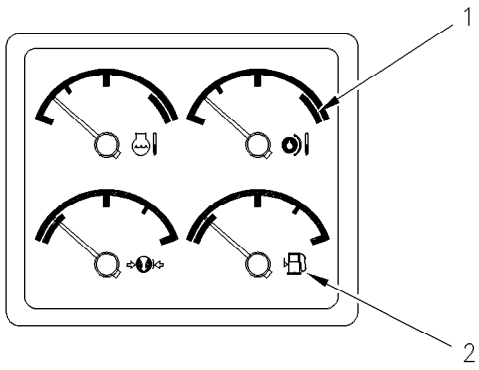


Illustration 59 g00302063

Quad gauge module

(1) Gauge warning area. (2) Pictograph symbol.

The quad gauge module shows the following information: engine coolant temperature, power train oil temperature/torque converter oil temperature, hydraulic oil temperature and fuel level. The main display module uses the information from the sensor inputs and the Cat Data Link in order to calculate the values that are shown on the gauges. Pictograph symbol (2) identifies the parameter for the machine system which is shown on each gauge. Abnormal values are shown by the gauge warning area (1).

The following tables show the information for the quad gauges on specific models.

Table 10

Engine Coolant Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
515, 525, 545, 525B, and 535B	40°C	85°C	108°C	125°C
525(S/N: 1DN1-374)	40°C	82°C	107°C	124°C
533, 543, TK370, TK371, TK380, TK381	40°C	85°C	108°C	125°C
844	40°C	82°C	107°C	124°C
990	40°C	82°C	107°C	124°C
IT38F	45°C	82°C	107°C	122°C
814F/F2, 815F/F2, and 816F/F2	45°C	82°C	107°C	122°C
938F	45°C	82°C	107°C	122°C

(continued)

(Table 10, contd)

Engine Coolant Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
938F (Fuel Tank)	45°C	82°C	107°C	122°C
950F	45°C	82°C	107°C	122°C
960F	45°C	82°C	107°C	122°C
966F	40°C	82°C	107°C	124°C
970F	40°C	82°C	107°C	124°C
IT62G	45°C	82°C	107°C	122°C
950G	45°C	82°C	107°C	122°C
950G (Secondary steering)	45°C	82°C	107°C	122°C
950G (Secondary steering axle oil temperature)	45°C	82°C	107°C	122°C
962G	45°C	82°C	107°C	122°C
962G (Secondary steering axle oil temperature)	45°C	82°C	107°C	122°C
962G (Secondary steering)	45°C	82°C	107°C	122°C
966G	40°C	82°C	107°C	124°C
966G (Secondary steering axle oil temperature)	45°C	82°C	107°C	122°C
966G(Secondary steering)	45°C	82°C	107°C	122°C
972G	40°C	82°C	107°C	124°C
972G (Secondary steering)	45°C	82°C	107°C	122°C
972G (Secondary steering axle oil temperature)	45°C	82°C	107°C	122°C
980G (Water/Glycol)(1)	40°C	82°C	107°C	124°C
988G (Logger standard transmission)	40°C	82°C	107°C	124°C
988G (Short boom bucket)	40°C	82°C	107°C	124°C
988G (Standard lift)	40°C	82°C	107°C	124°C
988G (Logger block handler transmission)	40°C	82°C	107°C	124°C
988G (Block handler transmission)	40°C	82°C	107°C	124°C
R1300G	45°C	82°C	107°C	124°C
R1300G Series II	40°C	87°C	112°C	130°C
R1600G	45°C	82°C	107°C	124°C
R1700G	45°C	82°C	107°C	124°C
R2900G	45°C	82°C	106°C	124°C
834G/H	40°C	82°C	107°C	124°C

(continued)

(Table 10, contd)

Engine Coolant Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
836G/H	40°C	82°C	107°C	124°C
824GSeries II/H	40°C	82°C	107°C	124°C
825GSeries II/H	40°C	82°C	107°C	124°C
826GSeries II/H	40°C	82°C	107°C	124°C
980G	45°C	98°C	129°C	140°C
988G/H	40°C	82°C	107°C	124°C
844H	40°C	82°C	107°C	124°C
990H	40°C	82°C	107°C	124°C
950GSeries II 962GSeries II IT62GII 966GSeries II 972GSeries II 980GSeries II	45°C	82°C	107°C	122°C
950H 962H IT62H 966H 972H 980H	45°C	82°C	107°C	122°C

(1) Special custom applications

Note: The information is received from the engine coolant temperature sensor. The warning level for this gauge is a Level II.

Table 11

Power Train Oil Temperature/Torque Converter Oil Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
938F	45°C	95°C	129°C	145°C
IT38F	45°C	95°C	129°C	145°C
938F (Fuel Tank)	45°C	95°C	129°C	145°C
950G (Secondary steering)	45°C	82°C	129°C	145°C
962G (Secondary steering)	45°C	82°C	129°C	145°C
950G (Secondary steering axle oil temperature)	45°C	82°C	129°C	145°C
962G (Secondary steering axle oil temperature)	45°C	82°C	129°C	145°C
950G (Secondary steering)	45°C	82°C	129°C	145°C
962G (Secondary steering)	45°C	82°C	129°C	145°C
IT62G	45°C	82°C	129°C	145°C
966G (Secondary steering)	45°C	82°C	129°C	145°C

(continued)

(Table 11, contd)

Power Train Oil Temperature/Torque Converter Oil Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
972G (Secondary steering)	45°C	82°C	129°C	145°C
834G/H	45°C	98°C	129°C	140°C
836G/H	45°C	98°C	129°C	140°C
988G (Logger standard transmission)	45°C	82°C	129°C	145°C
966G (Secondary steering axle oil temperature)	45°C	82°C	129°C	145°C
972G (Secondary steering axle oil temperature)	45°C	82°C	129°C	145°C
950G	45°C	82°C	129°C	145°C
950F	45°C	82°C	129°C	145°C
960F	45°C	82°C	129°C	145°C
962G	45°C	82°C	129°C	145°C
966G	45°C	82°C	129°C	145°C
966F	45°C	82°C	129°C	145°C
972G	45°C	82°C	129°C	145°C
970F	45°C	82°C	129°C	124°C
980G	45°C	98°C	129°C	140°C
950GSeries II 962GSeries II 966GSeries II 972GSeries II 980GSeries II	45°C	82°C	129°C	145°C
950H 962H 966H 972H 980H	45°C	98°C	129°C	145°C
988G/H	45°C	98°C	129°C	140°C
824GSeries II/H	45°C	98°C	129°C	140°C
825GSeries II/H	45°C	98°C	129°C	140°C
826GSeries II/H	45°C	98°C	129°C	140°C
980G (Water/Glycol)(1)	45°C	98°C	129°C	140°C
525(S/N: 1DN1-374)	45°C	98°C	129°C	140°C
988G (Short boom bucket)	45°C	98°C	129°C	140°C
988G (Standard lift)	45°C	98°C	129°C	140°C
988G (Logger block handler transmission)	45°C	98°C	129°C	140°C
988G (Block handler transmission)	45°C	98°C	129°C	140°C

(continued)

(Table 11, contd)

Power Train Oil Temperature/Torque Converter Oil Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
814F/F2, 815F/F2, and 816F/F2	45°C	82°C	129°C	145°C
515, 525, 545, 525B, and 535B	45°C	110°C	130°C	145°C
844	45°C	98°C	121°C	140°C
990	45°C	98°C	121°C	140°C
R1300G	45°C	98°C	129°C	140°C
R1600G	45°C	98°C	129°C	140°C
R1700G	45°C	98°C	129°C	140°C
R2900G	45°C	98°C	129°C	140°C
884H	45°C	98°C	129°C	140°C
990H	45°C	98°C	129°C	140°C

(1) Special custom applications

Note: The information is received from the Power Train Oil Temperature/Torque Converter Oil Temperature sensor. The sensor is connected to pin 28 of the 40-pin connector. The warning level for this gauge is a Level II.

Table 12

Hydraulic Oil Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
938F	45°C	95°C	104°C	135°C
IT38F	45°C	95°C	104°C	135°C
938F (Fuel Tank)	45°C	95°C	104°C	135°C
950G (Secondary steering)	45°C	82°C	104°C	135°C
962G (Secondary steering)	45°C	82°C	104°C	135°C
950G (Secondary steering axle oil temperature)	45°C	82°C	104°C	135°C
962G (Secondary steering axle oil temperature)	45°C	82°C	104°C	135°C
950G (Secondary steering)	45°C	82°C	104°C	135°C
962G (Secondary steering)	45°C	82°C	104°C	135°C
IT62G	45°C	82°C	104°C	135°C
966G (Secondary steering)	45°C	82°C	104°C	135°C
972G (Secondary steering)	45°C	82°C	104°C	135°C
834G/H	40°C	80°C	93°C	120°C
836G/H	40°C	80°C	93°C	120°C

(continued)

(Table 12, contd)

Hydraulic Oil Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
988G (Logger standard transmission)	40°C	80°C	93°C	120°C
966G (Secondary steering axle oil temperature)	45°C	82°C	104°C	135°C
972G (Secondary steering axle oil temperature)	45°C	82°C	104°C	135°C
950G	45°C	82°C	104°C	135°C
950F	45°C	82°C	104°C	135°C
960F	45°C	82°C	104°C	135°C
962G	45°C	82°C	104°C	135°C
966G	45°C	82°C	104°C	135°C
966F	45°C	82°C	104°C	135°C
972G	45°C	82°C	104°C	135°C
970F	45°C	82°C	104°C	135°C
980G	40°C	98°C	104°C	120°C
950GSeries II 962GSeries II IT62GII 966GSeries II 972GSeries II 980GSeries II	45°C	82°C	104°C	135°C
950H 962H IT62H 966H 972H 980H	45°C	82°C	104°C	120°C
988G/H	40°C	80°C	93°C	120°C
824GSeries II/H	40°C	80°C	93°C	120°C
825GSeries II/H	40°C	80°C	104°C	120°C
826GSeries II/H	40°C	80°C	104°C	120°C
980G (Water/Glycol)(1)	40°C	69°C	88°C	92°C
525(S/N: 1DN1-374)	45°C	98°C	129°C	140°C
988G (Short boom bucket)	40°C	80°C	93°C	120°C
988G (Standard lift)	40°C	80°C	93°C	120°C
988G (Logger block handler transmission)	40°C	80°C	93°C	120°C
988G (Block handler transmission)	40°C	80°C	93°C	120°C
814F/F2, 815F/F2, and 816F/F2	40°C	82°C	96°C	120°C

(continued)

(Table 12, contd)

Hydraulic Oil Temperature Gauge				
Model	**Minimum Displayed Value**	**Midpoint Value**	**Red Zone Value**	**Maximum Displayed Value**
515, 525, 545, 525B, and 535B	40°C	80°C	96°C	110°C
533, 543, TK370, TK371, TK380, TK381	40°C	Linear	90°C	110°C
844	40°C	80°C	93°C	120°C
990	40°C	80°C	93°C	120°C
R1300G	45°C	80°C	104°C	120°C
R1600G	45°C	80°C	104°C	120°C
R1700G	45°C	80°C	104°C	120°C
R2900G	45°C	80°C	107°C	120°C
844H	40°C	80°C	93°C	120°C
990H	40°C	80°C	93°C	120°C

(1) Special custom applications

Note: The information is received from the hydraulic oil temperature sensor. The warning level for this gauge is a Level II.

Table 13

Fuel Level Gauge				
Model	**Minimum Displayed Value**	**Red Zone**	**Middle**	**Maximum Displayed Value**
938F	3%	13%		95%
IT38F	6%	13%		87%
938F (Fuel Tank)	3%	13%		95%
950G (Secondary steering)	14%	18%		94%
962G (Secondary steering)	14%	18%		94%
950G (Secondary steering axle oil temperature)	0%	18%	50%	94%
962G (Secondary steering axle oil temperature)	0%	18%	50%	94%
950G (Secondary steering)	14%	18%		94%
962G (Secondary steering)	14%	18%		94%
IT62G	0%	18%	50%	94%
966G (Secondary steering)	7%	10%		95%
966L (Secondary steering)	0%	12%		100%
972G (Secondary steering)	7%	10%		95%
966G (Secondary steering axle oil temperature)	7%	10%		95%

(continued)

(Table 13, contd)

Fuel Level Gauge				
Model	**Minimum Displayed Value**	**Red Zone**	**Middle**	**Maximum Displayed Value**
972G (Secondary steering axle oil temperature)	7%	10%		95%
834G	0%	15%		94%
834H	0%	15%		88%
836G	0%	15%		94%
836H	0%	15%		88%
988G (Logger standard transmission)	0%	15%		94%
950G	14%	18%		94%
962G	14%	18%		94%
966G	7%	10%		95%
966F	8%	10%		92%
972G	7%	10%		95%
970F	8%	10%		92%
980G	14%	18%		94%
988G	0%	15%		94%
988H	0%	15%		92%
950GSeries II 962GSeries II 966GSeries II 972GSeries II 980GSeries II	7%	10%		95%
950H 962H 966H 972H 980H	7%	10%		95%
824GSeries II/H	10%	15%		94%
825GSeries II/H	10%	15%		94%
826GSeries II/H	7%	16%		87%
825H	10%	15%		94%
826G	7%	16%		87%
826H	10%	15%		94%
980G (Water/Glycol)(1)	14%	18%		94%
525(S/N: 1DN1-374)	14%	18%		94%
988G (Short boom bucket)	0%	15%		94%
988G (Standard lift)	0%	15%		94%
988G (Logger block handler transmission)	0%	15%		94%

(continued)

(Table 13, contd)

Fuel Level Gauge				
Model	**Minimum Displayed Value**	**Red Zone**	**Middle**	**Maximum Displayed Value**
988G (Block handler transmission)	0%	15%		94%
814F, 815F, and 816F	14%	18%		94%
515, 525, 545, 525B, and 535B	5%	15%		95%
533, 543, TK370, TK371, TK380, TK381	5%	15%	50%	100%
844	10%		15%	94%
990	10%		15%	94%
R1300G	7%	15%		95%
R1600G	7%	15%		95%
R1700G	7%	15%		95%
R2900G	7%	15%		95%
844H	10%		15%	94%
990H	10%		15%	94%
814F2, 815F2, 816F2	10%	15%		94%

(1) Special custom applications

Note: The input is received from the fuel level sensor.
The warning level for this gauge is a Level I.

Table 14

Pressure of the Saw				
Model	**Minimum Displayed Value**	**Red Zone**	**Middle**	**Maximum Displayed Value**
533, 543, TK370, TK380	0	Linear	28610 kPa (4150 psi)	31030 kPa (4500 psi)

i02510651

Speedometer/Tachometer Module

SMCS Code: 7450

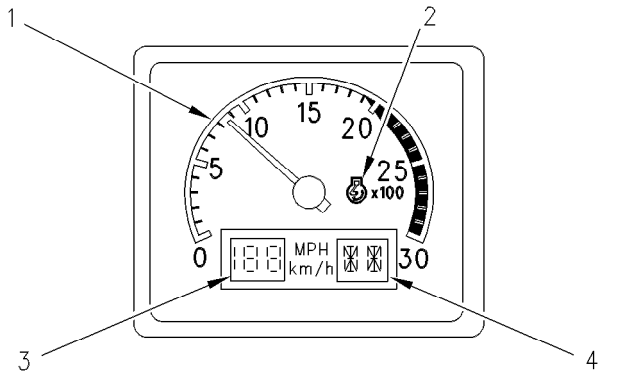


Illustration 60 g00357114

Speedometer/Tachometer module

(1) Tachometer. (2) Pictograph symbol. (3) Speed readout. (4) Gear readout.

Speed readout (3) consists of three digits and the readout may show the machine ground speed in MPH (km/h). The main display module calculates speed by using the information from a frequency sensor input or the Cat Data Link. Illumination of the appropriate digits shows the speed.

Gear readout (4) consists of two digits that show the transmission gear which is engaged. The left digit shows the actual gear, “1” , “2” , “3” , etc. The right digit shows the direction that is selected, “F” , “N” or “R” .

Tachometer (1) shows the engine speed in RPM. The engine speed is determined by the information that is sent to the main display module over the Cat Data Link. The engine speed is also determined from a frequency sensor input.

i01681719

Switches

SMCS Code: 1435; 7332

Switches provide information (input) to the main display module. Switches are two state devices. The two states of the switches are open and closed.

Closed – The switch connects the control input to frame ground.

Open – The switch connects the control input to nothing. (The input is floating.)

During normal operation, all the switches are closed to ground. When a condition exceeds the trip point of the switch, the switch opens. This tells the main display module of the abnormal condition. The main display module then begins the warning operation and the module notifies the operator of the abnormal condition (problem).

Note: For specifications on the switches, see the Electrical System Schematic for that particular machine.

Pressure Switch (Brake Oil)

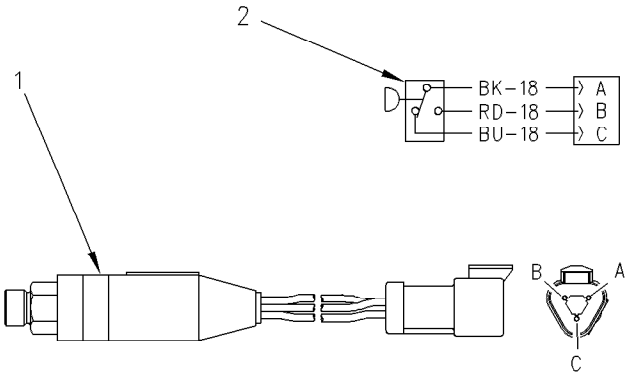


Illustration 61 g00304424

Pressure Switch (Brake Oil)

(1) Switch. (2) Schematic symbol.

During normal operation, brake oil pressure switch (1) is closed to ground. The switch opens when the brake oil pressure is less than the specified value for the switch. The open switch tells the main display module that there is low brake oil pressure. Then, the module tells the operator that there is low brake oil pressure. The switch is open when the switch is off the machine.

Pressure Switch (Filter)

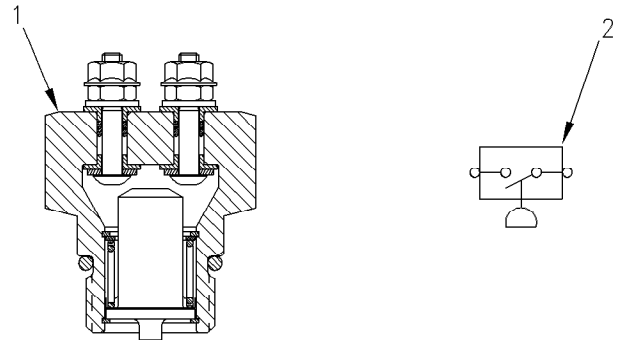


Illustration 62 g00304427

Pressure Switch (Filter)

(1) Switch. (2) Schematic symbol.

Filter pressure switch (1) has a plunger within the switch that closes the contacts with an acceptable pressure drop across the filter. During normal operation, the switch grounds the signal circuit. When the pressure across the filter is greater than a specified pressure, the switch plunger will move. This allows the switch contacts to open. The open switch tells the main display module that the filter is dirty. The switch is open when the switch is off the machine.

Note: The main display module also considers the fluid temperature before notifying the operator. Cold fluid has a higher viscosity which causes a higher differential pressure than fluid at a normal temperature. The operator is not notified when a filter bypass occurs with a cold fluid. The temperature inhibit is not used with the fuel filter.

Liquid Level Switch

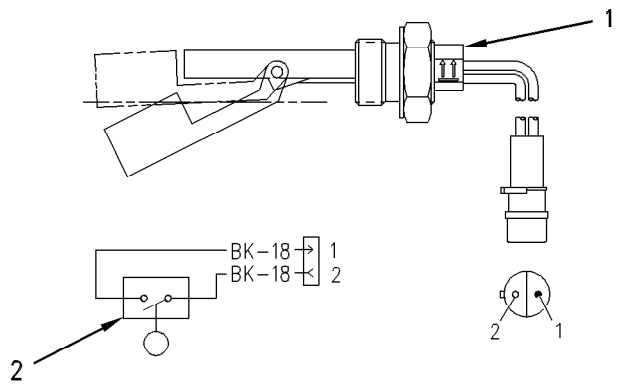


Illustration 63 g00304429

Liquid Level Switch

(1) Switch. (2) Schematic symbol.

During normal operation, level switch (1) is closed to ground. The switch opens when the liquid level is less than the minimum level. The open switch tells the main display module of the low level. The switch is open with the float in the DOWN position when the switch is off the machine.

Rocker Switch (Operator Mode Selector)

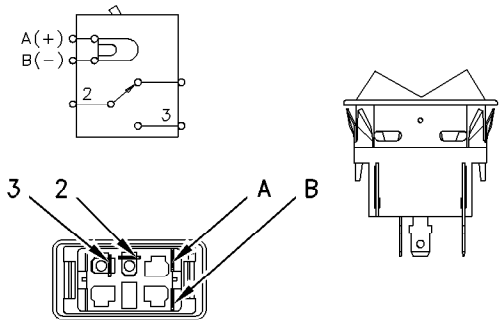


Illustration 64 g00867112

Operator Mode Selector Switch

Grounding the operator mode selector switch causes the main display module to scroll through the available operator modes for the machine. Opening the selector switch places the Caterpillar Monitoring System in the currently displayed operator mode. A list of possible operator modes is shown at the beginning of the Modes of Operation section. See the Operation And Maintenance Manual in order to determine the “Operator Modes” that are available for the machine that is being serviced.

Pressure Switch (Engine Oil)

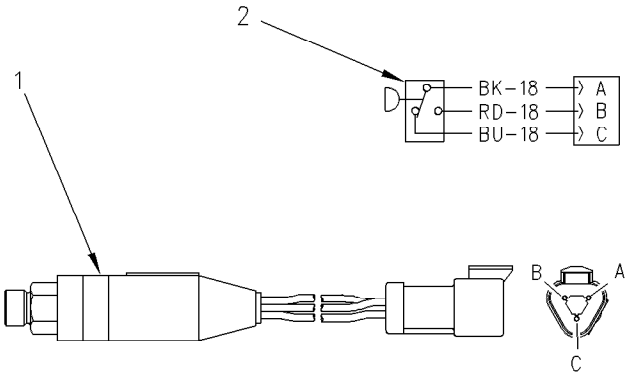


Illustration 65 g00304424

Pressure Switch (Engine Oil)

(1) Switch. (2) Schematic symbol.

During normal operation, engine oil pressure switch (1) is closed to ground. The switch opens when the engine oil pressure is less than the specified value for the switch. The open switch tells the main display module of the insufficient engine oil pressure. The switch is open when the switch is off the machine.

Pressure Switch (Differential Oil Filter)

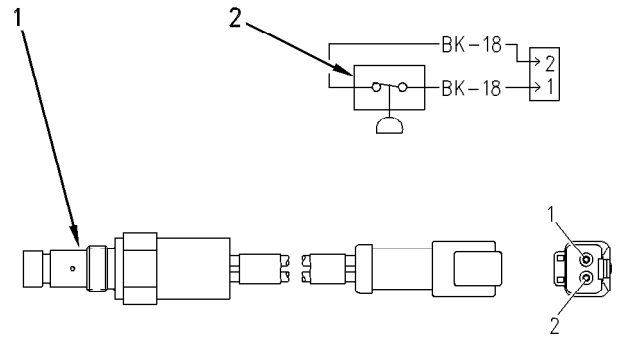


Illustration 66 g00587960

Pressure Switch (Differential Oil Filter)

(1) Switch. (2) Schematic symbol.

During normal operation, switch (1) is closed to ground. The switch opens when the differential oil filter is dirty and the oil pressure is greater than the specified value for the switch. The open switch tells the main display module that the differential oil filter is dirty. The switch is closed when the switch is off the machine.

Limit Switch (Transmission Neutralizer)

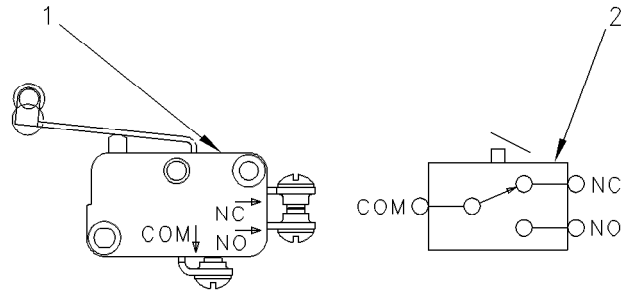


Illustration 67 g00304426

Limit Switch (Transmission Neutralizer)

(1) Switch. (2) Schematic symbol.

When the transmission is in neutral, the limit switch (1) is closed to ground. The switch opens when the shift lever is in any other position. On the machine, the normally closed terminals and common terminals are used. The open or closed condition of the limit switch (1) tells the main display module when the transmission control linkage is in the NEUTRAL position. The main display module uses this information to make decisions about related systems. The normally closed terminals and common terminals are normally closed when the terminals are off the machine. The normally open terminals and common terminals are normally open when the terminals are off the machine.

Flow Switch (Supplemental Steering)

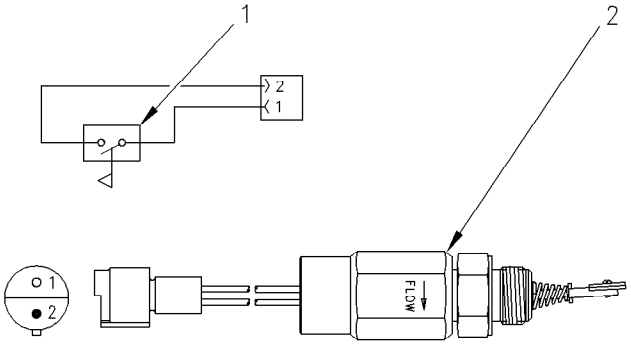


Illustration 68 g00304431

Flow Switch (Supplemental Steering)

(1) Schematic symbols. (2) Switch.

During normal operation, steering flow switch (2) is closed to ground. The switch opens when the oil flow for the steering system is less than a specified flow. The open switch tells the main display module of low oil flow in the steering system. The switch (2) is used in the primary steering system and the supplemental steering system. The switch is open when the switch is off the machine.

Temperature Switch

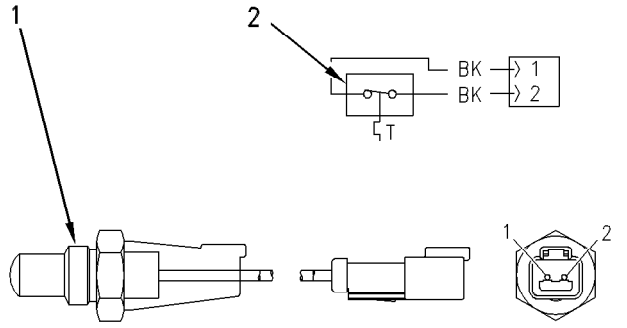


Illustration 69 g00304432

Temperature Switch

(1) Switch. (2) Schematic symbol.

A machine may have more than one temperature switch. During normal operation, temperature switch (1) is closed to ground. The switch opens when the temperature of the fluid system is greater than the specified value. The open switch tells the main display module of the high temperature. The switch is closed when the switch is off the machine.

Pressure Switch (Steering)

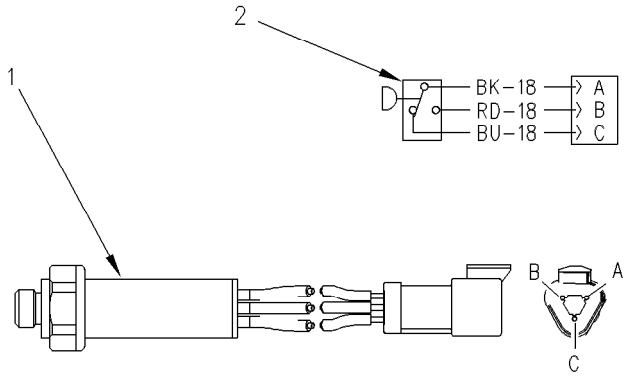


Illustration 70 g00304430

Pressure Switch (Steering)

(1) Switch. (2) Schematic symbol.

During normal operation, steering pressure switch (1) is closed to ground. The switch opens when the pressure in the steering system is less than a specified pressure. The open switch tells the main display module that the steering oil pressure is too low. The connector contacts “A” and “C” are closed, and connector contacts “A” and “B” are open when the switch is off the machine.

Level Switch (Coolant)

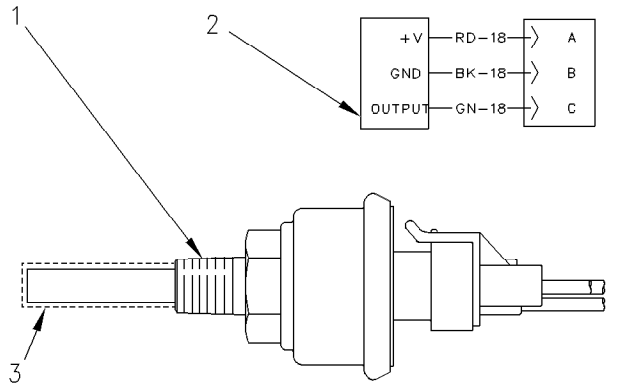


Illustration 71 g00304437

Level Switch (Coolant)

(1) Switch. (2) Schematic symbol. (3) Plastic sleeve.

The coolant level switch is an electronic switch that is activated by coolant. During normal operation, coolant level switch (1) is closed to ground. The switch opens when the coolant level is too low. The open switch tells the main display module of a low coolant condition in the cooling system. The switch has a connector with three contacts. Contact “A” connects to sensor power supply from the main display module. Contact “B” connects to ground. Contact “C” connects to the input of the main display module. The switch is open when the switch is off the machine. The switch cannot be tested when the switch is off the machine. See the Testing And Adjusting section for more information.

Note: DO NOT remove the plastic sleeve (3) from the probe. The plastic sleeve is required for proper operation of the switch.

i02510499

Senders

SMCS Code: 1408-UN

Level Sender (Fuel)

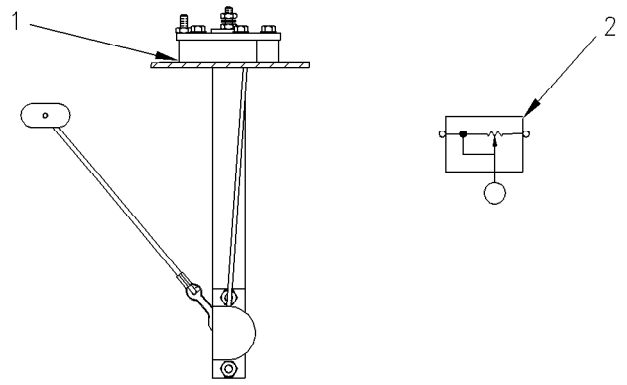


Illustration 72 g00303717

Level Sender (Fuel)

(1) Sender. (2) Schematic symbol.

Fuel level sender (1) provides fuel level sensing. A resistive signal which corresponds to the depth of fuel within the fuel tank is sent from the sender to the main display module. Typically, there are two possible types of senders: 0 to 90 ohms and 33 to 240 ohms. The main display module measures the resistance value in order to determine the fuel that is remaining in the tank. Typical gauge readings for the fuel level:

- When the fuel tank is at 4% of capacity, the gauge shows that the tank is empty.
- When the fuel tank is at 14% of capacity, the gauge shows the needle at the red zone on the gauge.
- When the fuel tank is at 77% of capacity, the gauge shows that the tank is full.

Temperature Sender

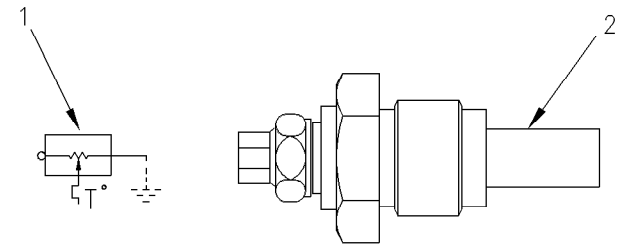


Illustration 73 g00303718

Temperature Sender

(1) Schematic symbol. (2) Sender.

Temperature sender (2) provides a method for sensing fluid temperature. The temperature sender produces a resistive signal which corresponds to the temperature of the fluid that is being monitored. Typically, the resistance range of the sender is from 70 ohms at 110°C (230°F) to 3000 ohms at 25°C (77° F). The main display module measures the resistance value in order to determine the fluid temperature.

i08026285

Sensors

SMCS Code: 1408-NS

General Information

Sensors provide information (input) to the main display module about changing conditions. The sensor signal changes in a proportional manner to reflect the changing condition. The main display module shows the sensor information on the gauges. The main display module recognizes two types of sensor signals.

Frequency – The sensor produces an AC signal. The frequency (Hz) will vary as the condition changes.

Pulse width modulated – The sensor produces a digital signal. The duty cycle will vary as the condition changes. The frequency of this signal is constant.

Analog – The sensor produces an analog DC voltage signal. The amplitude of the signal will vary between 0.5 V and 4.5 V nominally as the condition changes.

Frequency Sensors

Frequency sensors produce an AC signal. The frequency (Hz) will vary as the condition changes.

Speed Sensor

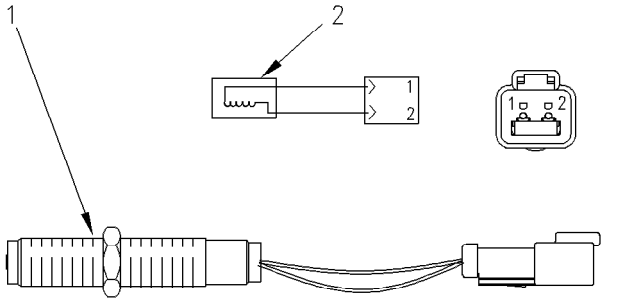


Illustration 74 g00304924

Speed Sensor

(1) Schematic symbol

Speed sensor (1) is a frequency sensor. Speed sensors are used to measure engine RPM. The Speed sensors are also used to measure the machine MPH (km/h). The sensor will generate an AC signal. The sensor recognizes the gear teeth as the teeth are passing. The signal is sent to the main display module. The main display module measures the sensor frequency (one pulse per gear tooth). The main display module then determines the signal that is being processed. The main display module displays either the engine speed or the machine speed.

The engine speed sensor is located on the flywheel housing. The machine speed sensor is located at the output end of the transmission housing.

Pulse Width Modulated Sensors (PWM Sensors)

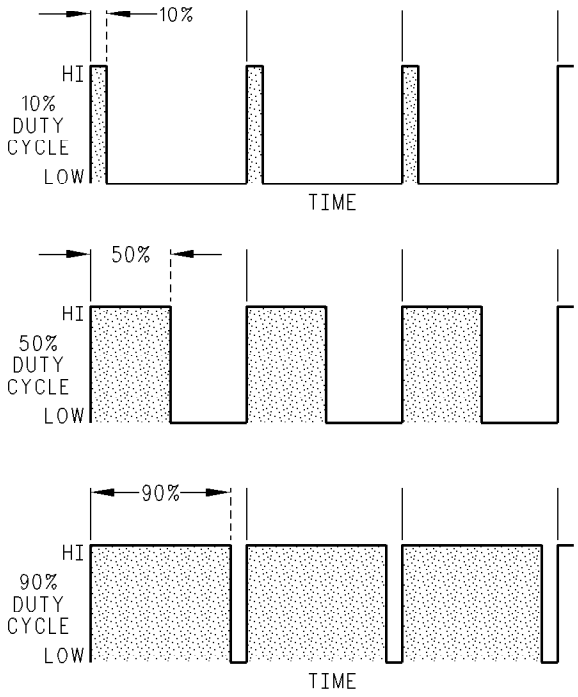


Illustration 75 g00304925

Pulse Width Modulated Signal

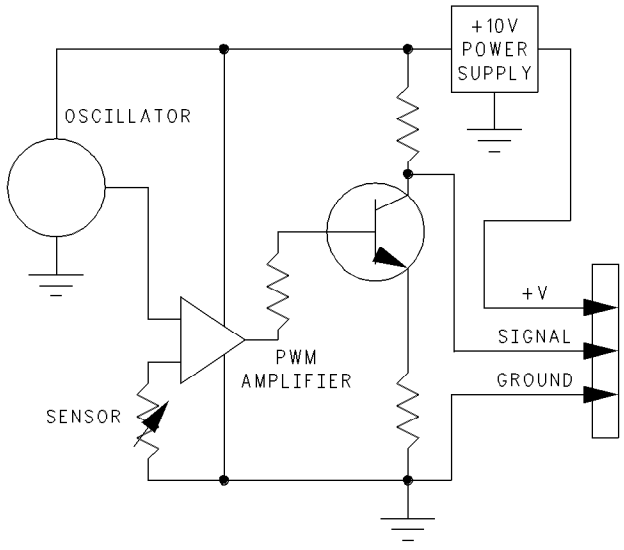


Illustration 76 g00304926

Typical PWM Sensor Schematic

A PWM sensor produces a digital signal. The duty cycle of the signal varies as the condition changes. The frequency remains constant.

Temperature Sensor

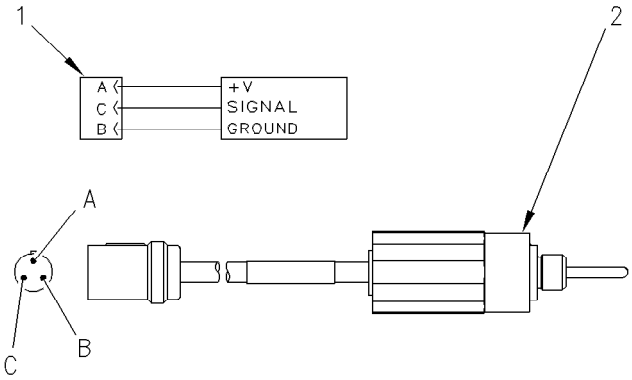


Illustration 77 g00304927

Temperature Sensor

(1) Schematic symbol
(2) Sensor

Temperature sensor (2) reacts to the temperature of the fluids. Examples of the fluids are hydraulic oil, power train oil, and engine coolant. The sensor receives operating power from the main display module (8 VDC) or from the battery (24 VDC). The main display module receives a PWM signal from the sensor. The PWM signal will change as the fluid temperature changes. The main display module measures the duty cycle of the sensor signal to determine the fluid temperature.

Fuel Level Sensor (Ultrasonic Type)

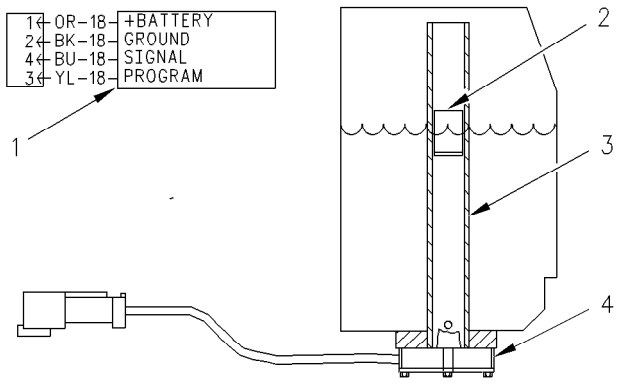


Illustration 78 g00304928

Fuel Level Sensor (Ultrasonic Type)

(1) Schematic symbol
(2) Float
(3) Guide tube
(4) Sensor

The fuel level sensor (4) reacts to the level of the fuel in the fuel tank. The fuel level sensor (4) emits an ultrasonic signal. The signal is emitted up the guide tube (3). The ultrasonic signal is reflected off a metal disk on the bottom of float (2) and the signal returns to the sensor. The sensor measures the time that is required for the ultrasonic signal to travel from the sensor to the float and then back to the sensor. The sensor also measures the level of the fuel. The open status or the grounded status of contact 3 tells the sensor whether the sensor is installed in a deep tank or the sensor is installed in a shallow tank. Contact 3 is open if the maximum depth of the tank is 2286 mm (90 inch). Contact 3 is grounded if the maximum depth of the tank is 1150 mm (45 inch). The sensor receives the operating power from the machine electrical system. The main display module receives a PWM signal from the sensor. The signal will change as the fuel level changes. The main display module measures the duty cycle of the sensor signal to determine the fuel level.

Note: The fuel level sensor cannot be bench tested. The sensor must have fuel in the guide tube (3) to operate properly. The sensor can only be tested while the sensor is installed on the machine. For specifications and test procedures, see Diagnostic Function, “Pulse Width Modulated Sensor”.

Fuel Level sensor (Capacitive Type)

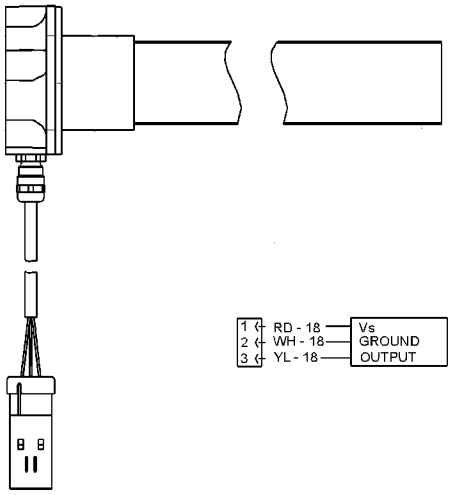


Illustration 79 g06514657

Fuel Level sensor (Capacitive Type)

The Capacitive Type Fuel sensors are applicable to the following machines:

- D9 GC (AK4)
- D9R (WDM and HWH)

The fuel level sensor reacts to the level of the fuel in the fuel tank. The fuel level sensor has a sensing element within the tube that detects the presence of fluid. The sensing element then generates an analog signal that is proportional and linearly related to the level of fluid being detected on the sensing element. The sensor receives the operating power from the machine electrical system. The main display module receives an analog signal from the sensor. The signal will change as the fuel level changes. The main display module measures the amplitude of the sensor signal to determine the fuel level.

Pressure Sensor

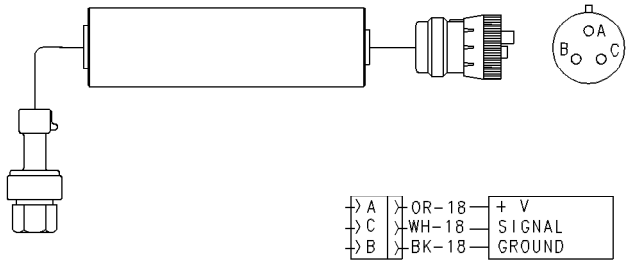


Illustration 80 g00304929

Pressure Sensor

The pressure sensor reacts to the pressure of the fluids. The sensor receives operating power from the main display module (8 VDC) or from the battery (24 VDC). The main display module receives a PWM signal from the sensor. The signal changes as the fluid pressure changes. The main display module measures the duty cycle of the sensor signal to determine the fluid pressure.

i02510635

Action Lamp

SMCS Code: 1408-LMP; 7400-LMP



Illustration 81 g00304970

Action Lamp Symbol

The action lamp connects to an output of the main display module. The action lamp is an LED that is located within the operator's viewing area. The FLASHING of the action lamp tells the operator that a condition exists. The condition will require changing the operation of the machine. The action lamp is located on the main display module. The action lamp will FLASH whenever a warning category 2, a warning category “2S” , or a warning category 3 problem exists.

i02510637

Action Alarm

SMCS Code: 7407

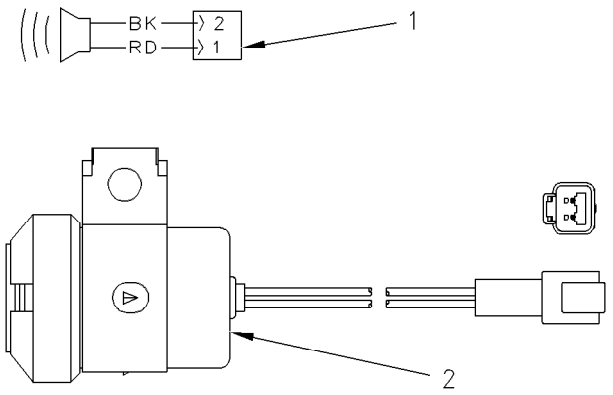


Illustration 82 g00307223

Action Alarm

(1) Schematic symbol. (2) Action alarm.

The action alarm connects to an output of the main display module. When the action alarm is audible, the machine needs immediate attention. A safe machine shutdown is required. The main display module will sound the action alarm whenever a warning category 3 problem exists. An alarm for a warning category 3 is a pulsating sound. The alarm for a warning category 2S is a continuous tone.

The action alarm does not operate when the engine is stopped. The main display module uses functions in order to determine when the engine is running. The following functions are examples: engine oil pressure, alternator speed and engine speed. If necessary, the action alarm SOUNDS when the main display module decides that the engine is running.

i02510502

Related Components

SMCS Code: 1408; 7450

Alternator

The R terminal of the alternator is connected to an input of the main display module. The main display module monitors the frequency at the R terminal of the alternator. This tells the main display module if the alternator is rotating.

Other Electronic Controls

Some machines have electronic control modules that communicate with the main display module. The Cat Data Link connects these electronic controls together. This connection allows the sharing of information. The following information is an example of the information that is shared: engine oil pressure, harness codes and diagnostic information. For example, an electronic engine control sends the engine speed information to the main display module over the Cat Data Link. In this situation, the engine speed sensor is not a Caterpillar Monitoring System component. If there is a problem with the engine speed sensor, the electronic engine control service manual would be used to troubleshoot the speed sensor circuit.

Troubleshooting Section

Introduction

i01400224

General Information

SMCS Code: 7490

Troubleshooting the Caterpillar Monitoring System requires additional information from the machine's Service Manual. The additional manuals that may be required are the Service Manual, the System Schematic, the Parts Manual and the Operation and Maintenance Manual for the machine that is being serviced.

As a guide, a typical system schematic is included at the end of this manual. For an accurate representation of the machine that is being diagnosed, refer to Electrical System Schematic in the Service Manual for the machine that is being serviced.

When the troubleshooting procedure instructs you to “REPAIR THE HARNESS”, use the Electrical System Schematic for the machine that is being serviced to trace the circuit. Perform continuity checks at the harness connectors in order to locate harness failures. At the connectors of the components, always check the ground circuit. Less than five ohms of resistance is required between the ground contacts of the connector and the frame ground. Excessive ground resistance that is greater than five ohms can cause incorrect diagnosing of problems.

During troubleshooting, inspect all connections before any component is replaced. If these connections are not clean and tight, permanent electrical problems or intermittent electrical problems can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

Failure of an electrical component can cause the failure of other components. Also, failure of an electrical component can be caused by the failure of other components. Always attempt to correct the cause of an electrical system failure before you replace a component.

i08199306

Service Tools

SMCS Code: 0785

The following service tools should be used to aid in troubleshooting the electrical system.

Table 15

Service Tools	
Part Number	**Part**
Current Version	CAT Electronic Technician (Cat-ET)
538-5051	Communication Adapter Gp
4C-8195	Control Service Tool
6V-7070 or 9U-7330	Digital Multimeter
8T-3224	Needle Tip Group
7X-1710	Multimeter Probe Group
8T-8726	Adapter Cable Assembly
6V-3000	Connector Repair Kit Sure Seal
9U-7246	Connector Repair Kit Deutsch (DT)
4C-3406	Connector Repair Kit (Deutsch)
4C-8195	Control Service Tool (Switch Box)
4C-3406	Connector Repair Kit
276-7273	Sensor Test Box (1)

(1) Instrument used to test Cylinder Position sensors.

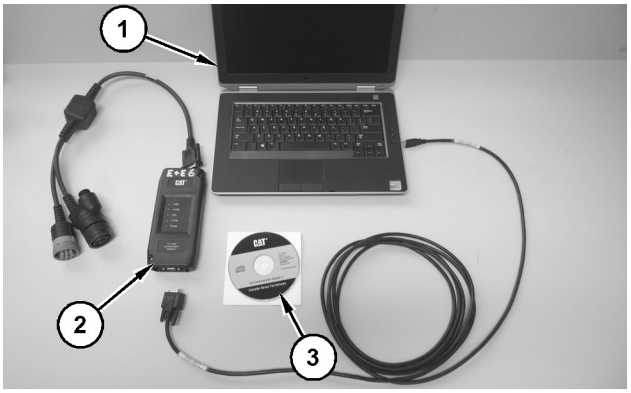


Illustration 83 g06114774

Connections for the Communication Adapter III and the Caterpillar Electronic Technician (ET)

The components that are needed to use the Communication Adapter III and the Caterpillar Electronic Technician to determine diagnostic codes are listed:

(1) Current version of Caterpillar Electronic Technician software and an IBM-COMPATIBLE personal computer
(2) 478-0235 Communication Adapter IIII
(3) Special Publication, JEBD3003, Special Publication, JERD2124, Special Publication, JERD2129: Caterpillar Electronic Technician software

Reference: Refer Special Publication, NEHS0758, “Communications Adapter II User Manual Contains Software”.

Note: Caterpillar Electronic Technician (Cat-ET) is a software program that can be used on an IBM compatible personal computer.

To use the Cat-ET service tool, order the following materials: Special Publication, JERD2124, “ET Single Use Program License”, Special Publication, JEHP1026, “Information and Requirements Sheet”, 7X-1425 Data Link Cable and the Data Subscription and Special Publication, JERD2142, “Data Subscription”. The Special Publication, JEHP1026, “Information and Requirements Sheet” lists the required hardware and the features of the Cat-ET service tool.

The Cat-ET service tool is not required to determine the diagnostic codes. The Cat-ET service tool is also not required to clear the diagnostic codes. However, the process of determining the diagnostic codes is easier and faster by using the ET. The ET can also display information on the history of a diagnostic code and the parameter status of diagnostic codes. These features allow the Cat-ET service tool to be useful tool in troubleshooting.

The Cat-ET service tool is used to communicate to the electronic control module over the data link by connecting to the machine diagnostic connector. For more information and the locations of the connectors, see Troubleshooting, “Electrical Components and Connector Locations” and the Electrical System Schematic in your machine Service Manual.

For instructions on servicing Sure Seal connectors, see Special Instruction, SMHS7531. For instructions on servicing Deutsch DT connectors, see Special Instruction, SEHS9615.

Use the digital multimeter for making continuity checks or for measuring voltage. For instructions about the use of the 6V-7070 Digital Multimeter, see Special Instruction, SEHS7734. The 7X-1710 Multimeter Probe measures the voltage at the connectors without disconnecting the connectors. The probe cables are pushed into the back of the connector along the wire. The 8T-8726 Adapter Cable has a three-pin breakout connector. The adapter cable is used for measurements in the sensor circuits.

Except for harness tests, the use of certain test equipment is not recommended for use on modern Caterpillar electrical circuits. Such testers include the following examples: the 8T-0500 Continuity Tester and 5P-7277 Voltage Tester.

Note: A procedure has been developed to test “In Cylinder” Position Sensors. Reference Special Instruction REHS7338, “Procedure to Test the Position Sensor of a Hydraulic Cylinder”.

Service Switches

During troubleshooting, use of the diagnostic operations of the Caterpillar Monitoring System is necessary. Service personnel must use the service switches to access the different display modes of diagnostic operation.

The switches are the momentary type of switch. The service personnel activate the switches by pressing and holding. Pressing the clear switch grounds the clear input (contact 33) of the monitor. Pressing the set switch grounds the service switch (contact 23) of the monitor. The location of the service switches will vary depending on the machine that is being serviced. Not all machines are equipped with service switches. For a more accurate location of the service switches, see the Electrical System Schematic in the Service Manual for the machine.

4C-8195 Control Service Tool



Illustration 84 g00743610

4C-8195 Control Service Tool

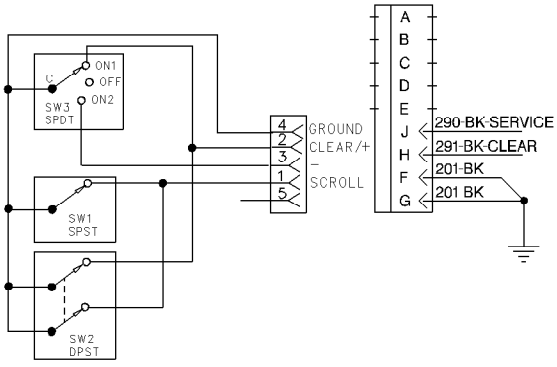


Illustration 85 g00778406

Schematic for the Control Service Tool

The 4C-8195 Control Service Tool is used on machines that are not equipped with service switches. The 4C-8195 Control Service Tool is helpful for the service person to make the proper electrical connections at the service connector during troubleshooting. Three connectors are wired in parallel so that the service tool is usable on the different types of machine harnesses.

Actuating the mode switch scrolls through the display modes. Actuating the scroll switch will scroll through the display while the main display module is in the service mode or the numeric readout mode. Actuating the clear switch clears the diagnostic code that is being continuously shown when the main display module is in service mode. Actuating the clear switch clears all extreme values when the main display module is in tattletale mode.

Changing Modes

Table 16

Activation Of Display Operations (Quick Reference)		
Display Operation	**Service Contact (1)**	**Clear Contact(1)**
Changing Modes:		
To Scroll	Ground	Ground
To Hold	Open	Open
Service Modes:		
To Scroll	Ground	Open
To Hold	Open(2)	Open
To Clear(3)	Open	Ground
Tattletale Mode:		
To Clear	Open	Ground
Numeric Readout Mode:		
To Scroll	Ground	Open
To Hold	Open	Open

(1) of the service connector.
(2) Open when the desired information is shown during scrolling.
(3) A diagnostic code can be cleared only while on hold. The diagnostic code for a fault that is currently present cannot be cleared

For a detailed explanation of the different modes, see Systems Operation , “Modes of Operation".

i02661635

Electrical Component and Connector Locations

SMCS Code: 7553-546-WW

General Information

The Electrical System Schematic, Parts Manual and Operation and Maintenance Manual for the machine that is being serviced should be used to locate electrical components and connectors.

The following information is a guide to reading the tables on the back of the Electrical System Schematic.

- The “Component Location” table uses white circles to mark the locations in the profile of the machine and in the area views. Alphabetical letters in the “Machine Location” column indicate a general area of the machine. Refer to the corresponding footnote at the end of the table for a description of the location.
- The “Harness Connector Location” table uses white circles to mark the locations in the general view and in the area views. Alphabetical letters in the “Machine Location” column indicate a general area of the machine. Refer to the corresponding footnote at the end of the table for a description of the location.

Note: The “Harness Connector Location” table uses black circles on certain electrical system schematics.

Connector Contact Numbers for the Main Display Module

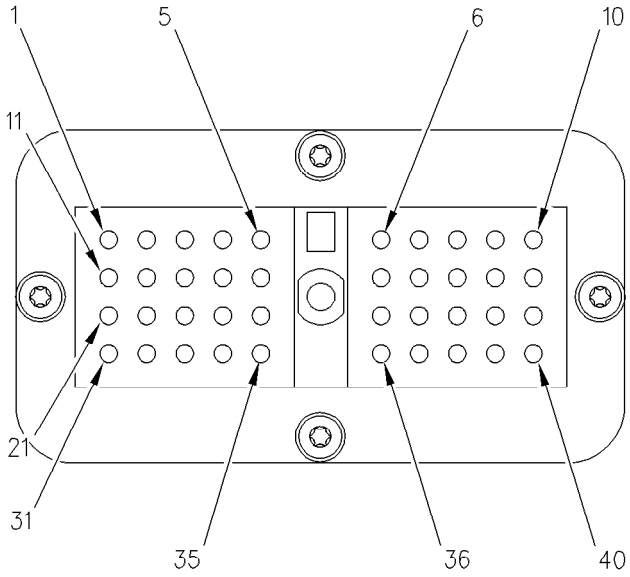


Illustration 86 g00309228

Connector of the main display module

Service Connector

The service connector provides access to the service and clear inputs of the main display module. Connector contact 1 is the service input and contact 2 is the clear input. Contacts 3 and 4 could be any wire from the 200 family. The service connector is usually located under the dashboard within the operator compartment. The service connector is a DT type of connector. For a more accurate location of the service connector, see the Electrical System Schematic in the Service Manual.

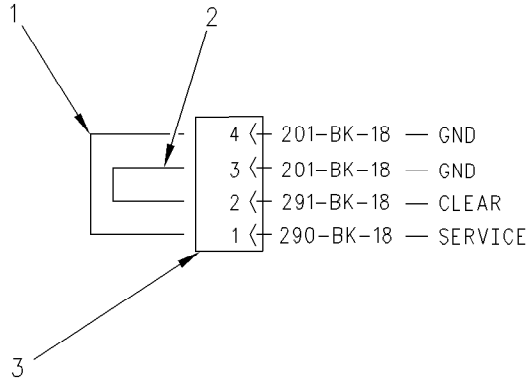


Illustration 87 g00309224

Service connector with jumpers (typical example)

(1) Jumper. Service contact grounded (2) Jumper. Clear contact grounded (3) Service connector.

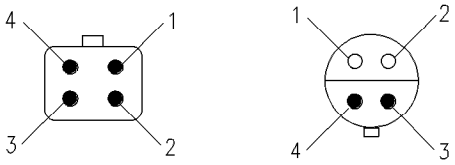


Illustration 88 g00309227

End view of service connectors

Various diagnostic functions require the grounding and/or the opening of the service and clear contacts at the service connector. During troubleshooting, it is necessary for the service person to make the proper electrical connections between the contacts of the service connector.

i01671837

Diagnostic Capabilities

SMCS Code: 7490

The Caterpillar Electronic Technician (ET)



Illustration 89 g00777826

The Caterpillar Electronic Technician (ET) is a software program that is used to access data. The service technician can use the Caterpillar Electronic Technician in order to perform maintenance work on the machine. Some of the options that are available with the Caterpillar Electronic Technician are listed below:

- View Diagnostic codes. See Troubleshooting, “Using the Caterpillar Electronic Technician to Determine Diagnostic Codes”.
- View the status of parameters.
- Clear active diagnostic codes and clear logged diagnostic codes
- Perform calibration of machine systems.
- Program the ECM (Flash). This is done with the “WINflash” program. See Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program”.
- Print reports.

The following list contains some of the diagnostic functions and programming functions that are performed by the service tools.

- The failures of the ECM system are displayed.
- The status of most of the inputs and the outputs are displayed.
- The settings for the ECM are displayed.
- Display the status of the input and output parameters in real time.

- Display the clock hour of the internal diagnostic clock.
- The number of occurrences and the clock hour of the first occurrence and the last occurrence is displayed for each logged diagnostic code.
- The definition for each logged diagnostic code and each event is displayed.
- Load new FLASH software.

See Troubleshooting, “Diagnostic Code List” for the list of diagnostic codes for the ECM.

See Troubleshooting, “Using the Caterpillar Electronic Technician to Determine Diagnostic Codes”. Diagnostic information is accessed with the following drop down menus:

- Active diagnostic codes
- Logged diagnostic codes

Status Groups For The Electronic Technician

The Status groups are lists of machine parameters. The status of the parameters are shown in real time.

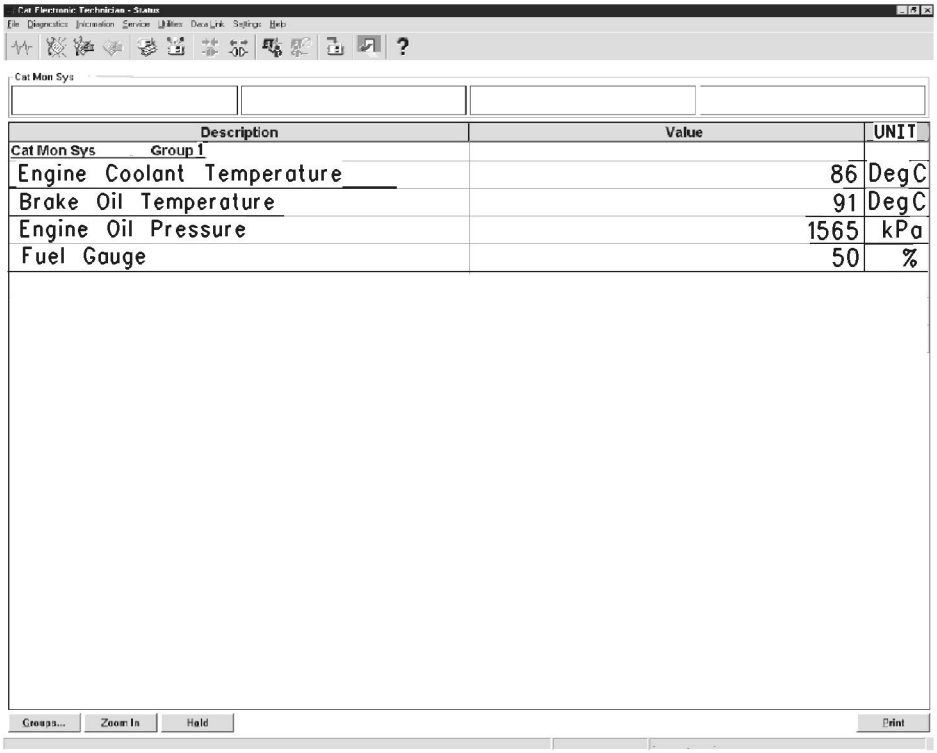


Illustration 90 g00867289
Typical ET Status Screen

Symptom Procedures

i04107169

Symptom Troubleshooting

SMCS Code: 7000-035

Use the following guidelines as you troubleshoot a symptom:

Know the Machine

Understand the operation of the machine. Know if the symptom is a characteristic of normal operation or if the symptom is a failure.

Read the systems operation information to understand the systems of the machine. Understand the interaction of the machine systems.

Understand the Symptom

Speak with the operator about the symptom. Acquire the following Information:

- The performance of the machine prior to the failure
- First occurrence of the symptom
- The operating conditions at the time of the failure
- The sequence of events prior to the failure (order of the occurrences)
- The troubleshooting steps that have been taken
- The history of repairs of the machine
- The preventive maintenance of the machine
- Related service information about current problems that affect the serial number of the machine
- Inspect the Machine. Look for problems. Notice any unusual odors in the air. Listen for unusual noises.

Verify the Symptom

When possible, attempt to duplicate the symptom. Operate the machine and repeat the conditions that caused the failure. Check the gauges inside the cab. Notice any unusual odors in the air. Listen for unusual noises.

Determine if the ECM has detected any faults. A diagnostic code is used to specify each detected fault.

Determine Possible Causes

Use the information from the operator and your inspection. Attempt to identify a common cause if there is more than one symptom.

If you troubleshoot diagnostic codes and the problem is not resolved, continue troubleshooting using the “Symptom Troubleshooting” section of this manual. Identify the component that is the most probable cause of the symptom.

Test and Repair the System

Use the tests and procedures in this manual to verify the cause of the symptom. Once the cause has been identified, repair the failure. Then, test the system again to verify that the symptom is resolved.

Provide Feedback to Caterpillar

Share your troubleshooting information. Use the form in “SIS” or “CBT” feedback to write a brief description about the symptom, testing, and repair. Include your phone number or e-mail address so that you can be contacted. This feedback information helps Caterpillar improve service information.

i04146390

Emerging Symptom Information

SMCS Code: 7000-035

This space is for new symptom information for this product.

Note: Use the Service Information System on the Web in order to find the most up-to-date information.

Share your troubleshooting knowledge of symptoms. Use the feedback form in “SIS” or “CBT” to write a brief description about the symptom, testing, and repair of the machine. Your feedback information will help Caterpillar improve the symptom information for this product.

i01395498

Alert Indicator Is Always Flashing

SMCS Code: 7400-035-IND

System Operation Description:

This procedure is for the parameter that has the alert indicator which is FLASHING constantly. This condition is caused by an undesired open circuit or a failed main display module.

The main display module is unable to identify system errors in simple circuits. No service code is available in order to assist the operator with troubleshooting. A possible problem exists when the operation of an alert indicator does not correspond to a known condition of the machine. For example, the alert indicator always FLASHES regardless of the actual pressure of the engine oil. Before you start troubleshooting, ensure that a diagnostic code exists. For a description of normal conditions that cause these events, see the Operation and Maintenance Manual for the machine that is being serviced. Perform the following procedures only if a fault is suspected.

Note: The indicator reflects the open or grounded condition of the switch inputs. When a switch input is open, the corresponding alert indicator FLASHES. When a switch input is grounded, the corresponding alert indicator is OFF. Therefore, in order to check a circuit, the service person opens the switch. Then, the service person grounds the switch. This is done while the service person is watching for the correct result on the alert indicator.

Test Step 1. LOCATE THE SWITCH.

A. Locate the switch which corresponds to the parameter that always FLASHES the alert indicator. (If necessary, use the Electrical System Schematic in order to assist in locating the switch.)

Expected Result:

The appropriate switch is located.

Results:

- OK – The appropriate switch is located.Proceed to test step 2.

Test Step 2. CHECK THE HARNESS.

A. Disconnect the signal wire from the switch.

B. Place a jumper wire from the signal wire to the ground wire. (If a ground wire is not present, connect the signal wire to frame ground.)

Expected Result:

The alert indicator continues FLASHING.

Results:

- YES – The alert indicator continues FLASHING. The machine harness is open or the main display module has failed.Proceed to test step 3.

- NO – The alert indicator stops FLASHING. The circuit is operating correctly. The switch has failed.

  Repair: Check or replace the switch.

  STOP.

Test Step 3. CHECK THE HARNESS.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. On the Electrical System Schematic, trace the signal wire from the switch to the main display module.

C. Determine the signal contact (connector contact) of the machine harness at the main display module.

D. Disconnect the machine harness from the main display module.

E. At the machine harness connector for the main display, check for continuity between the signal contact and contact 2 or frame ground if a ground wire is not present at contact 2. (The jumper is in place from the previous test.)

Expected Result:

The resistance is greater than 5.0 ohms.

Results:

- YES – The resistance is greater than 5 ohms.

  Repair: Repair the harness or replace the harness.

  STOP.

- NO – The resistance is less than 5 ohms. The harness is not causing the problem. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01397167

Alert Indicator Never Flashes

SMCS Code: 7450-035-IND

System Operation Description:

The main display module is unable to identify system errors in simple circuits. No service code is available in order to assist the operator with troubleshooting. A possible failure exists when the operation of an alert indicator does not correspond to a known condition of the machine. For example, the alert indicator never FLASHES regardless of the actual pressure of the engine oil. Before you start troubleshooting, ensure that a problem exists. For a description of normal conditions that cause these events, see the Operation and Maintenance Manual for the machine that is being serviced. Perform the following procedures only if a failure is suspected.

The indicator reflects the open or grounded condition of the switch inputs. When a switch input is open, the corresponding alert indicator FLASHES. When a switch input is grounded, the corresponding alert indicator is OFF. Therefore, in order to check a circuit, the service person opens the switch. Then, the service person grounds the switch. This is done while the service person is watching for the correct result on the alert indicator.

Test Step 1. LOCATE THE SWITCH

A. Locate the switch for the alert indicator that never flashes. (If necessary, use the Electrical System Schematic to assist in locating the switch.)

Expected Result:

The switch is located.

Results:

- OK – The switch is located.Proceed to test step 2.

Test Step 2. CHECK THE HARNESS.

A. Disconnect the signal wire from the switch.

Expected Result:

The alert indicator is FLASHING.

Results:

- YES – The alert indicator FLASHES. The circuit is operating correctly. The switch has failed.

  Repair: Repair the switch or replace the switch.

  STOP.

- NO – The alert indicator does NOT FLASH. The circuit has failed. The signal wire is probably shorted to ground.Proceed to test step 3.

Test Step 3. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The signal wire remains disconnected from the switch. Do not allow the signal wire to touch any objects.

C. On the Electrical System Schematic, trace the signal wire from the switch to the main display module.

D. Determine the signal contact (connector contact) of the machine harness at the main display module.

E. Disconnect the machine harness from the main display module.

F. At the machine harness connector for the display module, check for continuity between the signal contact and contact 2 or frame ground if a ground wire is not present at contact 2.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- YES – The resistance is greater than 5000 ohms. The harness is not causing the failure. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NO – The resistance is less than 5000 ohms. The harness has failed. The signal wire within the harness is shorted to ground.

  Repair: Repair the harness or replace the harness.

  STOP.

Diagnostic Code Procedures

i03642457

Diagnostic Code List

SMCS Code: 7569

Table 17

Diagnostic Codes For The Caterpillar Monitoring System (MID No. 030) [1]	
CID/FMI	**Description**
CID 0096 - Level Sender (Fuel):	
FMI 03	Signal voltage above normal or short to +battery
FMI 04	Voltage below normal or short to ground
FMI 08	Signal is abnormal
CID 0096 - Level Sensor (Fuel):	
FMI 08	Signal is abnormal
CID 0100 - Pressure Sensor (Engine Oil):	
FMI 08	Signal is abnormal
CID 0110 - Temperature Sensor (Engine Coolant):	
FMI 04	Voltage below normal or short to ground
FMI 08	Signal is abnormal
CID 0177 - Temperature Sensor (Transmission Oil):	
FMI 04	Voltage below normal or short to ground
FMI 08	Signal is abnormal
CID 0248 - Data Link:	
FMI 02	Data erratic, intermittent, or incorrect
CID 0263 - Sensor Power Supply:	
FMI 03	Signal voltage above normal or short to +battery
FMI 04	Voltage below normal or short to ground
CID 0271 - Alarm (Action):	
FMI 03	Signal voltage above normal or short to +battery
FMI 05	Current below normal or open circuit
FMI 06	Current above normal or short to ground
CID 0324 - Lamp (Action):	
FMI 03	Signal voltage above normal or short to +battery
FMI 05	Current below normal or open circuit

(continued)

(Table 17, contd)

Diagnostic Codes For The Caterpillar Monitoring System (MID No. 030) [1]	
CID/FMI	**Description**
FMI 06	Current above normal or short to ground
CID 0427 - Temperature Sensor (Front Axle Oil):	
FMI 08	Signal is abnormal
CID 0428 - Temperature Sensor (Rear Axle Oil):	
FMI 08	Signal is abnormal
CID 0600 - Temperature Sender (Hydraulic Oil):	
FMI 03	Signal voltage above normal or short to +battery
FMI 04	Voltage below normal or short to ground
FMI 08	Signal is abnormal
CID 0600 - Temperature Sensor (Hydraulic Oil):	
FMI 08	Signal is abnormal
CID 0819 - Display Data Link:	
FMI 02	Data erratic, intermittent, or incorrect
FMI 15	Invalid code
FMI 31	Invalid code
CID 0821 - Display Power Supply:	
FMI 03	Signal voltage above normal or short to +battery
FMI 04	Voltage below normal or short to ground
CID 0826 - Temperature Sender (Torque Converter Oil):	
FMI 03	Signal voltage above normal or short to +battery
FMI 04	Voltage below normal or short to ground
FMI 08	Signal is abnormal
CID 0826 - Temperature Sensor (Torque Converter Oil):	
FMI 08	Signal is abnormal
CID 0830 - Temperature Sensor (Brake Oil):	
FMI 08	Signal is abnormal
CID 1791 - Saw Pressure Sensor:	
FMI 08	Signal is abnormal

[1] This table pertains only to diagnostic codes with a MID of 030.

Note: Every machine may not have all of the diagnostic codes that are listed in the preceding table. Also, every machine may not have all the FMI for a given CID.

Note: The preceding table shows the diagnostic codes for the Caterpillar Monitoring System. When the Caterpillar Monitoring System is in the service mode, diagnostic codes from the other electronic control modules are shown on the display area of the Caterpillar Monitoring System. The information from the diagnostic code is transferred from other electronic control modules via the Cat Data Link to the main display module. This diagnostic information is shown when the main display module is in the service mode. The module identifier (MID) indicates the electronic control module that is sending the diagnostic code. The MID for the Caterpillar Monitoring System is “030” . This Service Manual is used for diagnostic codes with a MID of “030” . The MID of other electronic control modules on a particular machine are listed on the Electrical System Schematic. Troubleshooting information for those diagnostic codes can be found in the service manual for that system.

Note: When a sensor diagnostic code is present, the corresponding warning for that sensor is also activated for the operator. For example, if the signal wire for the engine coolant temperature sensor is shorted to the +battery, then the following actions take place:

- The corresponding diagnostic code is stored in memory.
- The gauge for the engine coolant temperature is indicating in the warning region.
- The action lamp is FLASHING.

Notice that the second and third above items are the same warning indications that are activated if the engine overheats.

i02510638

Using Caterpillar Monitoring System to Determine Diagnostic Codes

SMCS Code: 7490; 7569

Procedure

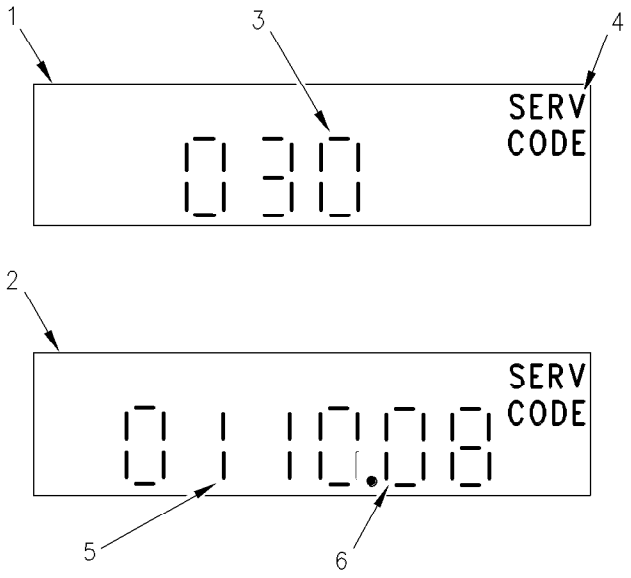


Illustration 91 g00429460

Display Area

(1) First display. (2) Second display. (3) Module identifier (MID). (4) service code indicator (SERV CODE). (5) Component identifier (CID). (6) Failure mode identifier (FMI).

Note: Illustration 91 shows the display from current production machines. The CID is now four digits. A decimal point “.” has replaced the “F” . The “F” came before the FMI. The display that is seen on earlier models is shown in illustration 92 .

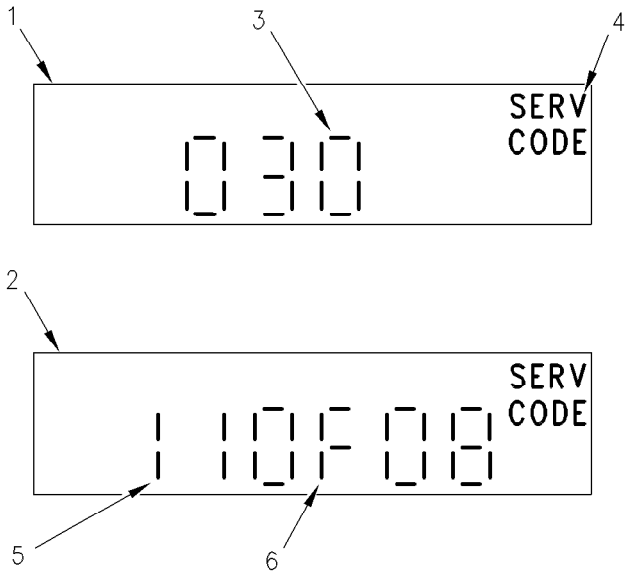


Illustration 92 g00300658

Display Area

(1) First display. (2) Second display. (3) Module identifier (MID). (4) Service code indicator (SERV CODE). (5) Component identifier (CID). (6) Failure mode identifier (FMI).

The following procedures may cause new diagnostic codes to be logged. Therefore, before any procedures are performed make a list of all the active diagnostic codes in order to determine the system problems. Clear the diagnostic codes that were caused by the procedure, when each procedure is complete.

Note: Before performing a procedure, always check all the circuit breakers. Repair the cause of any circuit breaker that is tripped.

Use the following procedure to troubleshoot diagnostic code information.

1. Place the Caterpillar Monitoring System in service mode (mode 3). In order to place the Caterpillar Monitoring System in service mode, close the service and clear switches. Open the switches when service mode “3” is shown on the display.

Note: The diagnostic scrolling mode may be entered in order to see the diagnostic codes, but the diagnostic codes can be more easily diagnosed by using the service mode. The service mode allows the diagnostic codes to be placed on hold for further investigation. The service mode allows the diagnostic codes to be cleared when the problem has been fixed.

2. The diagnostic code is shown and the diagnostic code is on hold at this time. The display toggles between showing MID (3) and CID (5) and FMI (6). If you are in the service mode and a diagnostic code is not present, “—” will be displayed.

3. In order to view all the diagnostic codes, scroll through the diagnostic codes. In order to scroll through the diagnostic codes, close the service switch. The display momentarily shows MID (3), CID (5) and FMI (6) for each diagnostic code. The word “End” will be shown after the last diagnostic code in the list.

4. Place the desired diagnostic code on hold. In order to place the diagnostic code on hold, open the service switch when the desired diagnostic code is shown.

5. Use the information from the MID in order to determine the ECM that is generating the diagnostic code. If the MID is not 030, see Electrical System Schematic, “Module Identifier (MID) Table” of the machine that is being serviced. Use the table to determine the ECM that has detected the diagnostic code. Then see the service manual module for that electronic control. If the MID is 030, use this Service Manual Module to troubleshoot the diagnostic code that is generated.

6. Observe the “SERV CODE” indicator (4). In the service mode, the “SERV CODE” indicator functions as a “SERV CODE” indicator.

- If the “SERV CODE” indicator (4) shows “SERV CODE” , then the failure that caused the diagnostic code that is shown is currently present.
- If the “SERV CODE” indicator (4) is OFF, then the diagnostic code that caused the diagnostic code that is shown is not present at this time.

7. See the corresponding test in order to troubleshoot the diagnostic code. Use the Service Manual for the ECM that is generating the diagnostic code.

8. After a diagnostic code is corrected, clear the diagnostic code. In order to clear the diagnostic code, close the clear switch while the diagnostic code is on hold. After clearing, the display advances to the next available diagnostic code.

9. Repeat Steps 2 through 8 for the remaining diagnostic codes. Return to the normal mode when you are finished. In order to return to the normal mode, close the service and clear switches. Open the switches when mode “0” is shown on the display.

i07545261

Using Caterpillar Electronic Technician to Determine Diagnostic Codes

SMCS Code: 0785-UE; 7569

Connect Cat ® Electronic Technician (Cat ® ET) to the machine. Turn the key start switch to the RUN position. Start Cat ® ET. Cat ® ET will initiate communications with the Electronic Control Modules on the machine. After communication has been established, Cat ® ET will list the Electronic Control Modules. Choose the desired Electronic Control Module. After the diagnostic codes have been determined with Cat ® ET, refer to the test procedure for the corresponding diagnostic code.

Reference: Troubleshooting, “Service Tools”

Active Diagnostic Codes

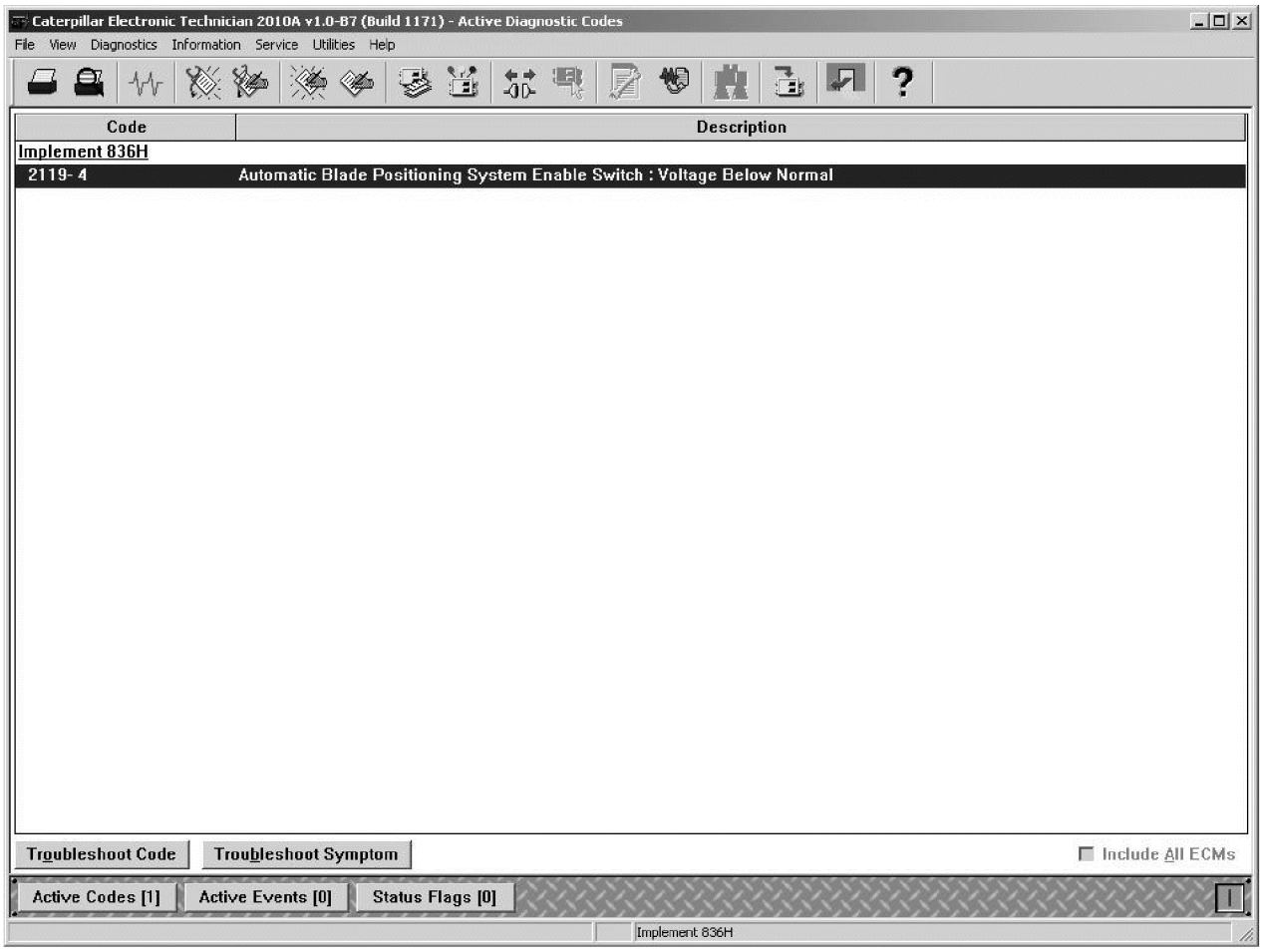


Illustration 93 g02052559

Typical Cat ® ET screen for active diagnostic codes

The following procedures may cause new diagnostic codes to be logged. Therefore, before any procedures are performed, make a list of all the active diagnostic codes to determine the system problems. Clear the diagnostic codes that were caused by the procedure, when each procedure is complete.

Note: Before performing a procedure, always check all the circuit breakers. Repair the cause of any circuit breaker that is tripped.

A screen is provided in Cat ® ET for active diagnostic codes. The screen will display the diagnostic codes that are active. Active diagnostic information shall include a component identifier (CID), a failure mode identifier (FMI), and a text description of the problem.

Logged Diagnostic Codes

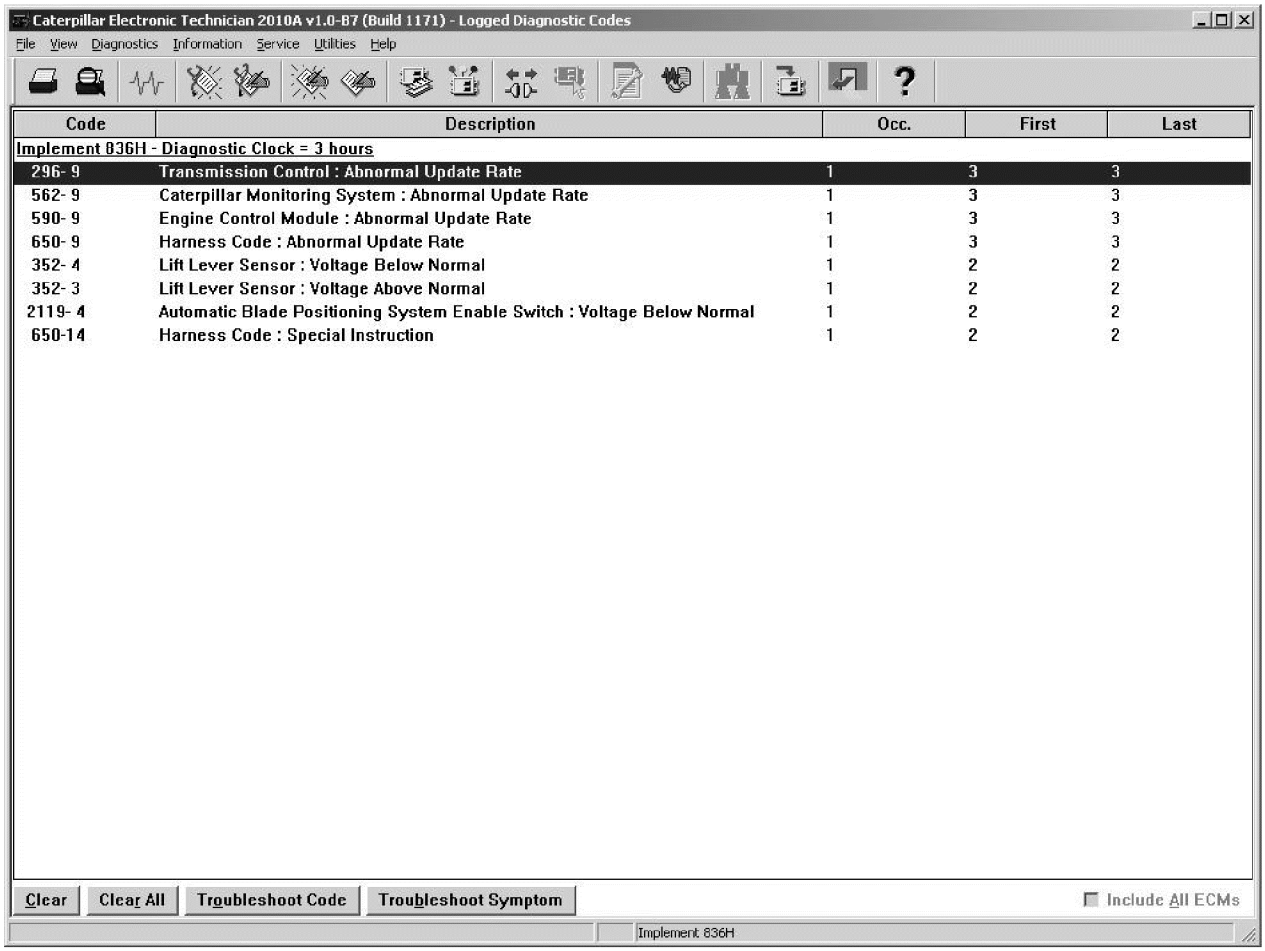


Illustration 94 g02052574

Typical Cat ® ET screen for logged diagnostic codes

A screen is provided in Cat ® ET for logged diagnostic codes. The screen will display diagnostic codes that are logged. Cat ® ET will log diagnostic codes that are intermittent. The logged diagnostic data shall include a component identifier (CID), a failure mode identifier (FMI), and a text description of the problem. Also, the logged diagnostic data shall include the number of occurrences of the problem and two time stamps. The time stamp displays the first occurrence of the problem and the time stamp displays the most recent occurrence of the problem.

Diagnostics are logged in non-volatile memory. On powerup, the ECM will clear any diagnostic codes that have not been detected or active within the last 150 hours of machine operation.

i01392326

MID 030 - CID 0096 - FMI 03

SMCS Code: 1273-038-UN

Conditions Which Generate This Code:

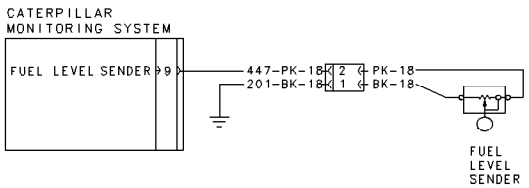


Illustration 95 g00314973

Schematic for the fuel level sender

This diagnostic code is recorded when the main display module reads the signal voltage. The voltage from the sender is too high. The corresponding gauge (fuel level) will indicate an abnormally low fuel level. The following causes could signal this diagnostic code:

- The sender has failed.
- The ground circuit for the sender in the machine harness is shorted to +battery.
- The signal circuit in the machine harness is shorted to +battery.
- The signal circuit in the machine harness is open or the sender is disconnected.
- The main display module has failed.

Service Notes: Ensure that the desired diagnostic code (CID and FMI) is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS.

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” for the diagnostic code.

C. Disconnect the machine harness from the sender that is causing the diagnostic code.

D. Connect the signal wire 447-PK(Pink) to the ground wire 201-BK(Black) on the machine harness connector.

E. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator remains ON.

Results:

- YES – The diagnostic code indicator remains ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sender has failed.

  Repair: Replace the sender.

  STOP.

Test Step 2. CHECK FOR AN OPEN GROUND.

A. Remove the jumper wire between the signal wire 447-PK(Pink) and the ground wire 201-BK(Black).

B. Turn the disconnect switch and the key start switch to the OFF position.

C. Measure the resistance between frame ground and the ground wire for the sender.

Expected Result:

The resistance is 5 ohms or less.

Results:

- YES – The resistance is 5 ohms or less.Proceed to test step 3.
- NO – The resistance is greater than 5 ohms. The ground wire for the harness is open.

  Repair: Repair the ground wire or replace the ground wire for the sender.

  STOP.

Test Step 3. CHECK THE SIGNAL WIRE FOR THE SENDER.

A. Turn the disconnect switch and the key start switch to the ON position.

B. Measure the voltage between the frame ground and the signal wire for the sender.

Expected Result:

The voltage measurement should be within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT 6.0 BUT ABOVE 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01678452

MID 030 - CID 0096 - FMI 04

SMCS Code: 1273-038-UN

Conditions Which Generate This Code:

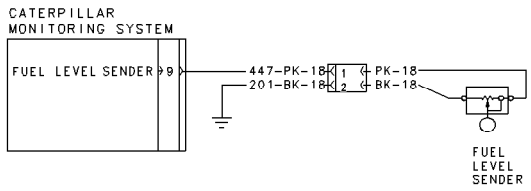


Illustration 96 g00866238

Schematic for the fuel level sender

This diagnostic code is recorded when the main display module reads the signal voltage of the fuel level sender and the voltage is too low.

The possible causes of this failure are listed here:

- The sender has failed.
- The signal circuit in the machine harness is shorted to ground.
- The main display module has failed. This is unlikely.

This failure causes the fuel gauge to always indicate an empty fuel tank or the fuel gauge may intermittently indicate an empty fuel tank.

Test Step 1. CHECK THE SENDER.

A. Disconnect the machine harness from the sender.

Expected Result:

The diagnostic code changes from CID 0096 FMI 04 to CID 0096 FMI 03.

Results:

- OK – The diagnostic code changed from CID 0096 FMI 04 to CID 0096 FMI 03. This indicates that the failure is no longer present. The sender has failed.

  Repair: Replace the sender.

  STOP.

- NOT OK – The diagnostic code remains. The failure remains present. The sender is not causing the failure. Proceed to test step 2.

Test Step 2. CHECK THE HARNESS.

A. The sender remains disconnected from the machine harness.

B. Turn the disconnect switch and the key start switch to the OFF position.

C. Disconnect the J1 machine harness connector from the main display module.

D. At the machine harness connector for the sender, measure the resistance between the signal contact 1 (wire 447-PK(Pink)) and frame ground.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. The main display module has failed.

  Repair: It is unlikely that the ECM has failed. Exit this procedure, and perform this procedure again. If the failure is not found, replace the ECM. See Testing and Adjusting, “ Module - Replace”.

  STOP.

- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed. There is a short between frame ground and the signal circuit in the machine harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

i01916153

MID 030 - CID 0096 - FMI 08

SMCS Code: 1273-038-UN

Conditions Which Generate This Code:

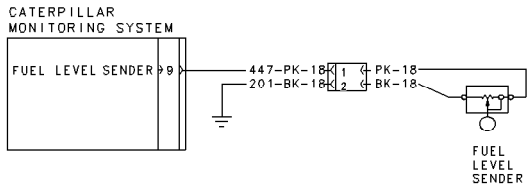


Illustration 97 g00866238

Schematic for the fuel level sender

Service Notes: Ensure that the desired code (CID and FMI) is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Sensor Signal Voltage” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage ”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i01916177

MID 030 - CID 0100 - FMI 08

SMCS Code: 1924-038-NS

Conditions Which Generate This Code:

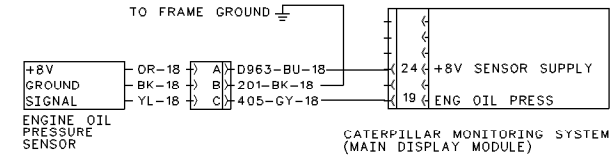


Illustration 98 g00590014

Schematic for the pressure sensor (engine oil)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Sensor Signal Voltage ” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i01393112

MID 030 - CID 0110 - FMI 04

SMCS Code: 1906-038-ENG

Conditions Which Generate This Code:

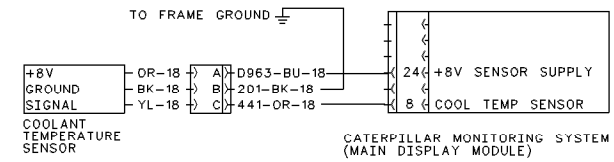


Illustration 99 g00443488

Schematic for temperature sensor (engine coolant)

This diagnostic code is recorded when the main display module reads the sensor signal as being too low. As a result of this diagnostic code the corresponding gauge will indicate an abnormally high value. The possible causes are listed below:

- The sensor has failed.
- The signal circuit in the machine harness is shorted to ground.
- The main display module has failed.

Note: The main display module is unable to determine when a sensor is open or when the harness has an open. This condition is recognized as a gauge that has an indicator at the far left side of the scale.

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS.

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” .

C. Disconnect the machine harness from the sensor that is causing the problem.

D. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is ON.

Results:

- YES – The diagnostic code indicator stays ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sensor has failed.

  Repair: Replace the sensor.

  STOP.

Test Step 2. CHECK THE SIGNAL WIRE FOR A SHORT TO GROUND.

A. The machine harness remains disconnected from the sensor.

B. The disconnect switch and the key start switch remain in the ON position.

C. At the machine harness connector for the sensor, measure the voltage. Measure the voltage from contact “C” (wire 441-OR(Orange)) and frame ground.

Expected Result:

The voltage that is measured is within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sensor.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT 6.0 BUT ABOVE 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sensor.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01916181

MID 030 - CID 0110 - FMI 08

SMCS Code: 1906-038-ENG

Conditions Which Generate This Code:

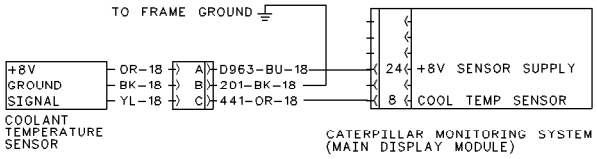


Illustration 100 g00443488

Schematic for the temperature sensor (engine coolant)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the fault present indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Senor Signal Voltage” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i01393820

MID 030 - CID 0177 - FMI 04

SMCS Code: 3080-038-NS; 3080-038-UN

Conditions Which Generate This Code:

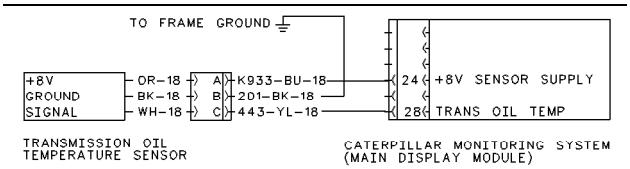


Illustration 101 g00594692

Schematic for the temperature sensor (transmission oil)

This diagnostic code is recorded when the main display module reads a low sensor signal. As a result of this diagnostic code the corresponding gauge will indicate an abnormally high value. The possible causes are listed below:

- The sensor has failed.
- The signal circuit in the machine harness is shorted to ground.
- The main display module has failed.

Note: The main display module is unable to determine when a sensor is open or a sensor signal harness is open. Also, the main display module is unable to determine when the resistance is too high. This condition is recognized as a gauge that has an indicator at the far left side of the scale.

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS.

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” .

C. Disconnect the machine harness from the sensor that is causing the problem.

D. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is ON.

Results:

- YES – The diagnostic code indicator stays ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sensor has failed.

  Repair: Replace the sensor.

  STOP.

Test Step 2. CHECK THE SIGNAL WIRE FOR A SHORT TO GROUND.

A. The machine harness remains disconnected from the sensor.

B. The disconnect switch and the key start switch remain in the ON position.

C. At the machine harness connector for the sensor, measure the voltage. Measure the voltage from contact “C” (wire 443-YL(Yellow)) and frame ground.

Expected Result:

The voltage that is measured is within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT 6.0 BUT ABOVE 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. It is unlikely that the main display module has failed. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01916184

MID 030 - CID 0177 - FMI 08

SMCS Code: 3080-038-NS; 3080-038-UN

Conditions Which Generate This Code:

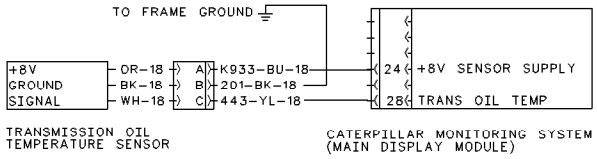


Illustration 102 g00594692

Schematic for the temperature sensor (transmission oil)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and the wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Senor Signal Voltage” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i08164718

MID 030 - CID 0248 - FMI 02

SMCS Code: 7490-038

Conditions Which Generate This Code:

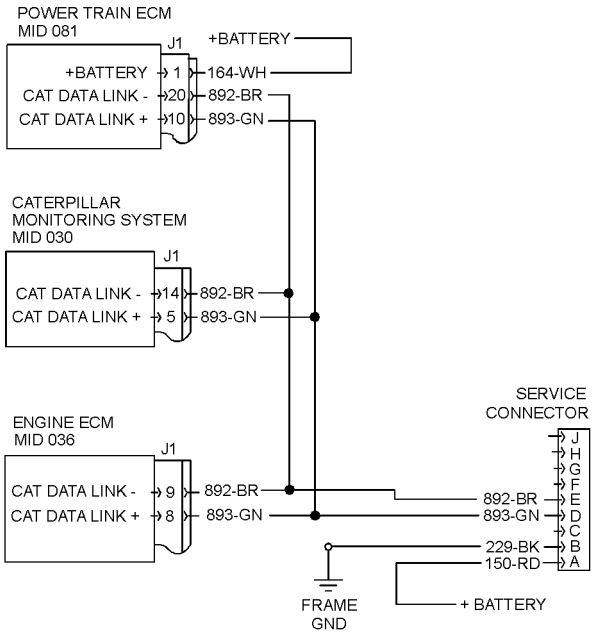


Illustration 103 g06584539

Schematic for the Cat Data Link

This diagnostic code is recorded when the main display module does not receive expected information. The following example shows a possible diagnostic code. The information from the actual gear status is not being received from other electronic control modules through the Cat Data Link. The information from the Cat Data Link indicates the abnormal values in the readout. The possible causes of this diagnostic code are listed below. The causes are listed in order of probability:

- Poor electrical connection at a machine harness connector
- The circuit for the Cat Data Link in the machine harness is shorted to ground.
- The circuit for the Cat Data Link in the machine harness is shorted to the +battery.
- The circuit for the Cat Data Link in the machine harness is open.

Note: An electronic control module which uses the Cat Data Link may have lost power or an electronic control may have failed. This situation is unlikely. If the main display module was recently replaced, refer to Topic “Main Display Module Initialization - Adjust“.

Service Notes: Ensure that the desired diagnostic code (CID and FMI) is on hold. Ensure that the service code indicator shows “SERV CODE” .

Test Step 1. CHECK FOR OTHER CODES.

A. Check other electronic control modules for a similar diagnostic code. If a similar diagnostic code is found, exit this test. Perform the corresponding procedures for the other diagnostic codes that are shown.

Expected Result:

There are other diagnostic codes that are showing.

Results:

- YES – Exit this procedure and perform the other procedures for the diagnostic codes that are shown.

  STOP.

- NO – There are not any other diagnostic codes that are shown.Proceed to test step 2.

Test Step 2. INSPECT THE HARNESS CONNECTORS.

A. Turn the disconnect switch to the OFF position.

B. Inspect the connections for the machine harness that are related to the Cat Data Link.

C. Make sure that connectors are clean and tight.

Expected Result:

The machine harness is correct.

Results:

- OK – The machine harness is correct.Proceed to test step 3.
- NOT OK – The machine harness is not correct.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK FOR A SHORT TO GROUND.

A. The disconnect switch remains OFF.

B. Disconnect the machine harness from all the electronic control modules that use the Cat Data Link.

C. At the machine harness connector for the main display module, measure the resistance between frame ground and the Cat Data Link circuits (contacts 5 and 14).

Expected Result:

The resistance that is measured is less than 5000 ohms.

Results:

- YES – The resistance is less than 5000 ohms. The machine harness has failed. There is a short between the frame ground and the Cat Data Link circuit in the machine harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

- NO – The resistance is greater than 5000 ohms. The harness circuit resistance is correct.Proceed to test step 4.

Test Step 4. CHECK FOR A SHORT TO THE +BATTERY.

A. The disconnect switch remains OFF.

B. All related control modules remain disconnected from the machine harness.

C. At the machine harness connector for the main display module, measure the resistance between the +battery (contact 1) and the Cat Data Link circuits (contacts 5 and 14).

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct.Proceed to test step 5.

- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed. There is a short between the +battery and the Cat Data Link circuit in the machine harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK FOR AN OPEN HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. All related control modules remain disconnected from the machine harness.

C. Check the continuity of the Cat Data Link circuit in the machine harness.

D. Measure the resistance from contact 5 (Wire 893-GN(Green)) of the main display module to the corresponding connector contact (Wire 893-GN(Green)) of each related ECM.

E. Measure the resistance from contact 14 (Wire 892-BR(Brown)) of the main display module to the corresponding connector contact (Wire 892-BR(Brown)) of each related ECM.

Expected Result:

The resistance is less than 5 ohms.

Results:

- YES – The resistance is less than 5 ohms. The Cat Data Link circuit in the machine harness is correct.

  Repair: Failure of the main display module is unlikely. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. Refer to Topic “Module - Replace“.

  STOP.

- NO – The resistance is greater than 5 ohms. The machine harness has failed. The Cat Data Link circuit is open in the machine harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

i01394334

MID 030 - CID 0263 - FMI 03

SMCS Code: 7490-038-NS

Conditions Which Generate This Code:

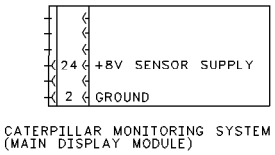


Illustration 104 g00530637

Schematic for the sensor power supply

This diagnostic code is recorded when the main display module reads an above normal sensor supply voltage (+8 DCV).

Note: The procedures that are used to troubleshoot this diagnostic code may cause additional diagnostic codes to be logged. Find the cause and repair the cause of this diagnostic code before you troubleshoot any new diagnostic codes.

Test Step 1. CHECK THE VOLTAGE AT THE MAIN DISPLAY MODULE.

A. Use the 7X-1710 Multimeter Probe in order to check the voltage at the connector for the main display module. Measure the voltage from the contact 24 to the contact 2 (ground). DO NOT disconnect the harness from the module.

Expected Result:

The supply voltage that is measured is 8.0 ± 0.5 DCV.

Results:

- YES – The voltage is 8.0 ± 0.5 DCV. The sensor supply voltage is correct. Verify that the diagnostic code is still present. If the diagnostic code is still present the main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NO – The voltage is NOT 8.0 ± 0.5 DCV. The sensor supply voltage is NOT correct.Proceed to test step 2.

Test Step 2. CHECK THE HARNESS FOR A SHORT TO +BATTERY.

A. Disconnect the machine harness from the main display module.

B. At the machine harness connector for the main display module, measure the voltage from the connector contact 24 to 2 (ground).

Expected Result:

The voltage that is measured should be approximately 0 DCV.

Results:

- YES – The voltage is approximately 0 DCV. The voltage is correct.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NO – The voltage is NOT approximately 0 DCV. The harness or a sensor has failed.Proceed to test step 3.

Test Step 3. DISCONNECT THE SENSORS.

A. Disconnect one of the sensors that are connected to the +8 DCV sensor supply of the main display module from the machine harness.

B. After you disconnect the sensor, measure the voltage from the connector contact 2 (ground) to contact 24 of the machine harness connector for the main display module.

Expected Result:

The voltage that is measured should be approximately 0 DCV.

Results:

- YES – The voltage is approximately 0 DCV. The voltage is correct. The sensor that was just disconnected has failed.

Repair: Replace the sensor.

STOP.

- NO – The voltage is NOT approximately 0 DCV. The harness or a sensor has failed. Repeat this test. The machine harness is shorted to the +battery if all the sensors have been disconnected from the machine harness and the voltage is NOT approximately 0 DCV.

  Repair: Repair the harness or replace the harness.

  STOP.

i01394435

MID 030 - CID 0263 - FMI 04

SMCS Code: 7490-038-NS

Conditions Which Generate This Code:

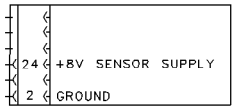


Illustration 105 g00530356

Schematic for the sensor power supply

This diagnostic code is recorded when the main display module reads the signal voltage. The voltage from the sensor is too low.

Test Step 1. CHECK THE VOLTAGE AT THE MAIN DISPLAY.

A. Use the 7X-1710 Multimeter Probe in order to check the voltage at the connector for the main display module. Measure the voltage from contact 24 to contact 2 (ground). DO NOT disconnect the harness from the module.

Expected Result:

The voltage measures 8.0 ± 0.5 DCV.

Results:

- YES – The voltage is 8.0 ± 0.5 DCV. The sensor supply voltage is correct. Verify that the diagnostic code exists.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NO – The voltage is NOT 8.0 ± 0.5 DCV. The sensor supply voltage is NOT correct.Proceed to test step 2.

Test Step 2. DISCONNECT THE SENSORS.

A. Continue to monitor the sensor supply voltage.

B. Disconnect one of the sensors that are connected to the +8 DCV sensor supply of the main display module from the machine harness.

C. After you disconnect the sensor, check the voltage reading on the multimeter.

Expected Result:

The voltage that is measured is 8.0 ± 0.5 DCV.

Results:

- YES – The voltage is 8.0 ± 0.5 DCV. The sensor supply is correct. The sensor that was just disconnected has failed.

  Repair: Replace the sensor.

  STOP.

- NO – The voltage is NOT 8.0 ± 0.5 DCV. Repeat this test step for the remaining sensors. If the voltage is NOT correct after the remaining sensors are disconnected and tested. Continue to the next test step.Proceed to test step 3.

Test Step 3. CHECK FOR A SHORT TO GROUND.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The sensors remain disconnected.

C. Disconnect the machine harness from the main display module.

D. At the machine harness connector for the main display module, measure the resistance between the frame ground and the sensor supply circuit (connector contact 24).

Expected Result:

The resistance that is measured is greater than 5000 ohms.

Results:

- YES – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NO – The resistance is less than 5000 ohms. The machine harness has failed. There is a short to ground in the machine harness.

  Repair: Repair the harness or replace the harness.

  STOP.

i01394484

MID 030 - CID 0271 - FMI 03

SMCS Code: 7407-038

Conditions Which Generate This Code:

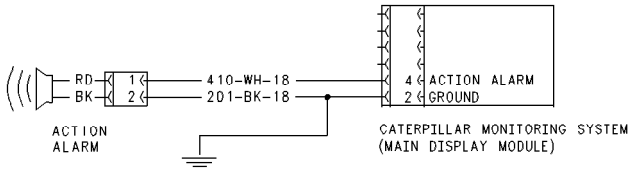


Illustration 106 g00544121

Schematic for the alarm (action)

This diagnostic code is recorded when the main display module reads the voltage of the circuit for the action alarm as above normal. The result of this diagnostic code is the continuous sounding of the action alarm. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

CHECK THE ALARM CIRCUIT.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Disconnect the machine harness from the main display module.

C. Turn the disconnect switch to the ON position.

D. Listen for the SOUNDING of the action alarm.

E. Turn the key start switch to the ON position.

Expected Result:

The alarm is sounding.

Results:

- YES – The alarm is SOUNDING. The harness circuit 410-WH(White) is shorted to the +battery.

  Repair: Repair the harness or replace the harness.

  STOP.

- NO – The alarm does NOT SOUND. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01394545

MID 030 - CID 0271 - FMI 05

SMCS Code: 7407-038

Conditions Which Generate This Code:

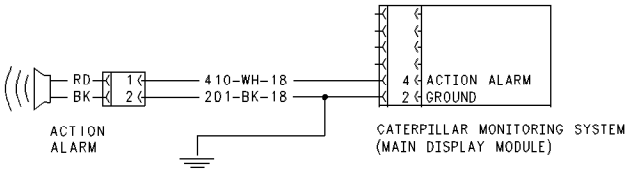


Illustration 107 g00544121

Schematic for the alarm (action)

This diagnostic code is recorded when the main display module reads the current of the action alarm. The current for the action alarm is below normal. The action alarm does not SOUND as a result of this diagnostic code. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE ALARM.

A. Disconnect the machine harness from the alarm.

B. At the machine harness connector for the alarm, place a jumper across the two contacts.

Expected Result:

The CID 0271 FMI 05 is still present.

Results:

- YES – The CID 0271 FMI 05 remains present. The action alarm is not causing the diagnostic code. Verify that the action alarm is correct. The correct resistance for a good alarm is 200 ± 100 ohms. Proceed to test step 2.
- NO – The CID 0271 FMI 05 is NO longer present. The alarm is open.

  Repair: Replace the action alarm. Verify that the action alarm is open. The correct resistance for a good alarm is 200 ±100 ohms.

  STOP.

Test Step 2. CHECK THE HARNESS.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Remove the jumper from the connector of the alarm and reconnect the alarm to the machine harness.

C. Disconnect the machine harness from the main display module.

D. At the machine harness connector for the module, measure the resistance between contact 4 (410-WH(White)) and frame ground.

Expected Result:

The resistance is greater than 300 ohms.

Results:

- OK – The resistance is greater than 300 ohms. The harness circuit is open.Proceed to test step 3.
- NOT OK – The resistance is less than 300 ohms. The harness circuit resistance is correct.Proceed to test step 4.

Test Step 3. CHECK THE HARNESS.

A. Disconnect the machine harness from the alarm.

B. Check for an open in the circuit 410-WH(White). Check between the harness connector for the main display module (contact 4) and the harness connector for the action alarm (contact 1).

C. Check for an open in the circuit 201-BK(Black). Check between the harness connector for the action alarm (contact 2) and the frame ground.

Expected Result:

The machine harness is correct.

Results:

- OK – The machine harness is correct.

  STOP.

- NOT OK – The machine harness is not correct.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE MAIN DISPLAY MODULE.

A. Reconnect the machine harness connector to the main display module.

B. Reconnect the alarm to the machine harness.

C. Turn the disconnect switch and the key start switch to the ON position.

Expected Result:

The CID 0271 FMI 05 is still present.

Results:

- YES – The CID 0271 FMI 05 remains present. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NO – The diagnostic code is NO longer active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01394618

MID 030 - CID 0271 - FMI 06

SMCS Code: 7407-038

Conditions Which Generate This Code:

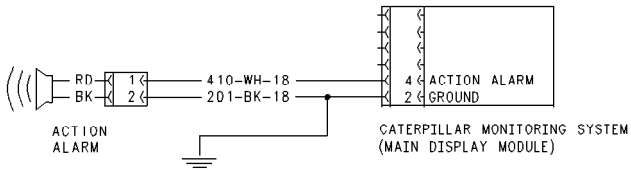


Illustration 108 g00544121

Schematic for the alarm (action)

This diagnostic code is recorded when the main display module reads the voltage of the circuit for the action alarm as above normal. The action alarm does not SOUND as a result of this diagnostic code. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE ALARM.

A. Disconnect the machine harness from the alarm.

Expected Result:

The CID 0271 FMI 06 remains present.

Results:

- OK – The diagnostic code remains present. The action alarm is not causing the diagnostic code. Proceed to test step 2.
- NOT OK – The diagnostic code is NO longer present. The correct resistance for a good alarm is 200 ± 100 ohms. The alarm has failed.

  Repair: Replace the action alarm.

  STOP.

Test Step 2. CHECK THE HARNESS.

A. Turn the disconnect switch to the OFF position.

B. The alarm remains disconnected from the machine harness.

C. Disconnect the machine harness from the main display module.

D. At the machine harness connector for the main display module, measure the resistance between contact 4 (410-WH(White)) and frame ground.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness resistance is correct.Proceed to test step 3.
- NOT OK – The resistance is less than 5000 ohms. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE MODULE.

A. Remove contact 4 from the machine harness connector for the main display module by using the correct service tools.

B. Reconnect the machine harness connector to the module.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Place the same diagnostic code on hold and check the service code indicator.

Expected Result:

The CID 0271 FMI 06 is present.

Results:

- OK – The CID 0271 FMI 06 remains present. The main display module has failed.

  Repair: It is unlikely that the module has failed. Exit this procedure and perform this diagnostic code procedure again. If the problem has not been found, then replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The diagnostic code is NO longer active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01394739

MID 030 - CID 0324 - FMI 03

SMCS Code: 7431-038-LMP

Conditions Which Generate This Code:

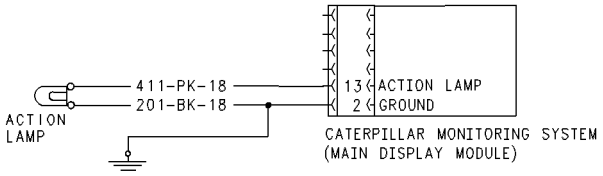


Illustration 109 g00544436

Schematic for the lamp (action)

This diagnostic code is recorded when the main display module reads the voltage of the circuit for the action lamp as above normal. The action lamp is ON CONTINUOUSLY as a result of this diagnostic code. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

CHECK THE LAMP CIRCUIT.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Disconnect the machine harness from the main display module.

C. Turn the disconnect switch to the ON position.

D. Observe the action lamp.

E. Turn the key start switch to the ON position.

Expected Result:

The action lamp is ON.

Results:

- OK – The action lamp is ON. The harness circuit 411-PK(Pink) is shorted to the +battery.

  Repair: Repair the harness or replace the harness.

  STOP.

- NOT OK – The action lamp is OFF. The module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01394817

MID 030 - CID 0324 - FMI 05

SMCS Code: 7431-038-LMP

Conditions Which Generate This Code:

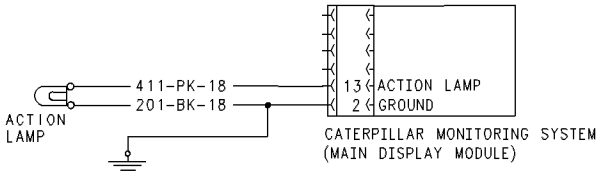


Illustration 110 g00544436

Schematic for the action lamp

This diagnostic code is recorded when the main display module reads the current of the circuit for the action lamp and the current is below normal. The action lamp does not light as a result of this diagnostic code. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE LAMP.

A. At the action lamp, use a jumper to connect wire 411-PK(Pink) to frame ground.

Expected Result:

The CID 0324 FMI 05 is no longer present.

Results:

- OK – The CID 0324 FMI 05 is no longer present. The lamp or the lamp socket is open.

  Repair: Replace the action lamp. **NOTE: For the purposes of this test, the correct resistance for a lamp is less than 200 ohms.**

  STOP.

- NOT OK – The CID 0324 FMI 05 is present. The action lamp is not causing the diagnostic code. Proceed to test step 2.

Test Step 2. CHECK THE HARNESS.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Remove the jumper from wire 411-PK(Pink) to frame ground. Make sure that the action lamp is connected to the machine harness.

C. Disconnect the machine harness from the main display module.

D. At the machine harness connector for the main display module, measure the resistance between contact 13 (411-PK(Pink)) and frame ground.

Expected Result:

The resistance is greater than 100 ohms.

Results:

- OK – The resistance is greater than 100 ohms. The harness circuit is open.Proceed to test step 3.
- NOT OK – The resistance is less than 100 ohms. The harness circuit resistance is correct. Replace the main display module.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

Test Step 3. CHECK THE HARNESS.

A. At the action lamp, disconnect wire 411-PK(Pink) from the lamp socket.

B. Check for an open in the circuit 411-PK(Pink). Check between contact 13 of the harness connector for the main display module and the lamp socket.

C. Check for an open in the circuit 201-BK(Black). Check between the lamp socket and the frame ground.

Expected Result:

The circuits are correct.

Results:

- OK – The circuits are correct.

  STOP.

- NOT OK – The circuits are NOT correct.

  Repair: Repair the harness or replace the harness.

  STOP.

i01394886

MID 030 - CID 0324 - FMI 06

SMCS Code: 7431-038-LMP

Conditions Which Generate This Code:

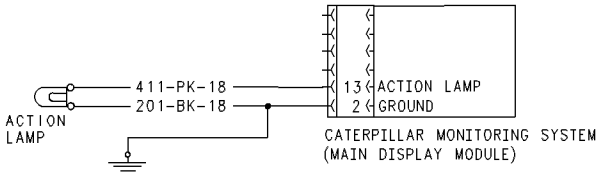


Illustration 111 g00544436

Schematic for the action lamp

This diagnostic code is recorded when the main display module reads the voltage of the circuit for the action lamp and the current is above normal. The action lamp does not light as a result of this diagnostic code. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE LAMP.

A. At the action lamp, disconnect wire 411-PK(Pink) from the lamp socket.

Expected Result:

The CID 0324 FMI 06 is present.

Results:

- OK – The CID 0324 FMI 06 is present. The action lamp is not causing the diagnostic code.Proceed to test step 2.
- NOT OK – The CID 0324 FMI 06 is NO longer present. The lamp or the lamp socket has failed. The correct resistance for a lamp is greater than 10 ohms.

  Repair: Replace the action lamp.

  STOP.

Test Step 2. CHECK THE HARNESS.

A. Turn the disconnect switch to the OFF position.

B. Wire 411-PK(Pink) remains disconnected from the action lamp.

C. Disconnect the machine harness from the main display module.

D. At the machine harness connector for the main display module, measure the resistance between contact 13 (411-PK(Pink)) and frame ground.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The harness resistance is correct.Proceed to test step 3.
- NOT OK – The resistance is less than 5000 ohms. The harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK THE MAIN DISPLAY MODULE.

A. Remove contact 13 from the machine harness connector for the main display module.

B. Reconnect the harness connector to the main display module.

C. Turn the disconnect switch and the key start switches to the ON position.

D. Place the same diagnostic code on hold. Check the service code indicator.

Expected Result:

The CID 0324 FMI 06 is present.

Results:

- OK – The CID 0324 FMI 06 remains present. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The diagnostic code is NO longer active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i04790645

MID 030 - CID 0427 - FMI 03

SMCS Code: 3260-038-NS

Conditions Which Generate This Code:

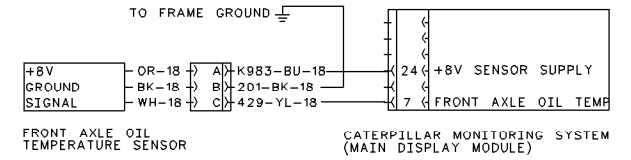


Illustration 112 g00738248

Schematic of the temperature sensor (front axle oil)

This diagnostic code is associated with the temperature sensor (front axle oil). The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The possible causes of this diagnostic code are listed below:

- The sensor signal circuit in the machine harness is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- Failure of the ECM is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0427 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. Turn the key start switch and the disconnect switch to the ON position.

C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the voltage supply wire (contact A).

D. Measure the voltage from the contact A to frame ground.

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV.Proceed to Test Step 2.
- NOT OK – The voltage is not 8 DCV. The + battery circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

A. The machine harness remains connected to the sensor.

B. Turn the key start switch and the disconnect switch to the OFF position.

C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (contact A).

D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

E. Measure the resistance from contact B to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness from the sensor.

C. At the harness connector for the sensor, connect a jumper wire between contact B and contact C.

D. Disconnect the machine harness connectors from the ECM.

E. At the harness connector for the ECM, measure the resistance between contact 7 (wire 429-YL(Yellow)) and frame ground (wire 201-BK(Black)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

  Repair: There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.

C. The machine harness connector remains disconnected from the ECM.

D. At the machine harness connector for the ECM, measure the resistance from the signal contact 7 (wire 429-YL(Yellow)) of the machine harness to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.
- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

  Repair: The short is between signal contact 7 (wire 429-YL(Yellow)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

A. Reconnect the machine harness connectors to the ECM. Reconnect the machine harness connector to the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

Expected Result:

The signal from the sensor is valid.

Results:

- OK – The signal from the sensor is valid.Proceed to Test Step 6.
- NOT OK – The signal from the sensor is not valid.

  Repair: The sensor has failed. Replace the sensor.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0427 FMI 03.

Expected Result:

The CID 0427 FMI 03 is active.

Results:

- YES – The CID 0427 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: If the cause of the problem is not found, the ECM may have failed, however ECM failure is unlikely. Prior to replacing an ECM, always contact the Technical Communicator at your dealership for possible consultation with Caterpillar. This consultation may reduce repair time. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0427 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i04790682

MID 030 - CID 0427 - FMI 04

SMCS Code: 3260-038-NS

Conditions Which Generate This Code:

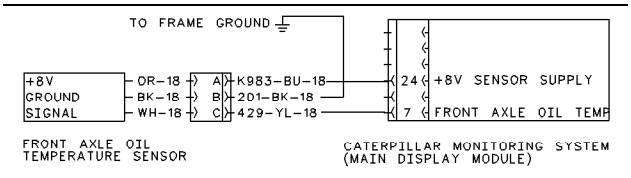


Illustration 113 g00738248

Schematic of the temperature sensor (front axle oil)

This diagnostic code is associated with the front axle oil temperature sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the sensor is below normal.

The pressure sensors are PWM sensors. The PWM signal is dependent on the input pressure and the signal will vary.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- Failure of the ECM is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0427 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Ensure that the diagnostic code is active.

C. Observe the status of the diagnostic code. Disconnect the sensor from the machine harness.

Expected Result:

The CID 0427 FMI 04 remains active. The FMI has not changed and the 04 is still active.

Results:

- OK – The diagnostic code remains active. The sensor is correct.Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

  Repair: Replace the sensor.

  STOP.

Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the sensor.

C. Disconnect the machine harness connector from the ECM.

D. At the machine harness connector for the ECM, measure the resistance from the signal contact 7 (wire 429-YL(Yellow)) of the machine harness to all possible sources of ground. Measure the resistance to all contacts of the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

  Repair: The short is between signal contact 7 (wire 429-YL(Yellow)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the contacts.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0427 FMI 04.

Expected Result:

The CID 0427 FMI 04 is active.

Results:

- YES – The CID 0427 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: If the cause of the problem is not found, the ECM may have failed, however ECM failure is unlikely. Prior to replacing an ECM, always

contact the Technical Communicator at your dealership for possible consultation with Caterpillar. This consultation may reduce repair time. If the ECM that has failed, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 0427 FMI 04 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01916188

MID 030 - CID 0427 - FMI 08

SMCS Code: 3260-038-NS

Conditions Which Generate This Code:

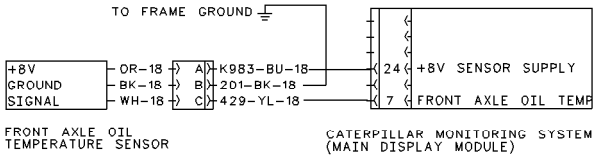


Illustration 114 g00738248

Schematic for the temperature sensor (front axle oil)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and the wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Sensor Signal Voltage” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i04790676

MID 030 - CID 0428 - FMI 03

SMCS Code: 3260-038-NS

Conditions Which Generate This Code:

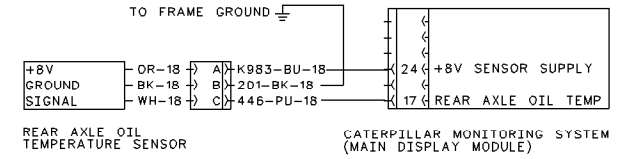


Illustration 115 g00738273

Schematic of the temperature sensor (Rear axle oil)

This diagnostic code is associated with the temperature sensor (Rear axle oil). The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The pressure sensors are PWM sensors. The PWM signal is based on the input pressure and the signal will vary.

The possible causes of this diagnostic code are listed below:

- The sensor signal circuit in the machine harness is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- Failure of the ECM is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0428 FMI 03 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

A. Do not disconnect the harness connector from the sensor.

B. Turn the key start switch and the disconnect switch to the ON position.

C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the voltage supply wire (contact A).

D. Measure the voltage from the supply to frame ground.

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV.Proceed to Test Step 2.
- NOT OK – The voltage is not 8 DCV. The + battery circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

A. The machine harness remains connected to the sensor.

B. Turn the key start switch and the disconnect switch to the OFF position.

C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (contact A).

D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

E. Measure the resistance from ground wire to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct.Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  Repair: Replace the machine harness or repair the machine harness.

  STOP.

Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness from the sensor.

C. At the harness connector for the sensor, connect a jumper wire between contact B and contact C.

D. Disconnect the machine harness connectors from the ECM.

E. At the harness connector for the ECM, measure the resistance between contact 17 (wire 446-PU(Purple)) and frame ground (wire 201-BK(Black)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The circuit is correct.Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

  Repair: There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

  STOP.

Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The key start switch and the disconnect switch remain in the OFF position.

B. The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.

C. The machine harness connector remains disconnected from the ECM.

D. At the machine harness connector for the ECM, measure the resistance from the signal contact 17 (wire 446-PU(Purple)) of the machine harness to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.
- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

  Repair: The short is between signal contact 17 (wire 446-PU(Purple)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

A. Reconnect the machine harness connectors to the ECM. Reconnect the machine harness connector to the sensor.

B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the signal wire (contact C).

C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).

D. Turn the disconnect switch and the key start switch to the ON position.

E. Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

Expected Result:

The signal from the sensor is valid.

Results:

- OK – The signal from the sensor is valid.Proceed to Test Step 6.
- NOT OK – The signal from the sensor is not valid.

  Repair: The sensor has failed. Replace the sensor.

  STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0428 FMI 03.

Expected Result:

The CID 0428 FMI 03 is active.

Results:

- YES – The CID 0428 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: If the cause of the problem is not found, the ECM may have failed, however ECM failure is unlikely. Prior to replacing an ECM, always contact the Technical Communicator at your dealership for possible consultation with Caterpillar. This consultation may reduce repair time. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

  STOP.

- NO – The CID 0428 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i04790680

MID 030 - CID 0428 - FMI 04

SMCS Code: 3260-038-NS

Conditions Which Generate This Code:

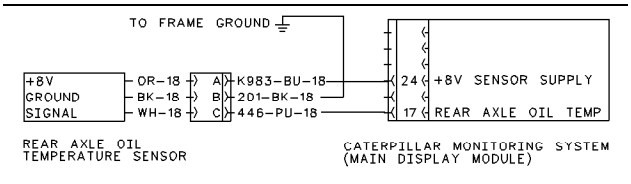


Illustration 116 g00738273

Schematic of the temperature sensor (rear axle oil)

This diagnostic code is associated with the rear axle oil temperature sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the sensor is below normal.

The pressure sensors are PWM sensors. The PWM signal is dependent on the input pressure and the signal will vary.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- Failure of the ECM is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0428 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SENSOR

A. Turn the disconnect switch and the key start switch to the ON position.

B. Ensure that the diagnostic code is active.

C. Observe the status of the diagnostic code. Disconnect the sensor from the machine harness.

Expected Result:

The CID 0428 FMI 04 remains active. The FMI has not changed and the “04” is still active.

Results:

- OK – The diagnostic code remains active. The sensor is correct.Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

  Repair: Replace the sensor.

  STOP.

Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the sensor.

C. Disconnect the machine harness connector from the ECM.

D. At the machine harness connector for the ECM, measure the resistance from the signal contact 17 (wire 446-PU(Purple)) of the machine harness to all possible sources of ground. Measure the resistance to all contacts of the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

  Repair: The short is between signal contact J2-37 (wire 446-PU(Purple)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the contacts.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 0428 FMI 04.

Expected Result:

The CID 0428 FMI 04 is active.

Results:

- YES – The CID 0428 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: If the cause of the problem is not found, the ECM may have failed, however ECM failure is unlikely. Prior to replacing an ECM, always

contact the Technical Communicator at your dealership for possible consultation with Caterpillar. This consultation may reduce repair time. If the ECM that has failed, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 0428 FMI 04 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i01916194

MID 030 - CID 0428 - FMI 08

SMCS Code: 3260-038-NS

Conditions Which Generate This Code:

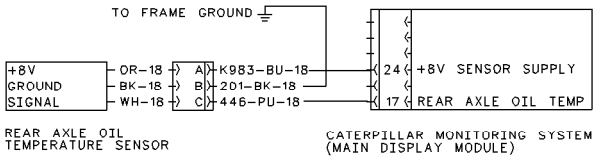


Illustration 117 g00738273

Schematic of the temperature sensor (rear axle oil)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and the wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Sensor Signal Voltage” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i01944171

MID 030 - CID 0600 - FMI 03

SMCS Code: 5050-038-UN; 5050-038-NS

Conditions Which Generate This Code:

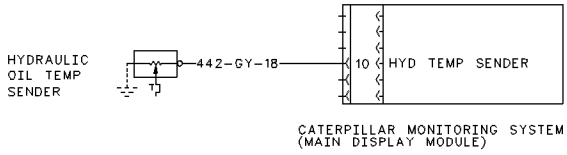


Illustration 118 g00315182

Schematic of the Temperature Sender (Hydraulic Oil)

This diagnostic code is recorded when the main display module reads the signal from the sender and the signal is too high. The possible causes are listed below:

- The sender has failed.
- The signal circuit in the machine harness is shorted to the + battery.
- The main display module has failed.

Note: Very low resistance in the sender causes the main display module to read the signal wire as having voltage too low. Low resistance can be caused by a short to ground in the signal circuit. This would cause the corresponding gauge on the display to indicate an abnormally high value. Very high resistance in the sender causes the main display module to read the signal wire as having voltage too high. High resistance can be caused by an open in the signal circuit. The internal circuitry of the main display module would pull a high voltage in the signal wire. This condition is recognized as a gauge that always has an indicator at the far left side of the scale.

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the fault present indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS.

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” .

C. Disconnect the machine harness from the sender that is causing the problem.

D. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is ON.

Results:

- YES – The diagnostic code indicator stays ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sender has failed.

  Repair: Replace the sender.

  STOP.

Test Step 2. CHECK FOR AN OPEN GROUND.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Measure the resistance between frame ground and the ground wire for the sender.

Expected Result:

The resistance is 5 ohms or less.

Results:

- YES – The resistance is 5 ohms or less.Proceed to test step 3.
- NO – The resistance is greater than 5 ohms. The ground wire for the harness is open.

  Repair: Repair the ground wire or replace the ground wire for the sender.

  STOP.

Test Step 3. CHECK THE SIGNAL WIRE FOR THE SENDER.

A. The machine harness remains disconnected from the sender.

B. The disconnect switch and the key start switch remain in the ON position.

C. At the machine harness connector for the sender, measure the voltage. Measure the voltage between the frame ground and the signal wire (442-GY(Grey)).

Expected Result:

The voltage that is measured is within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck the status of the diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck the status of the diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT 6.0 BUT ABOVE 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck the status of the diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i04859992

MID 030 - CID 0600 - FMI 04

SMCS Code: 5050-038-UN; 5050-038-NS

Conditions Which Generate This Code:

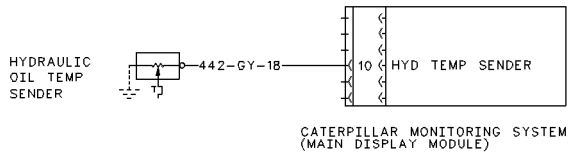


Illustration 119 g00315182

Schematic for the temperature sender (hydraulic oil)

This diagnostic code is recorded when the main display module reads the signal from the sender and the signal is too low. As a result of this diagnostic code the corresponding gauge will indicate an abnormally high value. The possible causes are listed below:

- The sender has failed.
- The signal circuit in the machine harness is shorted to ground.
- The main display module has failed.

Note: Very low resistance in the sender causes the main display module to read the signal wire as having voltage too low. Low resistance can be caused by a short to ground in the signal circuit. This would cause the corresponding gauge on the display to indicate an abnormally high value. Very high resistance in the sender causes the main display module to read the signal wire as having voltage too high. High resistance can be caused by an open in the signal circuit. The internal circuitry of the main display module would pull a high voltage in the signal wire. This condition is recognized as a gauge that always has an indicator at the far left side of the scale.

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the fault present indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” .

C. Disconnect the machine harness from the sender that is causing the problem.

D. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is ON.

Results:

- YES – The diagnostic code indicator stays ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sender has failed.

  Repair: Replace the sender.

  STOP.

Test Step 2. CHECK THE SENDER WIRE FOR A SHORT TO GROUND

A. The machine harness remains disconnected from the sender.

B. The disconnect switch and the key start switch remain in the ON position.

C. At the machine harness connector for the sender, measure the voltage. Measure the voltage between frame ground and the sender signal wire (442-GY(Grey)).

Expected Result:

The voltage that is measured is within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 5.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

STOP.

i01715320

MID 030 - CID 0600 - FMI 08

SMCS Code: 5050-038-UN; 5050-038-NS

Conditions Which Generate This Code:

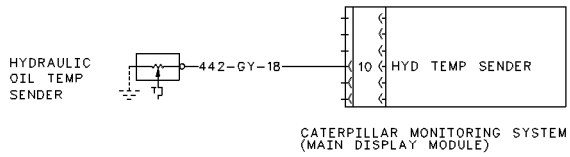


Illustration 120 g00315182

Schematic for the temperature sender (hydraulic oil)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

System Response:

The CID-FMI is logged in memory. The CID-FMI may be viewed on a display module or the ET. The ECM flags hydraulic oil temperature as invalid data.

Note: Go to Troubleshooting, “Temperature Sender” in order to troubleshoot this component.

Perform the following diagnostic procedure:
“Temperature Sender”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i03850569

MID 030 - CID 0819 - FMI 02

SMCS Code: 7450-038

Conditions Which Generate This Code:

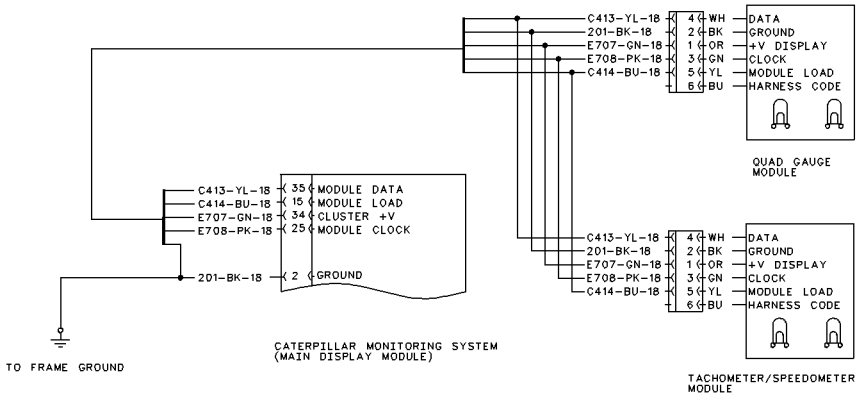


Illustration 121 g00737908

Schematic for the display power supply

This diagnostic code is recorded when the main display module does not receive expected information. When the main display module sends information to a display component, the display component sends a signal back to the main display module. The signal confirms correct information. When the main display module does not receive expected information, the diagnostic code is logged. As a result of this diagnostic code, the main display module may not respond to the information that is received. Gauges and readouts could be incorrect when the main display module is in normal mode. Check the connections for the display data link. Check for opens or shorts in the harness wiring for the display data link.

Test Step 1. INSPECT THE HARNESS CONNECTIONS.

A. Turn the disconnect switch to the OFF position.

B. Inspect the harness connections that are related to the display data link. Make sure that the connectors are clean and tight.

C. Check the mating of the harness connectors.

D. Check wires at the connector.

E. Check each wire for nicks or signs of abrasion in the insulation.

F. Check for moisture at the connector.

G. Check for dirty contacts or corroded contacts.

H. Check each pin and each socket.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and free of corrosion. Proceed to test step 2.
- NOT OK – The machine harness connectors are NOT tight and free of corrosion.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK FOR A SHORT TO +BATTERY.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the harness from the main display module.

C. Disconnect the machine harness connectors from all of the display components.

D. At the harness connectors for the main display module, measure the resistance between the contacts that are listed below:

- Connector contact 1(+ Battery) and the Display Data Link circuit contact 4 (wire C413-YL(Yellow)).
- Connector contact 1 (+ Battery) and the Display Data Link circuit contact 5 (wire C414-BU(Blue)).
- Connector contact 1 (+ Battery) and the Display Data Link circuit contact 3 (wire E708-PK(Pink)).

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. Proceed to test step 3.
- NOT OK – The resistance is less than 5 ohms. The machine harness has failed.

  Repair: There is a short between the +battery and the circuits of the display data link in the machine harness. Replace the machine harness or repair the machine harness.

  STOP.

Test Step 3. CHECK FOR AN OPEN HARNESS.

A. The disconnect switch and the key start switch remain in the OFF position.

B. All the display modules remain disconnected from the machine harness.

C. Measure the resistance of the circuits of the display data link that are listed below:

- Measure the resistance between connector contact 35 (wire C413-YL(Yellow)) to connector contact 4 (wire C413-YL(Yellow)) of the main display module.
- Measure the resistance between connector contact 15 (wire C414-BU(Blue)) to connector contact 5 (wire C414-BU(Blue)) of the main display module.
- Measure the resistance between connector contact 25 (wire E708-PK(Pink)) to connector contact 3 (wire E708-PK(Pink)) of the main display module.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The circuit resistance is correct.Proceed to test step 4.
- – The resistance is greater than 5000 ohms.

  Repair: There is an open in the machine harness. Repair the machine harness or Replace the machine harness.

  STOP.

Test Step 4. CHECK FOR A SHORT TO GROUND

A. The disconnect switch and the key start switch remain in the OFF position.

B. The main display module and all the display components remain disconnected from the machine harness.

C. At the machine harness connector for the main display module, measure the resistance between frame ground and the connector contacts 35 (wire C413-YL(Yellow)), 15 (wire C414-BU(Blue)) and 25(wire E708-PK(Pink)) of the display data link.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The resistance of the circuit is correct.Proceed to test step 5.
- NOT OK – The resistance is less than 5000 ohms. The resistance of the circuit is not correct.

  Repair: There is a short between frame ground and the circuits of the display data link in the machine harness. Replace the machine harness or repair the machine harness.

  STOP.

Test Step 5. CHECK FOR + 12 DCV

A. Reconnect all modules to the machine harness.

B. Turn the disconnect switch and the key start switch to the ON position.

C. Use the 7X-1710 Cable probes to check the voltage at the contact 1 (wire E707-GN(Green)) to contact 2 (wire 201-BK(Black)) of the main display module.

Expected Result:

The voltage is 9.0 ± 0.5 DCV.

Results:

- OK – The voltage is 9.0 ± 0.5 DCV.

  Repair: Replace the main display module.

  STOP.

- NOT OK – The voltage is NOT 9.0 ± 0.5 DCV. The voltage is not correct.

  Repair: The main display module has failed. It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. If the problem is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i03626961

MID 030 - CID 0819 - FMI 15

SMCS Code: 7450-038

Conditions Which Generate This Code:

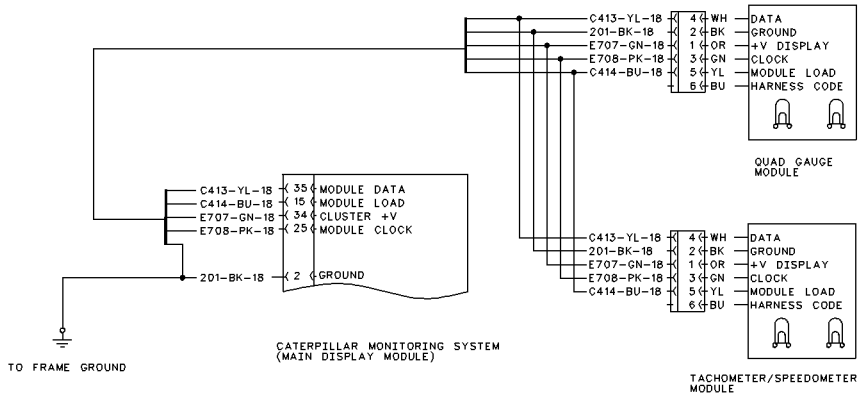


Illustration 122 g00737908

Schematic for the display power supply

CID 0819 FMI 15 is an invalid code and can be cleared by resetting the monitor harness code.

INITIALIZE THE SYSTEM

Note: Refer to the released electrical schematic for your machine in order to determine if your machine has a physical connection for the code plug. Not all machines have a harness code plug installed. If the connections for the harness code circuits are all open, the machine has harness code information hard wired into the machine harness.

A. Power down the machine.

B. Remove the harness code plug.

C. Power up the machine for one minute.

D. Replace the harness code plug.

Expected Result:

The invalid diagnostic code has been cleared.

Results:

- OK – The invalid diagnostic code has been cleared.

  STOP.

- NOT OK – The diagnostic code is still active.

  Repair: Refer to Testing and Adjusting, “Main Display Module Initialization - Adjust” in order to further diagnose the problem.

  STOP.

i03626963

MID 030 - CID 0819 - FMI 31

SMCS Code: 7450-038

Conditions Which Generate This Code:

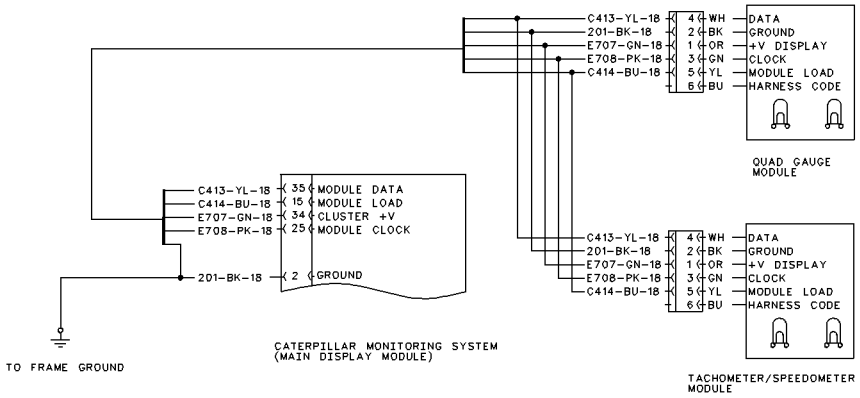


Illustration 123 g00737908

Schematic for the display power supply

CID 0819 FMI 31 is an invalid code and can be cleared by resetting the monitor harness code.

INITIALIZE THE SYSTEM

Note: Refer to the released electrical schematic for your machine in order to determine if your machine has a physical connection for the code plug. Not all machines have a harness code plug installed. If the connections for the harness code circuits are all open, the machine has harness code information hard wired into the machine harness.

A. Power down the machine.

B. Remove the harness code plug.

C. Power up the machine for one minute.

D. Replace the harness code plug.

Expected Result:

The invalid diagnostic code has been cleared.

Results:

- OK – The invalid diagnostic code has been cleared.

  STOP.

- NOT OK – The diagnostic code is still active.

  Repair: Refer to Testing and Adjusting, “Main Display Module Initialization - Adjust” in order to further diagnose the problem.

  STOP.

i01395272

MID 030 - CID 0821 - FMI 03

SMCS Code: 7450-038

Conditions Which Generate This Code:

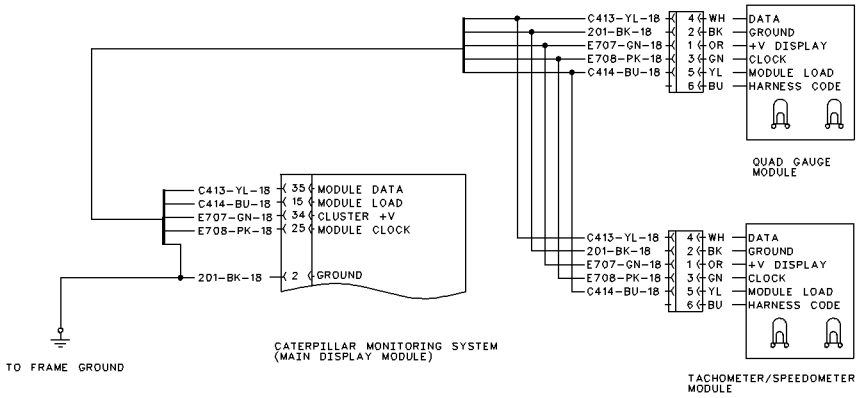


Illustration 124 g00737908

Schematic for the display power supply

This diagnostic code is recorded when the main display module reads the voltage of the display power supply circuit and the voltage is above normal. Normal display power supply voltage is 9.0 ± 0.5 DCV. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE VOLTAGE AT THE MAIN DISPLAY MODULE.

A. Use the 7X-1710 Multimeter Probe Group. Check the voltage at the connector for the main display module. Measure the voltage from the contact 34 to the contact 2 (ground).

B. DO NOT disconnect the harness from the module.

C. The correct voltage should measure 9.0 ± 0.5 DCV.

Expected Result:

The voltage that is measured is 9.0 ± 0.5 DCV.

Results:

- OK – The voltage is 9.0 ± 0.5 DCV. The display power supply voltage is correct. Check the main display module for the same diagnostic code. If the service code indicator is still ON, the main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The voltage is NOT 9.0 ± 0.5 DCV. The display power supply voltage is NOT correct. Proceed to test step 2.

Test Step 2. CHECK THE HARNESS FOR A SHORT TO +BATTERY.

A. Disconnect the machine harness from the main display module.

B. At the machine harness connector for the main display module, measure the voltage from the connector contact 34 to 2 (ground).

Expected Result:

The voltage that is measured is 0.0 ± 0.5 DCV.

Results:

- OK – The voltage is 0.0 ± 0.5 DCV. The voltage is correct. The main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The voltage is NOT 0.0 ± 0.5 DCV. The harness has failed.

  Repair: Repair the harness or replace the harness.

  STOP.

i01487073

MID 030 - CID 0821 - FMI 04

SMCS Code: 7450-038

Conditions Which Generate This Code:

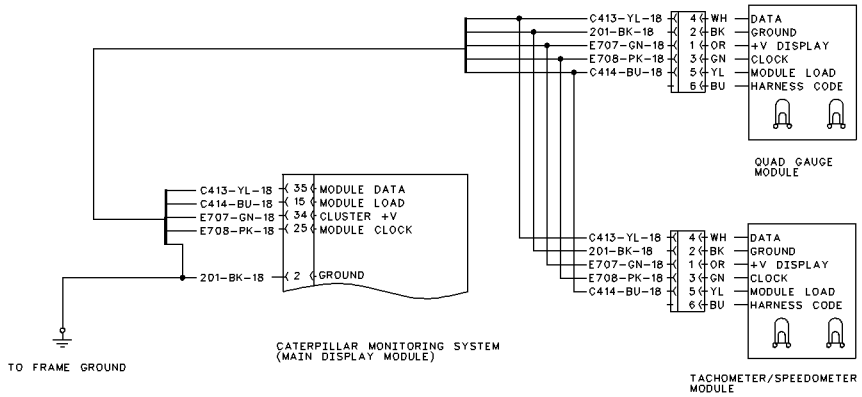


Illustration 125 g00737908

Schematic for the display power supply

This diagnostic code is recorded when the main display module reads the voltage of the display power supply circuit and the voltage is below normal. Normal display power supply voltage is 9.0 ± 0.5 DCV. The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE VOLTAGE AT THE MAIN DISPLAY MODULE.

A. DO NOT disconnect the harness from the module.

B. Use the 7X-1710 Multimeter Probe Group. Check the voltage at the connector for the main display module. Measure the voltage from contact 34 to contact 2 (ground).

Expected Result:

The voltage measures 9.0 ± 0.5 DCV.

Results:

- OK – The voltage is 9.0 ± 0.5 DCV. The display power supply voltage is correct. Check the main display module for the same diagnostic code. If the service code indicator is still ON, the main display module has failed.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The voltage is NOT 9.0 ± 0.5 DCV. The display power supply voltage is NOT correct. Proceed to test step 2.

Test Step 2. DISCONNECT THE MODULES.

A. Use the 7X-1710 Multimeter Probe Group. Check the voltage at the connector for the main display module. Measure the voltage from contact 34 to contact 2 (ground).

B. Disconnect a module from the machine harness one at a time.

C. Continue to measure the voltage at the connector for the main display module. Measure the voltage from contact 34 to contact 2.

Expected Result:

The voltage that is measured is 9.0 ± 0.5 DCV.

Results:

- OK – The voltage is 9.0 ± 0.5 DCV. The power supply to the module is correct. The module that was just disconnected has failed.

  Repair: Replace the module that was disconnected.

  STOP.

- NOT OK – The voltage is NOT 9.0 ± 0.5 DCV. The display power supply voltage is not correct. Repeat this test step again. All the modules have been disconnected from the machine harness and the voltage is NOT 9.0 ± 0.5 DCV. Proceed to test step 3.

Test Step 3. CHECK FOR A SHORT TO GROUND.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Disconnect the machine harness from the main display module.

C. At the machine harness connector for the main display module, measure the resistance. Measure the resistance between harness connector contact 34 and harness connector contact 2.

Expected Result:

The resistance that is measured is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms.

  STOP.

- NOT OK – The resistance is less than 5000 ohms. The harness has failed.

  Repair: Repair the harness or replace the harness.

  STOP.

i01944188

MID 030 - CID 0826 - FMI 03

SMCS Code: 3101-038-NS

Conditions Which Generate This Code:

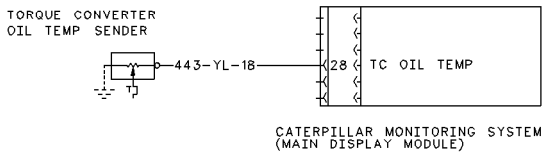


Illustration 126 g00881911

Schematic of the Temperature Sender (Torque Converter Oil)

This diagnostic code is recorded when the main display module reads the signal from the sender and the signal is too high. The possible causes are listed below:

- The sender has failed.
- The signal circuit in the machine harness is shorted to the + battery.
- The main display module has failed.

Note: Very low resistance in the sender causes the main display module to read the signal wire as having voltage too low. Low resistance can be caused by a short to ground in the signal circuit. This would cause the corresponding gauge on the display to indicate an abnormally high value. Very high resistance in the sender causes the main display module to read the signal wire as having voltage too high. High resistance can be caused by an open in the signal circuit. The internal circuitry of the main display module would pull a high voltage in the signal wire. This condition is recognized as a gauge that always has an indicator at the far left side of the scale.

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the fault present indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS.

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” .

C. Disconnect the machine harness from the sender that is causing the problem.

D. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is ON.

Results:

- YES – The diagnostic code indicator stays ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sender has failed.

  Repair: Replace the sender.

  STOP.

Test Step 2. CHECK FOR AN OPEN GROUND.

A. Turn the disconnect switch and the key start switch to the OFF position.

B. Measure the resistance between frame ground and the ground wire for the sender.

Expected Result:

The resistance is 5 ohms or less.

Results:

- YES – The resistance is 5 ohms or less.Proceed to test step 3.
- NO – The resistance is greater than 5 ohms. The ground wire for the harness is open.

  Repair: Repair the ground wire or replace the ground wire for the sender.

  STOP.

Test Step 3. CHECK THE SIGNAL WIRE FOR THE SENDER.

A. The machine harness remains disconnected from the sender.

B. The disconnect switch and the key start switch remain in the ON position.

C. At the machine harness connector for the sender, measure the voltage. Measure the voltage between the frame ground and the signal wire (443-YL(Yellow)).

Expected Result:

The voltage that is measured is within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck the status of the diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck the status of the diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT 6.0 BUT ABOVE 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck the status of the diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01944191

MID 030 - CID 0826 - FMI 04

SMCS Code: 3101-038-NS

Conditions Which Generate This Code:

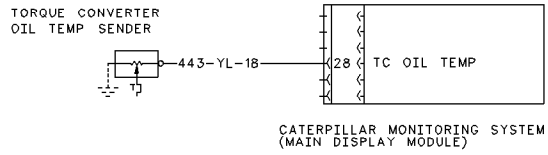


Illustration 127 g00881911

Schematic of the Temperature Sender (Torque Converter Oil)

This diagnostic code is recorded when the main display module reads the signal from the sender and the signal is too low. As a result of this diagnostic code the corresponding gauge will indicate an abnormally high value. The possible causes are listed below:

- The sender has failed.
- The signal circuit in the machine harness is shorted to ground.
- The main display module has failed.

Note: Very low resistance in the sender causes the main display module to read the signal wire as having voltage too low. Low resistance can be caused by a short to ground in the signal circuit. This would cause the corresponding gauge on the display to indicate an abnormally high value. Very high resistance in the sender causes the main display module to read the signal wire as having voltage too high. High resistance can be caused by an open in the signal circuit. The internal circuitry of the main display module would pull a high voltage in the signal wire. This condition is recognized as a gauge that always has an indicator at the far left side of the scale.

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the fault present indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Test Step 1. CHECK THE MAIN DISPLAY MODULE AND THE HARNESS.

A. Turn the disconnect switch and the key start switch to the ON position.

B. The diagnostic code indicator should show “SERV CODE” .

C. Disconnect the machine harness from the sender that is causing the problem.

D. Observe the diagnostic code indicator.

Expected Result:

The diagnostic code indicator is ON.

Results:

- YES – The diagnostic code indicator stays ON. The harness wiring or the main display module has failed.Proceed to test step 2.
- NO – The diagnostic code indicator turns OFF. The sender has failed.

  Repair: Replace the sender.

  STOP.

Test Step 2. CHECK THE SENDER WIRE FOR A SHORT TO GROUND.

A. The machine harness remains disconnected from the sender.

B. The disconnect switch and the key start switch remain in the ON position.

C. At the machine harness connector for the sender, measure the voltage. Measure the voltage between frame ground and the signal wire (443-YL(Yellow)).

Expected Result:

The voltage that is measured is within one of the following specifications.

Results:

- 6.0 ± 0.5 DCV – The voltage is 6.0 ± 0.5 DCV. The voltage is correct. Verify that the diagnostic code is still present.

  Repair: It is unlikely that the main display module has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT 6.0 BUT ABOVE 0.5 DCV – The voltage is less than 0.5 DCV. The harness wiring has failed. There is an open circuit or a short to ground in the signal wire for the sender.

  Repair: Repair the harness or replace the harness. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. It is unlikely that the main display module has failed. If the cause of the diagnostic code is not found, replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i01916195

MID 030 - CID 0826 - FMI 08

SMCS Code: 3101-038-NS

Conditions Which Generate This Code:

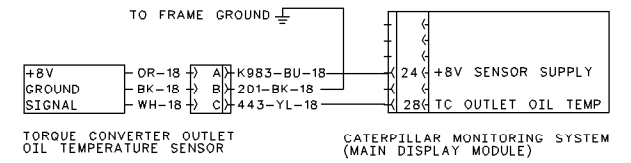


Illustration 128 g00738289

Schematic for the temperature sensor (torque converter outlet oil)

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and the wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: See Troubleshooting, “Sensor Signal Voltage” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i01916198

MID 030 - CID 0830 - FMI 08

SMCS Code: 4251-038-NS

Conditions Which Generate This Code:

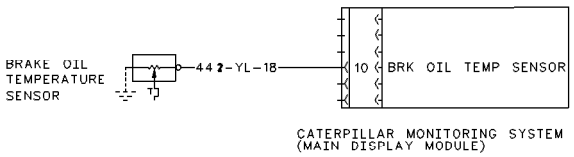


Illustration 129 g00998219

Schematic For The Brake Oil Temperature Sensor

Service Notes: Ensure that the desired diagnostic code (CID and FMI) is on hold. Ensure that the fault present indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

Note: Go to Troubleshooting, “Sensor Signal Voltage”in order to troubleshoot this component.

Perform the following diagnostic procedure: “Sensor Signal Voltage”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

i01942103

MID 030 - CID 1791 - FMI 08

SMCS Code: 5575-038-PXS

Conditions Which Generate This Code:

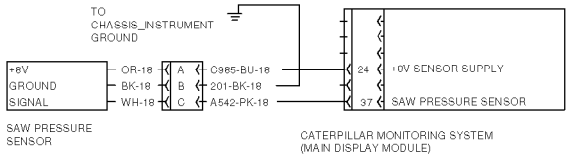


Illustration 130 g01010629

Schematic for the Saw Pressure Sensor

Service Notes: Ensure that the desired diagnostic code is on hold. Ensure that the diagnostic code indicator shows “SERV CODE” . The schematic that is shown above represents a typical installation of the component. Verify the connector contact and wire numbers by using the Electrical System Schematic for the machine that is being serviced.

System Response:

The CID-FMI is logged in memory. The CID-FMI may be viewed on a display module or the ET. The ECM flags hydraulic oil temperature as invalid data.

Note: Go to Troubleshooting, “Pulse Width Modulated Sensor” in order to troubleshoot this component.

Perform the following diagnostic procedure: “Saw Pressure Sensor”

Results:

- OK – STOP. OK
- REPAIRED, OK – STOP. REPAIRED, OK

Diagnostic System Procedures

i05926413

Harness Code

SMCS Code: 1408-038

System Operation Description:

This procedure is only for machines that are equipped with harness code plugs which create the harness code. This procedure does not apply to later machine models (example, H series Wheel Loaders) which have the harness code embedded into EMS software flash file and do not use harness code plug contacts for machine identification.

Table 18

Harness Code Troubleshooting[1]						
Main Display Module Connector Contact	**31**	**3**	**12**	**22**	**16**	**6**
Wire Identification	**270-BK(Black)**	**271-BK(Black)**	**272-BK(Black)**	**273-BK(Black)**	**274-BK(Black)**	**275-BK (Black)**
Harness Code Plug Contact[2]	**1**	**2**	**3**	**4**	**5**	**6**
Machine Code	**Specified Status**					
01	O[3]	G[4]	G	G	G	G
02	G	O	G	G	G	G
03	O	O	G	G	G	G
04	G	G	O	G	G	G
05	O	G	O	G	G	G
06	G	O	O	G	G	G
07	O	O	O	G	G	G
08	G	G	G	O	G	G
09	O	G	G	O	G	G
10	G	O	G	O	G	G
11	O	O	G	O	G	G
12	G	G	O	O	G	G
13	O	G	O	O	G	G
14	G	O	O	O	G	G
15	O	O	O	O	G	G
16	G	G	G	G	O	G
17	O	G	G	G	O	G

(continued)

(Table 18, contd)

Harness Code Troubleshooting[1]						
Main Display Module Connector Contact	**31**	**3**	**12**	**22**	**16**	**6**
18	G	O	G	G	O	G
19	O	O	G	G	O	G
20	G	G	O	G	O	G
21	O	G	O	G	O	G
22	G	O	O	G	O	G
23	O	O	O	G	O	G
24	G	G	G	O	O	G
25	O	G	G	O	O	G
26	G	O	G	O	O	G
27	O	O	G	O	O	G
28	G	G	O	O	O	G
29	O	G	O	O	O	G
30	G	O	O	O	O	G
31	O	O	O	O	O	G
32	G	G	G	G	G	O
33	O	G	G	G	G	O
34	G	O	G	G	G	O
35	O	O	G	G	G	O
36	G	G	O	G	G	O
37	O	G	O	G	G	O
38	G	O	O	G	G	O
39	O	O	O	G	G	O
40	G	G	G	O	G	O
41	O	G	G	O	G	O
42	G	O	G	O	G	O
43	O	O	G	O	G	O
44	G	G	O	O	G	O
45	O	G	O	O	G	O
46	G	O	O	O	G	O
47	O	O	O	O	G	O
48	G	G	G	G	O	O
49	O	G	G	G	O	O
50	G	O	G	G	O	O
51	O	O	G	G	O	O
52	G	G	O	G	O	O
53	O	G	O	G	O	O
54	G	O	O	G	O	O

(continued)

(Table 18, contd)

Harness Code Troubleshooting[1]						
Main Display Module Connector Contact	**31**	**3**	**12**	**22**	**16**	**6**
55	O	O	O	G	O	O
56	G	G	G	O	O	O
57	O	G	G	O	O	O
58	G	O	G	O	O	O
59	O	O	G	O	O	O
60	G	G	O	O	O	O
61	O	G	O	O	O	O
62	G	O	O	O	O	O
63	O	O	O	O	O	O

(1) Main display module is in the Harness Code Mode (Mode 1).
(2) For machines so equipped. For machines without a harness code plug, permanent harness code connections are in the machine harness.
(3) O = open
(4) G = grounded

Before you perform this procedure, determine the proper machine code. The main display module must have the correct part number for the particular machine. If the machine code is not shown correctly, this procedure determines the component that is malfunctioning. This failure could be caused by a failure in the main display module, a wrong harness code plug or a harness that has failed.

Note: The harness code and the machine code are similar terms. The codes describe the particular machine. The harness code is the status (open or ground) of the six harness code inputs (connector contacts 3, 6, 12, 16, 22 and 31). The main display module assigns a number to a machine. This number is the machine code. The machine code is shown during harness code mode. Each sales model has a specific harness code. Therefore, each sales model also has a specific machine code. The specific machine code is listed in Systems Operation, “Harness Code Mode”. The specific harness code is given in the Electrical System Schematic.

Note: The following procedure checks for incorrect harness codes on the inputs for the main display module. Compare the status of the harness code that is found in the test “Determine the machine code” to the status at the inputs for the main display module. The table identifies the connector contacts and wire identification of the harness code circuits. Contacts that are specified as grounded contacts should be checked for opens in the harness. Contacts that are specified as open contacts should be checked for shorts in the harness.

Test Step 1. CHECK FOR OPENS

A. Turn the disconnect switch to the OFF position.

B. Disconnect the machine harness from the main display module.

C. Check for continuity between the connector contacts that are grounded contacts and contact 2 (ground). Check for continuity at the machine harness connector for the main display module.

Expected Result:

The resistance measures 5.0 Ohms or less.

Results:

- YES – The resistance is 5.0 Ohms or less. The circuit for the harness code is not open. No defect was found in the ground circuits for the harness code. Proceed to test step 2.
- NO – The resistance is greater than 5.0 Ohms. The circuit for the harness code is open. Check the harness code plug on so equipped machines. Record the open contact of the machine harness connector.

  Repair: Repair the open circuits for the harness code that is found or replace the machine harness.

  If conditions are not resolved, proceed to test step 2.

Test Step 2. CHECK FOR SHORTS

A. The disconnect switch remains in the OFF position. The machine harness to the main display module remains disconnected.

B. Measure the resistance between the connector contacts that are specified as open contacts and contact 2 (ground). Measure the resistance at the machine harness connector for the main display module.

Expected Result:

The resistance measures 5000 Ohms or more.

Results:

- YES – The resistance is 5000 Ohms or more. The circuit for the harness code is not shorted to ground. No defect was found in the circuit for the harness code

  STOP.

- NO – The resistance is less than 5000 Ohms. The circuit for the harness code is shorted. Check the harness code plug on so equipped machines. Record the shorted contact of the machine harness connector.

  Repair: Repair the shorted circuits of the harness code that are found or replace the machine harness.

  If conditions are not resolved, proceed to test step 3.

Test Step 3. CHECK IF THE PROBLEM REMAINS

A. Reconnect the harness connectors.

B. Turn the disconnect switch and the key start switch to the ON position.

C. Recheck the machine code.

Expected Result:

The main display module shows the correct machine code.

Results:

- YES – The main display module shows the correct machine code

  STOP.

- NO – The main display module does not show the correct machine code. The main display module may have failed.

  Repair: Module failure is unlikely. Perform this diagnostic code procedure again. Prior to replacing a module, contact the Technical Communicator (TC) at your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time and expense. If replacement of the main display module is needed, refer to Testing and Adjusting, “Module - Replace”.

  STOP.

i01916278

Pulse Width Modulated Sensor

SMCS Code: 7490-038-NS

System Operation Description:

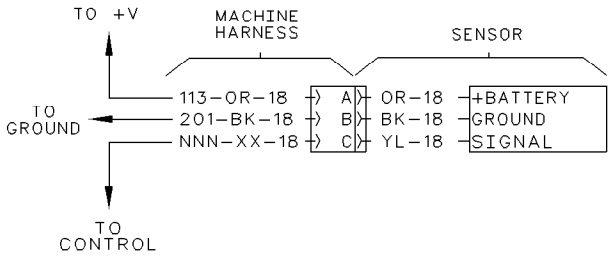


Illustration 131 g00315944

Schematic symbol for a typical pulse width modulated sensor (PWM)

Note: In addition to these tests, the Caterpillar Monitoring System diagnostics are helpful for troubleshooting sensors. Numeric readout mode shows a numeric value of the information from each sensor input. For a detailed explanation, refer to Systems Operation, “Numeric Readout Mode”.

When you are testing a sensor, it is necessary to identify the connector contacts and the harness wires. The Electrical System Schematic shows the connector contact numbers and corresponding wire numbers. See the Electrical System Schematic in the Service Manual for the machine.

On all machines, the wire numbers and connector contacts are identified by these general rules:

- The “+V” wire numbers are from 100 to 199. The “+V” contact corresponds to this wire number.
- The ground wire number is between 200 and 299. The ground contact corresponds to this wire number.
- The wire number for the signal circuits is from 400 to 499. The signal contact corresponds to this wire number.

For an example, see Illustration 131 :

- The “+V” wire is wire number 113.

- The “+V” contact is contact “A” .
- The ground wire is wire number 201.
- The ground contact is contact “B” .
- The signal wire is wire number 443.
- The signal contact is contact “C” .

Table 19

Tools Needed		
9U-7330	Multimeter	1
7X-1710	Multimeter Probe Group	1

Test Step 1. TROUBLESHOOT THE SENSORS.

Troubleshoot sensor circuits in the following order.

A. Perform the Troubleshooting, “Sensor Signal Voltage” procedure. This procedure checks the sensor voltages at the sensor while the circuits remain connected. DISCONNECT NOTHING. Troubleshoot “as is” before disconnecting any circuits. Disconnecting circuits first may alter a poor connection. Proving the original cause of a problem may be difficult or impossible.

Expected Result:

The Troubleshooting, “Sensor Signal Voltage” procedure has determined the cause of the problem.

Results:

- OK – This test step has determined the cause of the problem.

  STOP.

- NOT OK – This test step has NOT determined the cause of the problem.Proceed to test step 2.

Test Step 2. TROUBLESHOOT THE SENSORS

A. Perform the Troubleshooting, “Sensor Dynamic Operation” procedure. This is an additional test. This will test the sensor during actual operating conditions.

Expected Result:

The Troubleshooting, “Sensor Dynamic Operation” procedure has determined the cause of the problem.

Results:

- OK – This test step has determined the cause of the problem.

  STOP.

- NOT OK – This test step has NOT determined the cause of the problem.

  Repair: If the sensor and the harness are correct, it is likely that the main display module has failed. Replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

i02116939

Sensor Signal Voltage

SMCS Code: 7490-038-NS

System Operation Description:

Note: The main display module is connected.

Table 20

Sensor Voltage Specifications For The Sensor Voltage Test		
100-3055 Temperature Sensor And 131-0427 Temperature Sensor		
Temperature	**Signal Voltage(1)**	**Duty Cycle**
−20 to 0°C (−4 to 32°F)	1.1 to 1.4 DCV	11 to 15%
0 to 20°C (32 to 68°F)	1.4 to 2.0 DCV	15 to 23%
20 to 40°C (68 to 104°F)	2.0 to 3.1 DCV	23 to 37%
40 to 60°C (104 to 140°F)	3.1 to 4.5 DCV	37 to 55%
60 to 80°C (140 to 176°F)	4.5 to 5.7 DCV	55 to 71%
80 to 100°C (176 to 212°F)	5.7 to 6.6 DCV	71 to 82%
100 to 120°C (212 to 248°F)	6.6 to 7.2 DCV	82 to 89%
120 to 140°C (248 to 275°F)	7.2 to 7.4 DCV	89 to 93%

(1) These voltages are guidelines for troubleshooting and are not considered exact. The tolerance is ± 10%, depending on the condition of the harness. Most important is that the output voltage changes smoothly as the temperature changes.

Table 21

Sensor Voltage Specifications For Sensor Voltage Test		
3E-5370 Temperature Sensor Group And 131-0784 Temperature Sensor		
Temperature	**Signal Voltage(1)**	**Duty Cycle**
−40 to 20°C (−40 to −4°F)	0.8 to 1.5 DCV	4 to 11%
−20 to 0°C (−4 to 32°F)	1.5 to 2.5 DCV	11 to 22%
0 to 20°C (32 to 68°F)	2.5 to 3.7 DCV	22 to 34%
20 to 40°C (68 to 104°F)	3.7 to 4.8 DCV	34 to 46%
40 to 60°C (104 to 140°F)	4.8 to 6.0 DCV	46 to 59%
60 to 80°C (140 to 176°F)	6.0 to 7.2 DCV	59 to 71%
80 to 100°C (176 to 212°F)	7.2 to 8.1 DCV	71 to 81%
100 to 120°C (212 to 248°F)	8.1 to 8.8 DCV	81 to 87%
120 to 140°C (248 to 275°F)	8.8 to 9.2 DCV	87 to 92%

(1) These voltages are guidelines for troubleshooting and are not considered exact. The tolerance is ± 10%, depending on the condition of the harness. Most important is that the output voltage changes smoothly as the temperature changes.

Locate the suspect sensor. Identify the sensor wires and connector contacts. See Troubleshooting, “Pulse Width Modulated (PWM) Sensor - Test”. DO NOT DISCONNECT ANY HARNESS CONNECTORS AT THIS TIME. Turn the key start switch to the ON position. DO NOT START THE ENGINE.

Test Step 1. CHECK THE SENSOR POWER.

A. At the sensor connector, identify the +V and ground circuits.

B. Push the 7X-1710 Cable Probes in the back of the sensor connector along side of the +V and ground circuit wires.

C. Measure the system voltage.

Expected Result:

The voltage that is measured is between 7.5 and 8.5 DCV.

Results:

- YES – The voltage is between 7.5 and 8.5 DCV. The system voltage is present.Proceed to test step 2.
- NO – The voltage is not between 7.5 and 8.5 DCV. There is an open circuit. Trace the +V and ground circuits in the machine harness.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 2. CHECK THE SIGNAL VOLTAGE.

A. At the sensor connector, identify the signal and ground circuits.

B. Push the 7X-1710 Cable Probes in the back of the sensor connector along side of the signal and the ground circuit wires.

C. Measure the signal voltage and record the signal voltage.

Note: If a precise signal voltage is necessary, use the specifications that are listed in the provided tables.

Expected Result:

The measured signal voltage is approximately between 1.0 and 7.0 DCV. The measured signal voltage is approximately between 1.0 and 9.0 DCV when using the 3E-5370 Temperature Sensor Group.

Results:

- FROM 1.0 TO 7.0 (9.0) DCV – The voltage is between approximately 1.0 and 7.0 DCV (9.0 DCV for 3E-5370 Temperature Sensor Group). The signal voltage at the sensor is correct.

  Repair: The harness and the main display module are working properly. The voltage that is measured is correct.

  Proceed to test step 3.
- GREATER THAN 7.0 (9.0) – The voltage is NOT between approximately 1.0 and 7.0 DCV. (9.0 DCV for 3E-5370 Temperature Sensor Group). The signal voltage is not correct. The signal circuit of the machine harness is shorted to the +battery.

  Repair: Repair the machine harness or replace the machine harness. Repeat this test step in order to verify that the problem has been corrected. If the problem has not been corrected replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

- LESS THAN 1.0 DCV – The voltage is less than 1.0 DCV. The signal voltage is not correct. The signal circuit of the machine harness is shorted to ground.

  Repair: Repair the machine harness or replace the machine harness. Repeat this test step in order to verify that the problem has been corrected. If the problem has not been corrected replace the main display module. See Testing and Adjusting, “Module - Replace”.

  STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR THE MACHINE HARNESS .

A. At the machine harness connector for the main display module, identify the signal and ground circuits.

Note: DO NOT DISCONNECT THE HARNESS CONNECTOR.

B. Push the 7X-1710 Cable Probes in the back of the machine harness connector along side of the signal and ground circuit wires.

C. Measure the signal voltage.

D. Compare this measurement with the voltage that was measured in the previous test “Check the signal voltage”.

Expected Result:

The main display module is receiving a valid signal voltage of 1.0 to 7.0 DCV.

Results:

- OK – The main display module is receiving a valid signal voltage. If the problem has been corrected exit this procedure. No further testing is required. If the problem still persists, further testing is required. Proceed to test step 4.

- NOT OK – The voltage is not the same as in the previous test “Check the signal voltage” . The machine harness has an open in the signal or ground circuits.

  Repair: Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. Perform the following diagnostic procedure: “Sensor Dynamic Operation”

Results:

- OK – STOP. OK

- REPAIRED, OK – STOP. REPAIRED, OK

i01396902

Sensor Dynamic Operation

SMCS Code: 7490-038-NS

System Operation Description:

Note: The main display module is connected.

Table 22

Sensor Voltage Specifications (1) For Sensor Dynamic Test		
100-3055 Temperature Sensor And 131-0427 Temperature Sensor		
Temperature	**Signal Voltage(2)**	**Duty Cycle**
−40 to 20°C (−40 to −4°F)	1.0 to 1.1 DCV	10 to 11%
−20 to 0°C (−4 to 32°F)	1.1 to 1.4 DCV	11 to 15%
0 to 20°C (32 to 68°F)	1.4 to 2.0 DCV	15 to 23%
20 to 40°C (68 to 104°F)	2.0 to 3.1 DCV	23 to 37%
40 to 60°C (104 to 140°F)	3.1 to 4.5 DCV	37 to 55%
60 to 80°C (140 to 176°F)	4.5 to 5.7 DCV	55 to 71%
80 to 100°C (176 to 212°F)	5.7 to 6.6 DCV	71 to 82%
100 to 120°C (212 to 248°F)	6.6 to 7.2 DCV	82 to 89%
120 to 140°C (248 to 275°F)	7.2 to 7.4 DCV	89 to 93%

(1) If desired, use these specifications with the following procedure.
(2) These voltages are guidelines for troubleshooting and are not considered exact. The tolerance is ± 10%, depending on the condition of the harness. Most important is that the output voltage changes smoothly as the temperature changes.

Table 23

Sensor Voltage Specifications (1) For Sensor Dynamic Test		
3E-5370 Temperature Sensor Group And 131-0784 Temperature Sensor		
Temperature	**Signal Voltage(2)**	**Duty Cycle**
−40 to 20°C (−40 to −4°F)	0.8 to 1.5 DCV	4 to 11%
−20 to 0°C (−4 to 32°F)	1.5 to 2.5 DCV	11 to 22%
0 to 20°C (32 to 68°F)	2.5 to 3.7 DCV	22 to 34%
20 to 40°C (68 to 104°F)	3.7 to 4.8 DCV	34 to 46%
40 to 60°C (104 to 140°F)	4.8 to 6.0 DCV	46 to 59%

(continued)

(Table 23, contd)

Sensor Voltage Specifications (1) For Sensor Dynamic Test		
3E-5370 Temperature Sensor Group And 131-0784 Temperature Sensor		
Temperature	**Signal Voltage(2)**	**Duty Cycle**
60 to 80°C (140 to 176°F)	6.0 to 7.2 DCV	59 to 71%
80 to 100°C (176 to 212°F)	7.2 to 8.1 DCV	71 to 81%
100 to 120°C (212 to 248°F)	8.1 to 8.8 DCV	81 to 87%
120 to 140°C (248 to 275°F)	8.8 to 9.2 DCV	87 to 92%

(1) If desired, use these specifications with the following procedure.
(2) These voltages are guidelines for troubleshooting and are not considered exact. The tolerance is ± 10%, depending on the condition of the harness. Most important is that the output voltage changes smoothly as the temperature changes.

To use the following procedure, it is necessary to know the connector contact of the main display module and the contact that corresponds to the service code. See the Electrical System Schematic in the Service Manual for the machine in order to determine the proper connector contact of the main display module. Use the 7X-1710 Cable Probe on the connector contact of the sensor signal wire on the main display module.

Note: The sensors are provided power from the main display module . Therefore, the main display module must be connected in order for the sensors to function.

Two items are checked in this test:

- A sensor signal is present at the main display module.
- For an increase and/or a decrease in the system that is being monitored, the signal voltage will increase and/or the signal voltage will decrease.

Test Step 1. CHECK THE INITIAL SIGNAL VOLTAGE.

A. The engine coolant and the temperature sensors should be below operating temperature.

B. Ensure that the engine coolant and temperature sensors are below normal. Ensure that the key switch is OFF and that the sensor is connected to the machine harness.

C. Turn the key switch to the ON position. DO NOT START THE ENGINE.

D. At the machine harness connector for the main display module, measure the voltage and record the voltage (DCV) between the signal contact and frame ground. For correct operation, the approximate voltage is between 1.0 and 7.0 DCV. For the 3E-5370 and 131-0784 Temperature Sensor Groups the approximate voltage is between 1.0 and 9.0 DCV.

Note: When precise specifications for the signal voltage are necessary, use the specifications that are listed in the provided tables.

Expected Result:

The voltage that is measured is within the specifications.

Results:

- YES – The approximate voltage is between 1.0 and 7.0 DCV. For the 3E-5370 and 131-0784 Temperature Sensor Groups the approximate voltage is between 1.0 and 9.0 DCV. The signal voltage to the main display module is correct. Proceed to test step 2.
- NO – The approximate voltage is NOT between 1.0 and 7.0 DCV. For the 3E-5370 and 131-0784 Temperature Sensor Groups the approximate voltage is NOT between 1.0 and 9.0 DCV. The signal voltage to the main display module is not correct. The probable cause is a failed sensor.

  Repair: The sensor has failed. Replace the sensor.

  STOP.

Test Step 2. CHECK THE SIGNAL VOLTAGE WITH THE NEW CONDITIONS.

A. Increase the temperature, the pressure or the fuel level of the system that is being tested. The following procedures are examples: run the engine in order to increase the engine coolant temperature, operate the implement controls in order to increase the hydraulic oil temperature and add fuel in order to increase the fuel level.

B. At the machine harness connector for the main display module, measure the voltage (DCV) between the signal contact and frame ground.

C. For the correct operation, the voltage (DCV) is greater (and increases smoothly without step increases) than the voltage that was recorded in the previous test “Check the initial signal voltage”.

Note: The larger the change in the system that is being monitored, the greater the difference between the voltages of this test “Check the signal voltage with new conditions” and the previous test “Check the initial signal voltage”.

Expected Result:

The voltage increases during the test procedure.

Results:

- OK – The voltage increase during the test procedure and the sensor operates smoothly. The sensor has not failed.

  STOP.

- NOT OK – The voltage does not increase during the test procedure. The probable cause is a failed sensor.

  Repair: The sensor has failed. Replace the sensor.

  STOP.

i01397894

Temperature Sender

SMCS Code: 7490-038-UN

System Operation Description:

See the table for “Resistor, Sender and Solenoid Specifications” . This table is located in the Electrical System Schematic for the machine that is being serviced.

CHECK THE TEMPERATURE SENDER.

A. Disconnect the sender from the machine harness.

B. Measure the resistance between the terminal and the case of the sender.

The following data should be the correct approximate resistance:

- 54.4°C (130.0°F) at 850 to 1050 Ω
- 110°C (230.0°F) at 140 to 160 Ω

These values are not exact, but the values should be used as guidelines for troubleshooting.

Expected Result:

The resistance of the temperature sender is within specifications.

Results:

- OK – The resistance of the temperature sender is within specifications.

  STOP.

- NOT OK – The resistance of the temperature sender is NOT within specifications. The temperature sender has failed.

  Repair: Replace the sender.

  STOP.

i01397975

Fuel Level Sender

SMCS Code: 1273-038-UN

System Operation Description:

For the most accurate specifications for the sender, see the table “Resistor, Solenoid And Sender Specification”. This table is located in the Electrical System Schematic for the machine that is being serviced.

CHECK THE SENDER

A. Disconnect the sender from the machine harness.

B. Measure the resistance between the two contacts of the sender.

The following data is the correct approximate resistance:

106-3535 Level Sender Assembly and 134-3033 Fuel Level Sender

Empty tank	240 to 260 Ω
Half tank	97 to 118 Ω
Full tank	27 to 40 Ω

104-5546 Level Sender Assembly, 115-2086 Fuel Level Sender, 121-3174 Fuel Level Sender, 136-1617 Fuel Level Sender, 137-5156 Fuel Level Sender, 150-2995 Fuel Sender, and 151-1399 Sender

Empty tank	92 to 98 Ω
Full tank	0 to 3.5 Ω

9X-4942 Fuel Level Sender

Empty tank	80 to 85 Ω
Half tank	40 to 43 Ω
Full tank	0 to 2 Ω

C. Actuate the sender by hand while you are measuring the resistance.

D. The resistance should change as the sender is actuated through the empty range to the full range.

Expected Result:

The resistance that is measured is within the specifications.

Results:

- OK – The resistance for the fuel level sender is correct.

  STOP.

- NOT OK – The resistance for the fuel level sender is NOT correct.

  Repair: Replace the fuel level sender.

  STOP.

i02510466

Switch Circuits

SMCS Code: 1435-038; 7332-038

System Operation Description:

When a filter has been replaced and the bypass switch continues to indicate that a problem exists, further troubleshooting is necessary to isolate the problem. Refer to the Systems Operations, “Switches” section for additional information on the individual switches.

The possible causes of these failures are listed below:

- The signal circuit in the machine harness is open.
- The switch has failed.
- The ECM has failed.

Test Step 1. CHECK FOR AN OPEN IN THE HARNESS

A. Locate the switch that corresponds to the alert indicator that is located on the main display module. (If necessary, use the Electrical System Schematic to assist in locating the switch.)

B. Disconnect the signal wire from the switch.

C. Place a jumper wire from the signal wire to the ground wire.

Expected Result:

The alert indicator is no longer active on the main display module.

Results:

- OK – The alert indicator is no longer active on the main display module.

  Repair: The switch has failed. Check or replace the switch.

  STOP.

- NOT OK – The alert indicator remains on the main display module. The machine harness is open or the ECM has failed.Proceed to test step 2.

Test Step 2. CHECK THE VOLTAGE OF THE ECM.

A. Remove the jumper that was used in the previous test step.

B. The signal wire remains disconnected.

C. Measure the pull-up voltage from the signal wire to the ground wire with a digital multimeter.

Expected Result:

The voltage is 5 ± 0.5 volts.

Results:

- OK – The voltage is 5 ± 0.5 volts.

  Repair: The voltage is correct. The ECM has failed. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the fault is not found, replace the ECM. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The voltage is NOT 5 ± 0.5 volts. Proceed to test step 3.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE HARNESS.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Use the Electrical System Schematic to trace the signal wire from the switch back to the ECM.

C. Determine the signal contact (connector contact) of the machine harness at the ECM.

D. Disconnect the machine harness connector(s) from the ECM.

E. At the machine harness connector for the ECM, measure the resistance between the signal contact and contact 2 of the switch.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The signal circuit of the harness is correct.Proceed to test step 4.
- NOT OK – The resistance is greater than 5.0 ohms.

  Repair: The signal circuit of the harness is not correct. Repair the machine harness or replace the machine harness.

  STOP.

Test Step 4. CHECK THE GROUND CIRCUIT OF THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. The machine harness connector(s) remain disconnected from the ECM.

C. Use the Electrical System Schematic to trace the ground for the switch.

D. At the switch, measure the resistance between the ground wire and frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms.

  Repair: The machine harness is not the cause of the failure. The ECM has failed. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the fault is not found, replace the ECM. See Testing and Adjusting, “Module - Replace”.

  STOP.

- NOT OK – The resistance is greater than 5.0 ohms.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

i04751337

Charging System

SMCS Code: 1406-038

System Operation Description:

Often when problems with the charging system are being investigated, the alternator is not the problem. If a low battery condition is present test the batteries first. See Special Instruction, SEHS7633, “Battery Test Procedure” for more information. If the engine cranks slowly, then test the starting system. See Service Magazine, SEPD0020, “Testing The Starter On The Engine” for more information. If a warning indicator for the charging system is ON, see Service Magazine, SEBD1751, “Difference Between Alternator Indicator In Electronic Monitoring System (EMS) And Low Voltage Indicator In Operating Monitoring System (OMS)”.

Note: Severely discharged batteries can cause low system voltage. Severely discharged batteries can occur even while the engine is running above idle, and the alternator is working properly. Proper low engine idle is also important.

Table 24

Alternator Specifications		
	Peak Current Rating (Amps)	**Minimum Peak Current (Amps)**
12 V Alternators		
8C-5535	32	28
7N-4784, OR-5201	40	36
6T-1396, 7T-2096, 8C-5908, OR-3654	51	46
9W-2648, 9W-2949, 8T-9700, 105-2811(IG), OR-4327(IG), 105-2812(IG), OR-9273(IG), 34-3268, 68-4139, 3E-7295(D+), 7T-2876 (D+), 100-8223	55	49
7G-7889	60	54
8C-5510(I), OR5200	61	55
8N-2268	75	68
3E-7892, OR-3616	85	77
105-2813(IG), OR-9274(IG), 105-2814(IG), OR-4328(IG), 149-2064(REG), OR-9410(REG), 9X-0341(D+)	90	81
8C-6163, OR-1699, 107-2519	105	95
167-7816	110	99

(continued)

(Table 24, contd)

Alternator Specifications		
	Peak Current Rating (Amps)	**Minimum Peak Current (Amps)**
9X-6796, 9X-9096, 121-4134, 121-4136, OR-3527	115	104
3E-8827, 121-4135, 117-1379(I)	130	117
152-8746	135	122
125-9597, OR-8332	145	131
24 V Alternators		
2P-1204, 3Y-8200	19	17
2Y-8310	21	19
6T-1395, 7T-2095, OR-3653	33	30
6N-9294, OR-5217, OR-3482	35	32
5N-5692, OR-2698	45	41
5S-9088, 100-5047, 112-5041, 3E-7578, OR-5206, OR-3667, OR-3668	50	45
169-3345	50	30
109-2362, 9W-3043 , OR-3652(D+), 112-8032	55	50
3E-7772(IG), OR-9437(IG), 105-3132(IG), 4N-3986, OR-5203	60	54
200-2232	67.5	26
200-8281	67.5	26
155-7434, 132-2156(I), 107-7977(I), OR-8279(I)	70	63
169-4319, 167-7812	75	67.5
107-7976, 114-2401, OR-8997, 3E-7577, OR-3615	75	68
197-8820	95	85.5
165-5140	100	90
9X-7803, OR-3749	100	90
Parts-Service Only Discontinued 12 V Alternators		
6T-1193	18	16
7N-6118, 6N-5460, 4N-4540	40	36
6T-1195	42	38
7X-1340	45	41
9G-6079, 6T-1194	63	57
Parts-Service Only Discontinued 24 V Alternators		
9G-6081, 6T-1196	40	36

(continued)

(Table 24, contd)

Alternator Specifications		
	Peak Current Rating (Amps)	**Minimum Peak Current (Amps)**
D+ - Diode trio output. Alternator requires external excitation.		
REG - Regulator Terminal. Alternator requires external excitation.		
I - Ignition Terminal. Alternator can be externally excited through this terminal.		
IG - Ignition Terminal. System voltage must be supplied to this terminal to turn on the alternator. Some of these alternators use the IG terminal as a sense terminal.		

Test Step 1. DETERMINE THE ALTERNATOR EXCITATION METHOD.

A. Check the rear of your alternator in order to determine the method of excitation. See table 24 in order to verify the proper alternator excitation.

Expected Result:

Test method 1. These alternators have a “1” , “REG” , or “D+” terminal. Test method 2. These alternators are self-excited. Test method 3. These alternators have a “IG” terminal.

Results:

- Method 1 – The alternator has a “1” , “REG” , or “D +” terminal.Proceed to test step 2.
- Method 2 – The alternator is self-excited.Proceed to test step 4.
- Method 3 – The alternator has an “IG” terminal. Proceed to test step 3.

Test Step 2. CHECK THE RESISTANCE IN THE EXCITATION CIRCUIT.

A. Turn the key start switch to the ON position.

B. Verify voltage at the excitation terminal. Connect the red lead from a multimeter to the excitation terminal. Connect the black lead to a ground source (alternator case ground).

C. Read the voltage that is shown on the multimeter.

Expected Result:

The voltage reads at least .2 volts.

Results:

- YES – The voltage reads .2 volts or more. The excitation circuit is correct.Proceed to test step 4.
- NO – The voltage is less than .2 volts. There is a problem in the wiring harness to the alternator or there is a poor electrical connection. Correct the problem and operate the machine. Watch for a recurrence of the problem.

  STOP.

Test Step 3. CHECK THE RESISTANCE IN THE EXCITATION CIRCUIT (CONTINUED).

Note: This step is only for alternators with external excitation when the terminal for excitation is labeled: “IG” .

A. Turn the key start switch to the ON position.

B. Verify voltage at the excitation terminal. Connect the red lead from a multimeter to the excitation terminal. Connect the black test lead to a ground source (alternator case ground).

Note: For G3B, K3A, and L3A alternators, Insert a 7X-1710 Multimeter Probe Group into the rear of the middle wire in the connector. See figure 132 below. Insert the probes spoon lead between the seal and the wire that surrounds the wire and the outer shell of the connector. Do not insert the probe between the wire insulation and the black seal. This terminal (IG) is the terminal for excitation.

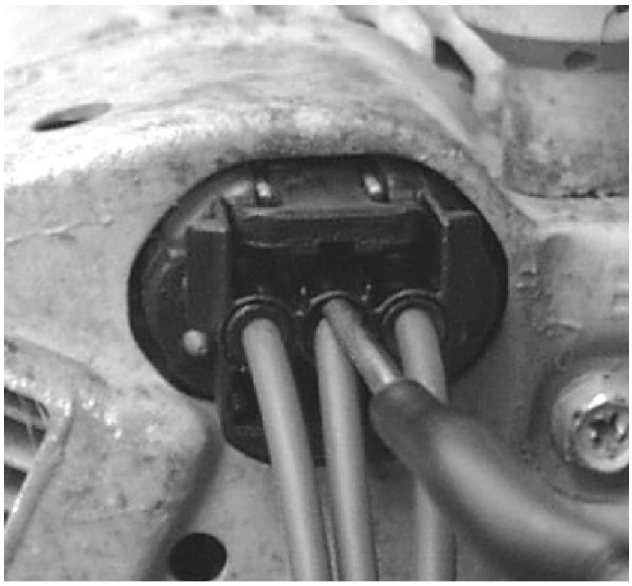


Illustration 132 g00496660

Special wire probe technique for G3B, Y3A, and L3A alternators.

C. Read the voltage that is shown on the multimeter.

Expected Result:

The voltage measurement is within .5 volts of the battery voltage.

Results:

- YES – The voltage reads battery voltage. The excitation circuit is correct. 4
- NO – The voltage that is measured is more than a .5 volt less than the battery voltage. There is a problem in the wiring harness to the alternator or there is a poor electrical connection. Correct the problem and operate the machine. Watch for a recurrence of the problem.

  STOP.

Test Step 4. CHECK THE SYSTEM VOLTAGE.

A. Before you start the machine, connect a voltmeter between the “B+” terminal and the case of the alternator. Turn OFF all electrical loads.

B. Turn the key to the ON position but do not start the engine. Read the voltage on the voltmeter. Make a note of the voltage that was measured.

Expected Result:

This voltage should be approximately system voltage.

Results:

- YES – The voltage is approximately system voltage. Proceed to test step 5.
- NO – The voltage is less than system voltage. Proceed to test step 7.

Test Step 5. CHECK THE OPERATION OF THE ALTERNATOR.

A. The voltmeter remains connected between the “B +” terminal and the case of the alternator.

B. Start the machine. Set the throttle to at least 75 percent. Read the voltage on the voltmeter. Make a note of the voltage that was measured.

Expected Result:

The voltage measurement is greater than the voltage that was recorded in the previous test step “Check The System Voltage” .

Results:

- VOLTAGE HIGHER – The voltage measurement is greater than the voltage that was observed in the previous test step “Check The System Voltage” . The voltage is also less than the maximum voltage that is listed in the specifications for the alternator. The alternator is partially charging the battery.Proceed to test step 6.
- VOLTAGE TOO HIGH – The voltage measurement is greater than the voltage that was observed in the previous test step “Check The System Voltage” . The voltage is also greater than the maximum voltage that is listed in the specifications for the alternator. The alternator is over charging.Proceed to test step 19.
- VOLTAGE LOWER – The voltage is not higher than the voltage that was observed in the previous test step.Proceed to test step 7.

Test Step 6. TEST THE ALTERNATOR OUTPUT.

Note: For the proper output current, refer to table 24 .

A. Ensure that the batteries are NOT fully charged.

Note: A fully charged battery may have open circuit voltage above 12.5 V on 12 V systems. 24 V systems may be as high as 25 V.

B. If the batteries are fully charged, then crank the engine for 30 seconds. This action reduces the battery voltage. Operate the lights for 10 minutes while the engine is off as an alternative.

C. Connect the 9U-5795 Current Probe to a DMM (digital multimeter) or use a 225-8266 Ammeter Tool Gp. The multimeter must have a peak hold feature. Clamp the probe around the alternator output wire “B+” . Before you clamp the probe around the wire, ensure that the probe is “zeroed”.

D. Set the digital multimeter to “peak hold” or “max mode” on the “mV” scale.

E. Turn on all electrical accessories: lights, air conditioning and radio.

F. Start the machine, and immediately set the throttle to at least 75 percent. The peak current will appear on the voltmeter in “peak hold” or “max” mode.

Expected Result:

The current reading should be at least 90 percent of the specified peak output.

Results:

- YES – The current is at least 90 percent of the specified peak output. Proceed to test step 13.
- NO – The current is less than 90 percent of the specified peak output.Proceed to test step 7.

Test Step 7. CHECK THE DRIVE SYSTEM OF THE ALTERNATOR.

A. Check the condition of the alternator drive belt. Clean the pulley and replace the drive belt if the drive belt is oily. Dry the drive belt if the belt is wet. Replace the drive belt, if the belt is worn.

B. Check the tension of the alternator drive belt. Adjust the drive belt to the correct tension.

C. Check the nut on the alternator pulley. Tighten the nut if the nut is loose.

Expected Result:

The drive system of the alternator is functioning correctly. No corrections to the drive system were necessary.

Results:

- YES – The drive system of the alternator is functioning correctly. No corrections were necessary.Proceed to test step 8.
- NO – The drive system of the alternator was not functioning correctly. Corrections were necessary.

  Repair: Ensure that the problems have been corrected. Exit this procedure and retest the alternator charging system.

  STOP.

Test Step 8. TEST THE CHARGING CIRCUIT.

A. Verify that the nut on the “B+” alternator terminal is tight. Also, verify that the wire has a good connection to the “B+” terminal.

B. Many Caterpillar machines are equipped with a connector for the 6V-2150 Starting/Charging Analyzer. Use of this tester replaces the remainder of this test step. To operate the analyzer, refer to Tool Operating Manual, SEHS7768, “Using the 6V-2150”.

C. Start the engine and set the throttle to at least 75 percent. Turn ON all electrical accessories for the remainder of this test step. Allow the engine to run for at least 3 minutes before continuing.

D. Measure the voltage between the “B+” alternator terminal and the alternator case ground. Make a note of the measured voltage. Perform the next measurement immediately.

E. Measure the voltage across the battery. Put the red lead on the battery positive terminal, and put the black lead on the battery negative terminal. Make a note of the voltage that was measured.

Expected Result:

The voltage at the battery should be less than the voltage at the alternator. The difference in voltages should not be more than 1 V on 12 V systems. The difference should not be more than 2 V on 24 V systems.

Results:

- YES – The voltage at the battery is less than the voltage at the alternator. Also, the difference in voltages is less than 1 V for 12 V systems and the difference is less than 2 V for 24 V systems. The wiring that is related to the alternator is correct at this time.

  Repair: There is an internal problem with the alternator. Repair or replace the alternator.

  STOP.

- NO – The voltage at the battery is less than the voltage at the alternator. However, the difference in voltages is greater than 1 V for 12 V systems and the difference is greater than 2 V for 24 V systems.Proceed to test step 9.

Test Step 9. TEST THE POSITIVE SIDE OF THE CHARGING CIRCUIT.

A. Measure the voltage between the frame ground and the “B+” alternator terminal. Make a note of the voltage that was measured. Perform the next measurement immediately.

B. Measure the voltage between the frame ground and the + battery post. Make a note of the voltage that was measured.

Expected Result:

The voltage difference does not exceed 1 V on 24 V systems or 0.5 V on 12 V systems.

Results:

- YES – The voltage difference does not exceed the tolerance. The positive circuit is good.Proceed to test step 10.

- NO – The voltage difference exceeds the tolerance.

  Repair: There is high resistance in the positive side of the charging circuit that is caused by one of the following conditions:

  - An electrical connection has loosened.
  - An electrical connection has corroded.
  - The main relay has failed.
  - A circuit breaker has failed.

  Repair the problem or replace any component that has failed. Exit this procedure and retest the alternator charging system.

  STOP.

Test Step 10. TEST THE NEGATIVE SIDE OF THE CHARGING CIRCUIT.

A. Check the voltage between the negative battery post and the alternator case ground.

Expected Result:

The voltage does not exceed 1 V on 24 V systems or 0.5 V on 12 V systems.

Results:

- YES – The voltage difference does not exceed the tolerance. The negative circuit is good. Proceed to test step 11.

- NO – The voltage difference exceeds the tolerance.

  Repair: There is high resistance in the negative side of the charging circuit that is caused by one of the following conditions:

  - An electrical connection has loosened.
  - The alternator ground has loosened.
  - The engine ground has opened.

  Repair the problem or replace any component that has failed. Exit this procedure and retest the alternator charging system.

  STOP.

Test Step 11. TEST THE CIRCUIT OF THE “R” TERMINAL.

A. Start the engine and set the throttle to at least 75 percent.

B. Connect a voltmeter between the “B+” terminal and the alternator case ground.

C. Disconnect the wire from the “R” terminal. Select “YES” if the “R” terminal is not used on the machine.

Expected Result:

The voltage does not change.

Results:

- YES – The voltage does not change.Proceed to test step 12.
- NO – The voltage rises and the alternator begins charging.

  Repair: The wire to the “R” terminal is shorted. Repair the wiring or replace the wiring. Exit this procedure and retest the alternator charging system.

  STOP.

Test Step 12. RESTORE THE RESIDUAL MAGNETISM OF THE ROTOR.

A. Connect one end of a jumper wire to the “B+” terminal (D+ terminal for K1, N1, and N3) of the alternator.

B. Connect the other end of the jumper wire to the “R” terminal of the alternator for 2 seconds.

Expected Result:

The voltage output rises on the “B+” terminal. The residual magnetism of the rotor has been restored.

Results:

- YES – The voltage output rises. The residual magnetism of the rotor has been restored. The alternator is now charging.

  Repair: Exit this procedure and retest the alternator charging system.

  STOP.
- NO – The voltage output does not rise.

  Repair: There is an internal problem with the alternator. Repair or replace the alternator.

  STOP.

Test Step 13. TEST FOR UNDESIRABLE CURRENT FLOW IN THE ALTERNATOR CHARGING SYSTEM.

A. Turn off all of the accessories. Turn the keyswitch to the OFF position.

B. Clamp a 9U-5795 Current Probe or 225-8266 Ammeter Tool Gp around the main ground cable. Clamp the tool with the positive side away from the battery. Reset the probe (zero) before you clamp the probe around the wire. Read the current on the meter. Make a note of the current that was measured.

Expected Result:

The current is below 2 A. The “YES” selection is dependent on the presence of a main disconnect switch on the machine that is being tested.

Results:

- YES - WITH DISCONNECT SWITCH – The current is below 2 A.For machines with a main disconnect switch, proceed to test step 14.
- YES - WITHOUT DISCONNECT SWITCH – The current is below 2 A.For machines without a main disconnect switch, proceed to test step 15.
- NO – The current is above 2 A. There is a current draw in the system.Proceed to test step 16.

Test Step 14. MEASURE THE CURRENT OF THE SYSTEM BY USING THE MAIN DISCONNECT SWITCH.

A. Turn the disconnect switch to the ON position.

B. Connect a multimeter across the disconnect switch terminals. Connect the red lead to the terminal on the frame side. Connect the black lead to the terminal on the battery side. Use the 10A connections in order to avoid damage.

C. Turn the disconnect switch to the OFF position and read the current. Make a note of the measured current.

Note: The standard acceptable current draw is 50 mA. A current draw above 50 mA usually indicates a problem. However, some large machines with multiple electronic control modules have a higher acceptable limit. For more information, contact a Caterpillar dealer or contact the business unit that produces the machine.

Expected Result:

The current is below 0.050 A (50 mA).

Results:

- YES – The current is below 0.050 A. The charging system is functioning properly at this time. The failure is possibly an intermittent draw in the system. The batteries may have failed. Ensure

that NO accessories were ON during the test. Exit this procedure and retest the alternator charging system.

STOP.

- NO – The current is above 0.050 A. There is a draw in the system.Proceed to test step 16.

Test Step 15. MEASURE THE CURRENT OF THE SYSTEM BY REMOVING THE NEGATIVE BATTERY CABLE.

A. Disconnect the ground cable from the negative battery post. There may be more than one battery that is connected to ground. Disconnect all of the batteries that are connected to ground. Do not disconnect cables that are between batteries that are connected in series.

B. Connect a multimeter between the disconnected battery ground cable and one of the negative battery terminals. Connect the red positive lead of the multimeter to the cable. The negative lead should be connected to the battery terminal. Use the 10A connections in order to avoid damage.

Note: The standard acceptable current draw is 50 mA. A current draw above 50 mA usually indicates a problem. However, some large machines with multiple electronic control modules have a higher acceptable limit. For more information, contact a Caterpillar dealer or contact the business unit that produces the machine.

Expected Result:

The current is below .050 A (50 mA).

Results:

- YES – The current is below 0.050 A. The charging system is currently good. The problem is a possible intermittent current draw in the system. The batteries may have failed. Check that NO accessories were ON during the test.

  STOP.

- NO – The current is above 0.050 A. There is excessive current flow in the system.Proceed to test step 16

Test Step 16. TEST THE CURRENT OF THE ALTERNATOR OUTPUT BELOW 2 AMPERES.

A. Turn the keyswitch to the OFF position.

B. Connect the 9U-5795 Current Probe to a DMM (digital multimeter) or use a 225-8266 Ammeter Tool Gp. Clamp the probe around the “B+” wire of the alternator. Before you clamp the probe around the wire, ensure that the probe is “zeroed”.

C. Read the current on the meter. Make a note of the current that was measured.

Expected Result:

The current is under 2 A.

Results:

- YES – The current is under 2 A.Proceed to test step 17.

- NO – The current is over 2 A.

  Repair: There is an internal problem with the alternator. Repair or Replace the alternator.

  STOP.

Test Step 17. TEST THE OUTPUT CURRENT OF THE ALTERNATOR BELOW 0.015 AMPERES.

A. Disconnect the wire from the “B+” terminal of the alternator. Set the multimeter on the 10 amp scale. Connect the red lead of the multimeter to the wire that was disconnected. Connect the black lead of the multimeter to the “B+” terminal of the alternator. Make a note of the current that was measured.

Expected Result:

The current is less than 0.015 A.

Results:

- YES – The current is under 0.015 A. The alternator is operating correctly. There may be a current draw on the machine.Proceed to test step 18.

- NO – The current is over 0.015 A.

  Repair: There is an internal problem with the alternator. Repair or replace the alternator.

  STOP.

Test Step 18. IDENTIFY THE SOURCE OF EXCESSIVE CURRENT DRAW.

A. Make sure that every electrical component is turned OFF. Make sure that the keyswitch is turned OFF. Make sure that the dome lights are OFF.

B. Clamp a 9U-5795 Current Probe or 225-8266 Ammeter Tool Gp around the main ground cable. Clamp the tool with the positive side away from the battery. Reset the probe (zero) before clamping the probe around the wire. Use the current probe if the draw is above approximately 2 A. Use the Ammeter if the draw is below approximately 2 A.

C. Remove the fuses or open the circuit breakers one at a time. Check the current after each fuse has been removed or each circuit breaker has been opened. After observing the current, reinstall the fuse or close the circuit breaker. Start with the main circuits first, and proceed to smaller circuits.

D. Check if any components on the circuit are ON.

E. If everything is OFF, then disconnect electrical components on the circuit one at a time. Monitor the current after each component is disconnected.

F. All of the components in the circuit should be disconnected. If the problem still exists, then check the wiring in the circuit. There may be circuit leakage through corrosion or circuit leakage through a short.

Note: The standard acceptable current draw is 50 mA. A current draw above 50 mA usually indicates a problem. However, some large machines with multiple electronic control modules have a higher acceptable limit. For more information, contact a Caterpillar dealer or contact the business unit that produces the machine.

Expected Result:

The source of the excessive current draw was determined.

Results:

- YES – The source of the excessive current draw was determined.

  Repair: Repair the problem or replace any component that has failed. Exit this procedure and retest the alternator charging system.

  STOP.

- NO – The source of the excessive current draw was not determined.

  Repair: Exit this procedure and retest the alternator charging system.

  STOP.

Test Step 19. TEST FOR AN OVERCHARGING CONDITION FROM THE ALTERNATOR.

A. Verify that the nut on the “B+” alternator terminal is tight. Also, verify that the wire has a good connection to the “B+” terminal.

B. Many Caterpillar machines are equipped with a connector for the 6V-2150 Starting/Charging Analyzer. Use of this tester replaces the remainder of this test step. To operate the analyzer, refer to Tool Operating Manual, SEHS7768, “Using the 6V-2150”.

C. Start the engine and set the throttle to at least 75 percent. Turn ON all electrical accessories for the remainder of this test step. Allow the engine to run for at least 3 minutes before continuing.

D. Measure the voltage between the “B+” terminal of the alternator and the case of the alternator. Make a note of the voltage that was measured. Perform the next measurement immediately.

E. Measure the voltage across the battery. Put the red lead on the positive terminal of the battery, and put the black lead on the negative terminal of the battery. Make a note of the voltage that was measured.

Expected Result:

The voltage at the battery should be less than the voltage at the alternator. On systems that are 12 V, the difference in voltages should not be more than 1 V. On systems that are 24 V, the difference should not be more than 2 V.

Results:

- YES – The voltage at the battery is less than the voltage at the alternator. Also, the difference in voltages is less than 1 V for 12 V systems and the difference is less than 2 V for 24 V systems. The wiring that is related to the alternator is correct at this time.

  Repair: There is an internal problem with the alternator. Repair or Replace the alternator.

  STOP.

- NO – The voltage at the battery is less than the voltage at the alternator. However, the difference in voltages is greater than 1 V for 12 V systems and the difference is greater than 2 V for 24 V systems.Proceed to test step 20.

Test Step 20. TEST THE POSITIVE SIDE OF THE CHARGING CIRCUIT.

A. Measure the voltage between the frame of the machine and the “B+” terminal of the alternator. Make a note of the voltage that was measured. Perform the next measurement immediately.

B. Measure the voltage between the frame of the machine and the positive terminal of the battery. Make a note of the voltage that was measured.

Expected Result:

The voltage difference does not exceed 1 V on 24 V systems or 0.5 V on 12 V systems.

Results:

- VOLTAGE OK - ALT. WITHOUT IG/S TERM. – The voltage difference does not exceed the tolerance. The positive circuit is good.

  Repair: There is an internal problem with the alternator. Repair or Replace the alternator.

  STOP.

- VOLTAGE EXCESSIVE - ALL ALT. – The voltage difference exceeds the tolerance.

  Repair: There is high resistance in the positive side of the charging circuit that is caused by one of the following conditions:

  - An electrical connection has loosened.
  - An electrical connection has corroded.
  - The main relay has failed.
  - A circuit breaker has failed.

  Correct the problem. Exit this procedure and retest the alternator charging system.

  STOP.

- VOLTAGE OK - ALT. WITH IG/S TERM. – The voltage difference does not exceed the tolerance. The positive circuit is good.Proceed to test step 21.

Test Step 21. ALTERNATOR OVERCHARGING TEST.

A. Start the engine and set the throttle to at least 75 percent.

B. Measure the voltage between the sense terminal (S) and/or the “IG” terminal to the case of the alternator.

Expected Result:

The voltage at the “S” terminal and/or “IG” terminal is above the specification.

Results:

- YES – The measured voltage exceeds the specification. There is an internal malfunction in the alternator. See the appropriate service manual for the alternator in order to test the internal components and connections.

  STOP.

- NO – The measured voltage is below the measurement that was taken in the initial tests (B+ to alternator case). The sense circuit in the generator set has high resistance. Correct the problem. Exit this procedure and retest the alternator charging system.

  STOP.

Testing And Adjusting Section

Testing and Adjusting

i02510615

System Self Test

SMCS Code: 7490-038

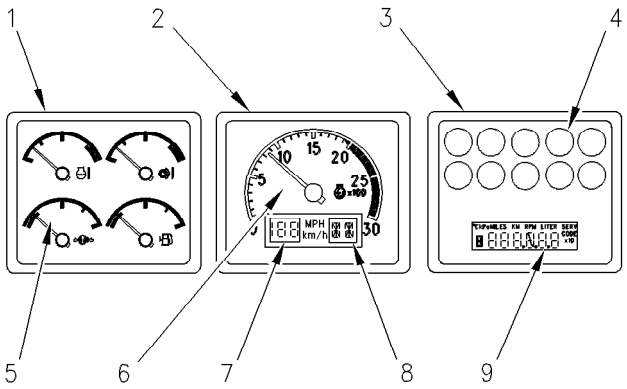


Illustration 133 g00296905

Caterpillar Monitoring System

(1) Quad gauge module. (2) Speedometer/ tachometer module. (3) Main display module. (4) Alert indicators. (5) Gauges. (6) Tachometer gauge. (7) Speed readout. (8) Transmission gear readout. (9) Display area.

The self test verifies that the main display module and the display modules are operating properly. The main display module performs an automatic self test when the key start switch is turned from the OFF position to the ON position.

The internal circuits and the outputs (displays, action lamp and action alarm) are automatically checked. The operator must observe the outputs in order to determine if the modules and the outputs are operating properly. The alert indicators and the display area are tested for approximately one second:

- All alert indicators (4) FLASH.
- Display area (9) shows: unit indicators, “SERV CODE” indicator, symbol for service meter and “888.X.8.8” on the six digit display area.

The display modules are tested for approximately three seconds:

- The test for the LCD segments for rpm, gear and direction (8) will turn on every segment of the display. The readout looks like a “0” with an “X” and a “+” . There should be twelve of these symbols next to each other on the lamp/gear module.
- The alert indicators (3) and the mode indicators (7) for the lamp/gear module will turn ON.
- Tachometer gauge (6) and gauges (5) jump to half scale. The gauges go to zero. The gauges then go to full scale. After reaching full scale, the tachometer and the gauges return to the current machine values.
- The actual transmission gear readout (8) turns on every segment of the readout. The readout looks like a “0” with an “X” and a “+” . There should be two of these symbols next to each other.
- Ground speed readout (7) turns on every segment of the readout. The readout looks like “188” . “MPH” and “km/h” are both turned ON.
- The action lamp turns ON.
- The action alarm SOUNDS once.

The main display module then goes into the normal mode of operation. The main display module can also scroll through the modes if the inputs to the operator switch, the service switch or the clear switch are grounded.

The module is operating properly if the main display module operates, as described. There is a problem with the harness code or the module has failed if the main display module does not operate, as described. In order to check the harness code, see Troubleshooting, “ Harness Code ”.

i05812177

Wiring Harness (Open Circuit) - Test

SMCS Code: 1408-081

An open circuit is a failure that results in no current flow. An open circuit can be caused by:

- Poor connections
- Broken wires

Open Circuit Test

Table 25

Troubleshooting Steps	Values	Results
1. Identify Open Circuit A. Identify the connectors and wires in the suspect circuits. Use the machine Electrical Schematic. B. Turn off the keyswitch and the disconnect switch. C. Disconnect the component and the ECM from the harness. D. At one of the disconnected harness connections, place a jumper wire from the suspect wire contact to frame ground. E. At the other connector of the harness, measure the resistance from the suspect wire contact to frame ground(1).	< 5 Ω	**OK -** The resistance is < 5 Ω. The circuit is not open. STOP **Not OK -** The resistance is ≥ 5K Ω. The circuit is open(2). **Repair:** Repair or replace the harness. STOP

(1) Use a calibrated digital multimeter for this check.
(2) A resistance ≥ 5 Ω but < 5K Ω, indicates a loose or corroded connection. A resistance ≥ 5K Ω indicates an open.

i05817010

Wiring Harness (Short Circuit) - Test

SMCS Code: 1408-081

A short circuit is a circuit failure resulting in undesired current, usually a circuit bypass across a load.

For example: a short across the circuit wires for a lamp produces too much current in the wires, but no current to the lamp. The lamp circuit is shorted.

Note: Normal circuit resistance can vary, but the normal resistance between a particular circuit and other unrelated circuits is always ≥ 5K Ω.

Short Circuit Test

Table 26

Troubleshooting Test Steps	Values	Results
1. Identify Short Circuit A. Identify the connectors and wire numbers of the suspect circuits(1). B. Turn off the keyswitch and disconnect switch. C. Disconnect the component and ECM from the harness. D. At the harness connector for the ECM, place a multimeter probe on the suspect wire contact. E. Use the other multimeter probe to check the resistance across all other ECM connector contacts and frame ground.	≥ 5K Ω	**OK -** All resistance is ≥ 5K Ω. STOP **Not OK -** A resistance is < 5 Ω . There is a short between the suspect wire and the low resistance wire(2). **Repair:** Repair or replace the harness. STOP

(1) Use the machine Electrical Schematic.
(2) A resistance ≥ 5 Ω but < 5K Ω , indicates a loose or corroded connection. A resistance ≥ 5K Ω indicates an open.

i02510614

Electrical Connector - Inspect

SMCS Code: 7553-040-WW

Intermittent electrical problems are often caused by poor connections. Use the following checks as a reference for inspecting connectors.

1. Check the connection of the connectors.

- Ensure that the locking rings are properly locked.
- Ensure that locking clips are used on Sure Seal connectors.
- Ensure that the center of the connector is tight.
- Ensure that the connector pins and sockets align properly.

2. Check the wires at the connector.

- Ensure that the wires enter the back of the connector straight.
- Ensure that each wire is properly crimped into the proper connector contact.
- Ensure that each connector contact is properly locked into the connector contact. When the connector contact is locked properly, the contact (wire) cannot be pulled out of the connector body without excessive force.

3. Check each wire for nicks or signs of abrasion in the insulation.

4. Check for moisture at the connector.

- Check for damaged connector seals or lost connector seals.
- Check for missing or loose wire hole plugs.
- Check for wires that do not enter the connector properly.
- If the wires enter the connector at an angle, there may not be a good seal between the connector and the wire insulation.
- Moisture can enter the connector through the wire insulation.

5. Check for dirty contacts or corroded contacts.

- Clean contacts with a cotton swab or a soft brush and denatured alcohol only.

6. Check each pin and each socket.

- Check each contact of the connector for a snug fit by using a new pin and socket. The new contact should stay connected if the connector is held with the contacts that are facing down.

i05432198

Module - Replace

SMCS Code: 7490-510

Prior to replacement of a module, ensure that replacement is absolutely necessary. A diagnostic code is seldom caused by the module. Always ensure that the machine code is correct for the machine. Also ensure that the power is available to the main display module. The system voltage is required between the contacts 1 and 2 of the connector for the main display module. To check the machine code, see System Operation, “Diagnostic Capabilities”.

Procedure

1. Replace the module.

a. Turn the key start switch to the OFF position.

b. Disconnect the machine harness from the module.

c. Ensure that the module that is replacing the old module has the correct part number.

d. Install the new module.

e. Connect the machine harness to the module. On so equipped machines, make sure that the harness code plug is installed.

f. Turn the disconnect switch and the key start switches to the ON position. Make sure that the module successfully completes the self test.

Expected Result:

The module has been successfully replaced and the module has completed the self test.

Results:

- YES - The module has been successfully replaced and has completed the self test. Proceed to Step 2.
- NO - The module has been successfully replaced but has not performed the self test properly. Ensure that the module is correct. Ensure that the installation is correct and ensure that no related diagnostic codes are present. STOP.

2. Setup

a. Set up the optional display modules, see Systems Operation, “Settings Menu”.

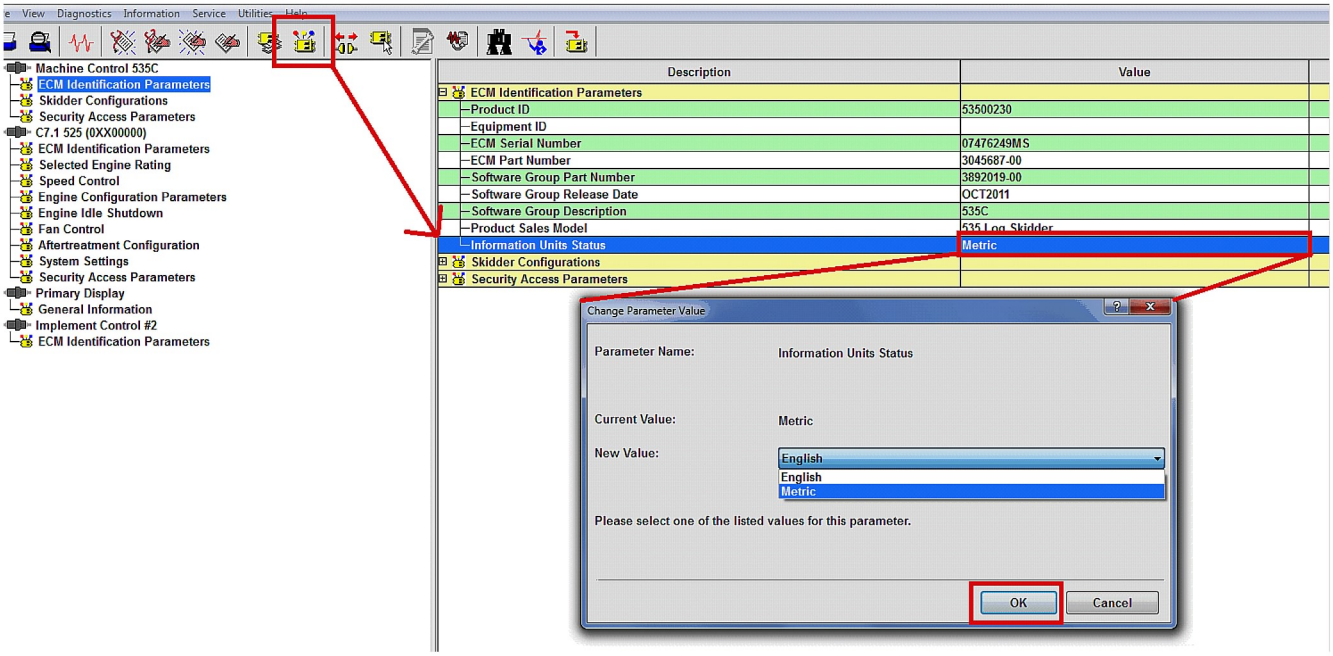


Illustration 134 g03428475

Changing Information Units Status in Caterpillar Electronic Technician

b. To set the desired “Information Units Status” to English or Metric, do the following.

- Connect Caterpillar Electronic Technician (Cat ET) to the machine service connector.
- Click the Configuration Tool icon or click “Service - Configuration” at the top menu.
- Under “ECM Identification Parameters” , click the value for “Information Units Status” (default value is metric).
- Select English or Metric in the pop-up box and click “OK” .

i04818112

Main Display Module Initialization - Adjust

SMCS Code: 7490-025

The initialization is an internal process within the main display module. During the initialization, the main display module listens to the Cat Data Link and the harness code inputs. From this information, the module learns about the machine. For example, the module learns that the information for the engine oil pressure is coming from an engine ECM.

Note: On later model products, the harness code is located within the module software and does not require this initialization procedure.

Normally, the initialization occurs when the main display module is replaced. Also, the initialization occurs when there is a change in the harness code. However, when a previously used main display module is used as a replacement, initialization could be necessary. Faults that cannot be explained with the Cat Data Link can occur if the main display module is not initialized correctly. **The service person must activate the initialization when the main display module has been previously used. Initialization is used if the module was taken out of an application that had the same machine code as the main display module that is to be removed.**

Procedure For Initialization

This procedure causes the initialization to occur on any main display module. Initialization requires that the main display module to be powered up with a valid harness code. The valid harness code must be different than the harness code when the module was last powered down. For a list of valid harness codes, see the table for Machine Codes in System Operation, “Harness Code Mode”.

1. Code input configuration.

a. Turn the key start switch to the OFF position.

b. Determine whether the harness code inputs are hard wired in the machine harness or accessible at a harness code plug. Use the Electrical System Schematic in the Service Manual for the machine.

Expected Result: There is a harness code plug.

Results:

- YES - There is a harness code plug. Remove the harness code plug. Proceed to 3.
- NO - The harness code inputs are hard wired in the machine harness. Proceed to 2.

2. Hard wired procedure.

a. Disconnect the machine harness from the main display module.

b. At the machine harness connector for the main display module, remove the wire for one of these contacts (3, 6, 12, 16, 22 or 31). Choose a contact that is connected to ground.

Note: If a ground wire is not available, on any of the mentioned ECM contacts, then install a jumper wire between contact 2 (ECM ground) and contact 3 and repeat 2b.

c. With tape, secure the removed connector contact out of the way.

d. Reconnect the machine harness to the main display.

Results:

- CONTINUE - Proceed to 3.

3. Reconnection and verification.

a. Turn the disconnect switch and the key start switches to the ON position.

b. Various indicators in the Caterpillar Monitoring System display area will illuminate. Wait 10 seconds.

c. Turn the key switch to the OFF position.

d. Depending on the previous procedure that was performed, either reinstall the harness code plug (from “Code input configuration”) or reinstall the ground connector contact (from “Hard wired procedure”).

e. Make sure that the main display module successfully completes the self test, see Testing and Adjusting, “System Self Test”.

f. Check the machine code. See System Operation, “Harness Code Mode”.

Expected Result: The display module has successfully completed the self test.

Results:

- OK - The display module successfully completed the self test. STOP.
- NOT OK - The display module did not complete the self test. Exit this procedure. Determine the cause of the failure and repeat “Initialization”. STOP.

i01519504

Main Display Module - Flash Program

SMCS Code: 7490-591

Perform the following procedure in order to flash program the ECM. The ECM is flashed in order to upgrade the software. Flash programming of the ECM must also be done if the ECM has been replaced. The Caterpillar Electronic Technician (ET) contains the program WinFlash. WinFlash is used in order to load software into the ECM. The following procedure is used in order to FLASH software into the ECM for the Caterpillar Monitoring System.

1. Procedure

a. Connect the 7X-1425 Data Link Cable between the 7x-1700 Communication Adapter and the Electronic Technician.

b. Connect the 139-4166 Data Link Cable between the 7x-1700 Communication Adapter and the diagnostic connector of the machine.

c. Turn the key to the ON position.

d. Use WinFlash in order to load the software.

Note: Flash programming is not allowed if the engine is running, or the machine is moving.

i02510504

Glossary of Terms

SMCS Code: 7490

Abnormal – This means a condition that is not normal. The presence of an abnormal condition or an abnormal signal indicates the existence of a problem. A warning is activated in order to alert the operator.

Alert Indicator – An alert indicator is a red indicator lamp that is located on the top portion of the main display module. The alert indicator notifies the operator of an abnormal condition.

+Battery – This pertains to any of the harness wiring which is part of the circuit that connects to the positive battery post. +Battery voltage is also referred to as system voltage.

Caterpillar Electronic Technician (ET) – This is a Windows based program, that is used to service Caterpillar products. The software operates on a service tool (personal computer).

Component Identifier (CID) – The CID is a diagnostic code that informs the operator of component or the system that has failed. The CID is a four digit code, that is located in the digital display area when the main display module is in service mode.

Clear – This is the removal of diagnostic information that is stored in the memory of the ECM. Before a failure is cleared, the failure must be on hold and the failure must not be present.

Connector Contact – A connector contact is the component of a harness connector that actually makes the electrical connection. Connector contacts are either pins or sockets.

Detected Diagnostic Code – A detected diagnostic code is a problem that has been found by the main display module. A service code that has been recorded for the problem and the diagnostic information is available when the main display module is in service mode.

Diagnostic – This is a process that takes place within an electronic control. The control senses the abnormal machine information. The control displays the abnormal machine information. The control stores the abnormal machine information. This stored information can aid the service technician.

Display – Display refers to the gauges, indicators, or readouts within the Caterpillar Monitoring System display area.

Failure Mode Identifier (FMI) – An FMI is a diagnostic code that identifies the type of failure that has occurred. The FMI consists of two digit code which is preceded by a decimal point “.” . This code is shown on the display area when the main display module is in service mode.

Diagnostic Code – A diagnostic code is a failure of a component in an electronic system. An associated CID FMI identifies the type of problem.

Diagnostic Event – This is a type of maintenance event. This event is displayed when an electronic control detects an abnormal condition in the electrical system. Sometimes abnormal conditions in the mechanical system can be detected through the electrical system.

Gauge – This is a display device that is typically circular in shape with an indicator needle. The gauge can be a mechanical device or the gauge can be a solid state device.

Ground (B-) – This is the reference point for the electrical system. On CAT products, ground is the machine frame or the engine. This is the connection point for the negative side of the battery.

Floating – This describes the end of a circuit that is open. The circuit is not connected to any other component.

Hard Wired – Hard wired refers to an electrical connection that is made within the harness. The connections are permanent. These soldered connections or crimped connections are not meant to be altered.

Harness – This is an assembly or a bundle of two or more wires that electrically connects system components. Typically, the harness is held together by a loom.

Harness Code – This refers to the grounded condition or the open circuit condition of the inputs for the harness code . The harness code provides the characteristics of the machine such as engine oil pressure, maximum engine speed, etc. The monitoring system uses this hard wired code in order to determine the module identifier (MID) that is used for data link communications.

Hertz (Hz) – This is a measure of frequency. The units are cycles per second.

Hysteresis – This is a measure of the “lag time that occurs between the turn ON and turn OFF values of a switch or a sensor”. As an example, the warning lamp may turn on at 40 psi with decreasing pressure and the warning lamp may turn off at 45 psi with increasing pressure. The hysteresis is 5 psi.

Indicator – An indicator is any of the items within the Caterpillar Monitoring System display area which operate in an ON, FLASHING or OFF manner in order to bring attention to a machine condition.

Jumper – A jumper is a piece of wire that is used to make an electrical connection during troubleshooting.

Key Start Switch – This is an automotive type key start that provides engine cranking/starting .

Lamp – This is a component of the machine electrical system that emits light by converting electrical energy into light.

Light Emitting Diode (LED) – This is a solid state device. The device emits light that is visible to the human eye when an electrical current is passed through the device. The LED is used as a lamp in electronic controls because the device is very reliable.

Liquid Crystal Display (LCD) – This is a type of solid state display that uses a liquid crystalline material. The material is sealed between two glass sheets. An electrical signal causes segments of the crystal material to be visible to the eye.

Machine Service Connector – This is a harness connector for the machine or for engine electrical

systems. The harness connector will allow the connection of a service tool for diagnostics.

Module Identifier (MID) – An MID is a diagnostic code that identifies the electronic control module which diagnosed the diagnostic code. The two-digit code is displayed in the display area when the machine is in the service mode.

Open Circuit – This is a condition that exists when an electrical circuit is broken.

Pressure Sensor – This is a device that generates a signal that is proportional to the pressure that is sensed.

Problem – This refers to the presence of an abnormal machine condition. When a problem exists, warning operation is activated and the main display module notifies the operator.

Pounds per square inch (psi) – This is an English unit of pressure measurement. The measurement represents the force that is applied to one square inch. The value is measured in pounds. 6.89 kPa (1 psi)

Pull up Voltage – This is the voltage that is measured on the input of an electronic control. The measurement is taken when an input device (sensor or switch) has been disconnected.

Pulse Width Modulation (PWM) – The PWM is a signal that consists of variable pulse widths at fixed intervals. The duty cycle can be varied. The frequency of a PWM signal is constant. The Caterpillar Monitoring System has sensors which provide a PWM signal to the main display module.

Scroll – When you scroll through information in the display area, all available sets of diagnostic information are shown by one set at a time. A set of diagnostic information is shown briefly. Then, the display automatically advances to the next set. After all sets have been shown, the sets are repeated.

Sender – This is a device that changes resistance according to a physical condition. The sender then sends a signal to a gauge. A single connection provides the signal and the power.

Sensor – This is a device that monitors the physical condition of a machine system. The sensors can monitor the conditions that are listed here: pressure, temperature, flow and mechanical movement. The sensors convert the condition into an electrical signal that can be understood by an electronic control.

Service Code – This is a type of maintenance code that describes a condition that has been identified by an electronic control system. The code indicates when service is required. This code is stored in the control for the service technician. This term was previously referred to as a fault code. This code is now referred to as a service type of maintenance event.

Service Tool – This is a tool that is used in order to service Caterpillar machines. This term most often refers to the service equipment that is listed here: Electronic Control Analyzer Programmer (ECAP), Caterpillar Electronic Technician (ET), a digital multimeter and laptop computer This may also refer to any other dedicated service equipment.

Short Circuit – A connection between two points in a circuit that is normally unwanted.

Show – This pertains to information that is within the Caterpillar Monitoring System display area that is viewed by the operator or a service person.

Signal – This is the changing voltage that is used to carry information. A signal is typically sent from a sensor to an electronic control. For example, a signal is sent from the transmission output speed sensor (TOS) to the transmission control.

Signal Wire – This is the harness wire that carries the signal voltage to the electronic control. The signal is sent by any of the components that are listed here: a sensor, a switch and any other similar components.

Speedometer/Tachometer Module – This is a display module that contains the components that are listed here: a speedometer for machine ground speed, a tachometer for engine speed and a display for actual gear.

Switch Input – This is an input to an ECM. This input may be ground. The input may be open. The input may be positive voltage (+battery).

System Voltage – System voltage is the actual voltage that exists between the positive battery post and the frame ground. The system voltage is referred to as the + battery.

Temperature Sensor – This is a device that generates a signal that is proportional to the change in temperature.

Uncommitted Switch Input – Uncommitted switch inputs are switch inputs that function according to the application. Information from the uncommitted switch inputs is typically used to operate the alert indicators.

Undetected Problem – This is a problem that is not detected by the main display module, but the problem is found by the operator or by a service technician. The many diagnostic functions of the main display module assist with the troubleshooting of undetected problems.

+V – This pertains to a constant voltage that is supplied to a component. +V is provided by an electronic control module or the battery.

i02662774

Connector Contact Description of Main Display Module

SMCS Code: 7490-546-CY

Table 27

Contact Description Of Main Module Connector 515 and 525			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Differential Lock Switch
12	Harness Code 2	Switch Input Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature

(continued)

(Table 27, contd)

Contact Description Of Main Module Connector 515 and 525			
No.	**Function**	**Type**	**Description**
29	Switch 2	Switch Input	Rear Differential Filter
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Front Differential Filter
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Transmission Filter / Temperature

Table 28

Contact Description Of Main Module Connector 533, 543, TK370, TK370, TK380, and TK381			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Switch Input	Brake Pressure Switch N/O
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Coolant Temperature Sender
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level Sender
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature Sender
11	Switch 7	Switch Input	Reverse Pressure Switch
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Switch Input	Brake Pressure Switch N/C

(continued)

(Table 28, contd)

Contact Description Of Main Module Connector 533, 543, TK370, TK370, TK380, and TK381			
No.	**Function**	**Type**	**Description**
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure Switch
20	Switch 4	Switch Input	Brake Oil Pressure Switch
21	Switch 8	Switch Input	Forward Pressure Switch
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	+8 VDC Power Supply
25	Display Datalink Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Switch Input	Front Differential Lock Switch
28	PWM/Switch/Sender 7	Switch Input	Hydraulic Lockout Status
29	Switch 2	Switch Input	Hydraulic Oil Level Switch
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Parking Brake Pressure Switch
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	Display Data Link Power
35	Display Module Data	Input/Output	Display Data Link Data
36	Frequency 2	Sensor Input - Frequency	Engine Speed Sender
37	PWM/Switch 3	Sensor Or Switch Input	Saw Pressure Sensor
38	PWM/Switch/Sender 8	Switch Input	Case Drain Temperature Switch
39	Switch 3	Switch Input	Implement Filter Switch
40	Switch 5	Switch Input	Rear Differential Lock Switch

Table 29

Contact Description Of Main Module Connector 545, 525B, and 535B			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch

(continued)

(Table 29, contd)

Contact Description Of Main Module Connector 545, 525B, and 535B			
No.	**Function**	**Type**	**Description**
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Primary Steering Pressure
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Secondary Steering Pressure
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	Unassigned
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Transmission Filter

Table 30

Contact Description Of Main Module Connector 814F, 815F, and 816F			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Brake Oil Temperature
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Secondary Steering
33	Clear	Switch Input	Clear Switch

(continued)

(Table 30, contd)

Contact Description Of Main Module Connector 814F, 815F, and 816F			
No.	**Function**	**Type**	**Description**
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Hydraulic Oil Level
40	Switch 5	Switch Input	Primary Steering

Table 31

Contact Description Of Main Module Connector 824GSeries II/H, 825GSeries II/H, and 826GSeries II/H			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Transmission Neutral
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch

(continued)

(Table 31, contd)

Contact Description Of Main Module Connector 824GSeries II/H, 825GSeries II/H, and 826GSeries II/H			
No.	**Function**	**Type**	**Description**
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Hydraulic Oil Level
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Transmission Filter Status
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Primary Steering

Table 32

Contact Description Of Main Module Connector 834G/H, and 988G/H			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Front Axle Oil Temperature
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned

(continued)

(Table 32, contd)

Contact Description Of Main Module Connector 834G/H, and 988G/H			
No.	**Function**	**Type**	**Description**
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Rear Axle Oil Temperature
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Transmission Filter Status
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Hydraulic Filter Status
40	Switch 5	Switch Input	Primary Steering

Table 33

Contact Description Of Main Module Connector 836G/H			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Transmission Filter Status
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC

(continued)

(Table 33, contd)

Contact Description Of Main Module Connector 836G/H			
No.	**Function**	**Type**	**Description**
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Hydraulic Filter Status
40	Switch 5	Switch Input	Primary Steering

Table 34

Contact Description Of Main Module Connector 938F and IT38F			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Gear Toggle
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC

(continued)

(Table 34, contd)

Contact Description Of Main Module Connector 938F and IT38F			
No.	**Function**	**Type**	**Description**
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Ground Speed Sensor
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Neutral
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Supplemental Steering Pressure
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Engine Speed Sensor
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Parking Brake
40	Switch 5	Switch Input	Primary Steering

Table 35

Contact Description Of Main Module Connector 950F II, 960F, 966F II, and 970F			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Brake Oil Temp
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver

(continued)

(Table 35, contd)

Contact Description Of Main Module Connector 950F II, 960F, 966F II, and 970F			
No.	**Function**	**Type**	**Description**
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Parking Brake
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Ground Speed Sensor
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Neutral
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Supplemental Steering Pressure
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Engine Speed Sensor
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Hydraulic Oil Level
40	Switch 5	Switch Input	Primary Steering

Table 36

Contact Description Of Main Module Connector 950G, 962G. IT62G, 966G, and 972G			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC

(continued)

(Table 36, contd)

Contact Description Of Main Module Connector 950G, 962G. IT62G, 966G, and 972G			
No.	**Function**	**Type**	**Description**
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Implement Filter Status
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Hydraulic Oil Level
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Rear Axle Oil Temperature
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module

(continued)

(Table 36, contd)

Contact Description Of Main Module Connector 950G, 962G. IT62G, 966G, and 972G			
No.	**Function**	**Type**	**Description**
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Front Axle Oil Temperature

Table 37

Contact Description Of Main Module Connector 950GSeries II/H, 962GSeries II/H, 966GSeries II/H, 972GSeries II/H, 980GSeries II/H			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Transmission Neutral
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch
24	Sensor Power Supply	Output	8 VDC

(continued)

(Table 37, contd)

Contact Description Of Main Module Connector 950GSeries II/H, 962GSeries II/H, 966GSeries II/H, 972GSeries II/H, 980GSeries II/H			
No.	**Function**	**Type**	**Description**
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Hydraulic Oil Level
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Transmission Filter Status
33	Clear	Switch Input	Clear Switch
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Primary Steering

Table 38

Contact Description Of Main Module Connector R1300G			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver

(continued)

(Table 38, contd)

Contact Description Of Main Module Connector R1300G			
No.	**Function**	**Type**	**Description**
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Engine Oil Pressure
20	Switch 4	Switch Input	Brake Accumulator Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch (Service Tool)
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Throttle Control Module
40	Switch 5	Switch Input	Unassigned

Table 39

Contact Description Of Main Module Connector R1300G Series II S/N: RSL1–Up			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC

(continued)

(Table 39, contd)

Contact Description Of Main Module Connector R1300G Series II S/N: RSL1–Up			
No.	**Function**	**Type**	**Description**
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Engine Coolant Temperature
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Accumulator Oil Pressure
21	Switch 8	Switch Input	Ground
22	Harness Code 3	Switch Input - Programming	Unassigned
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch (Service Tool)
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module

(continued)

(Table 39, contd)

Contact Description Of Main Module Connector R1300G Series II S/N: RSL1–Up			
No.	**Function**	**Type**	**Description**
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Unassigned

Table 40

Contact Description Of Main Module Connector R1600G			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Accumulator Oil Pressure
21	Switch 8	Switch Input	Unassigned
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	8 VDC

(continued)

(Table 40, contd)

Contact Description Of Main Module Connector R1600G			
No.	**Function**	**Type**	**Description**
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch (Service Tool)
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Transmission Oil Pressure
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Unassigned

Table 41

Contact Description Of Main Module Connector R1700G S/N: 8XZ1–Up			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver

(continued)

(Table 41, contd)

Contact Description Of Main Module Connector R1700G S/N: 8XZ1–Up			
No.	**Function**	**Type**	**Description**
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Axle Oil Temperature/Pressure
22	Harness Code 3	Switch Input - Programming	Programming Switch
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Transmission Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch (Service Tool)
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Impending Brake Application (IBA)
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Unassigned

Table 42

Contact Description Of Main Module Connector R1700G S/N: SBR1–Up			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Unassigned
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Unassigned
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Oil Pressure
21	Switch 8	Switch Input	Axle Oil Temperature/Pressure
22	Harness Code 3	Switch Input - Programming	Unassigned
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Unassigned
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch (Service Tool)

(continued)

(Table 42, contd)

Contact Description Of Main Module Connector R1700G S/N: SBR1–Up			
No.	**Function**	**Type**	**Description**
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Unassigned

Table 43

Contact Description Of Main Module Connector R2900G			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC
2	Ground	Ground	0 VDC
3	Harness Code 1	Switch Input - Programming	Programming Switch
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
6	Harness Code 5	Switch Input - Programming	Programming Switch
7	PWM/Switch 1	Sensor Or Switch Input	Unassigned
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
12	Harness Code 2	Switch Input - Programming	Programming Switch
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
16	Harness Code 4	Switch Input - Programming	Programming Switch
17	PWM/Switch 2	Sensor Or Switch Input	Unassigned
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Accumulator Oil Pressure
21	Switch 8	Switch Input	Axle Oil Temperature/Pressure
22	Harness Code 3	Switch Input - Programming	Programming Switch

(continued)

(Table 43, contd)

Contact Description Of Main Module Connector R2900G			
No.	**Function**	**Type**	**Description**
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
26	Frequency 1	Sensor Input - Frequency	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned
28	PWM/Switch/Sender 7	Sensor, Switch Or Sender Input	Torque Converter Oil Temperature
29	Switch 2	Switch Input	Unassigned
30	Alternator R terminal	Sensor Input - Frequency	Alternator Frequency
31	Harness Code 0	Switch Input - Programming	Programming Switch
32	Switch 6	Switch Input	Unassigned
33	Clear	Switch Input	Clear Switch (Service Tool)
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
36	Frequency 2	Sensor Input - Frequency	Unassigned
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Unassigned
40	Switch 5	Switch Input	Unassigned

Table 44

Contact Description Of Main Module Connector 844 and 990			
No.	**Function**	**Type**	**Description**
7	Sensor 1 PWM/Sw	Sensor, Switch Or Sender Input	Front Axle Oil Temperature
8	PWM/Switch/Sender 5	Sensor, Switch Or Sender Input	Unassigned
9	Input 10 Fuel/Sw	Switch Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
11	Switch 7	Switch Input	Unassigned
17	Sensor 2 PWM/Sw	Sensor, Switch Or Sender Input	Rear Axle Oil Temperature
18	Input 9 Fuel/Sw	Switch Input	Mode 0 Switch
19	Switch 1	Switch Input	Unassigned
20	Switch 4	Switch Input	Brake Accumulator Pressure
21	Switch 8	Switch Input	Unassigned
27	PWM/Switch 4	Sensor or Switch Input	Unassigned

(continued)

(Table 44, contd)

Contact Description Of Main Module Connector 844 and 990			
No.	**Function**	**Type**	**Description**
28	Sensor 7 Res/PWM/Sw	Sensor, Switch Or Sender Input	Torque Converter Outlet Oil Temperature
29	Switch 2	Switch Input	Parking Brake Pressure Switch
32	Switch 6	Switch Input	Transmission Filter Status
37	PWM/Switch 3	Sensor Or Switch Input	Unassigned
38	PWM/Switch/Sender 8	Sensor, Switch Or Sender Input	Unassigned
39	Switch 3	Switch Input	Hydraulic Pilot Pressure Switch
40	Switch 5	Switch Input	Primary Steering Pressure

Table 45

Contact Description Of Main Module Connector 844H and 990H			
No.	**Function**	**Type**	**Description**
1	+ Battery	Input - Voltage (Power)	28 VDC Switched
2	Ground	Ground	0 VDC
4	Action Alarm	Output	Alarm Driver
5	Cat Data Link +	Input/Output - Data Link	Driver/Receiver (+)
7	Sensor 1 PWM/Sw	Sensor, Switch Or Sender Input	Front Axle Oil Temperature
8	Switch /Sender 10	Switch Or Sender Input	Fuel Level
10	PWM/Switch/Sender 6	Sensor, Switch Or Sender Input	Hydraulic Oil Temperature
13	Action Lamp	Output	Lamp Driver
14	Cat Data Link -	Input/Output - Data Link	Driver/Receiver (-)
15	Display Module Load	Output	Driver for Gauge Module
17	Sensor 2 PWM/Sw	Sensor, Switch Or Sender Input	Rear Axle Oil Temperature
18	Switch/Sender 9	Switch Or Sender Input	Operator Switch
20	Switch 4	Switch Input	Brake Dual Charge Oil Pressure
23	Service	Switch Input	Scroll Switch (Service Tool)
24	Sensor Power Supply	Output	+8 VDC
25	Display Module Clock	Output	Driver for Gauge Sequencing
32	Switch 6	Switch Input	Transmission Filter Status
33	Clear	Switch Input	Clear Switch (Service Tool)
34	Display Module Power Supply	Output	9 VDC
35	Display Module Data	Input/Output	Data for Gauge Module
37	Switch 3	Switch Input	Steering Oil Temperature Switch
38	PWM/Switch/Sender	Sensor, Switch Or Sender Input	Transmission Lube Temperature
40	Switch 5	Switch Input	Primary Steering Pressure Switch

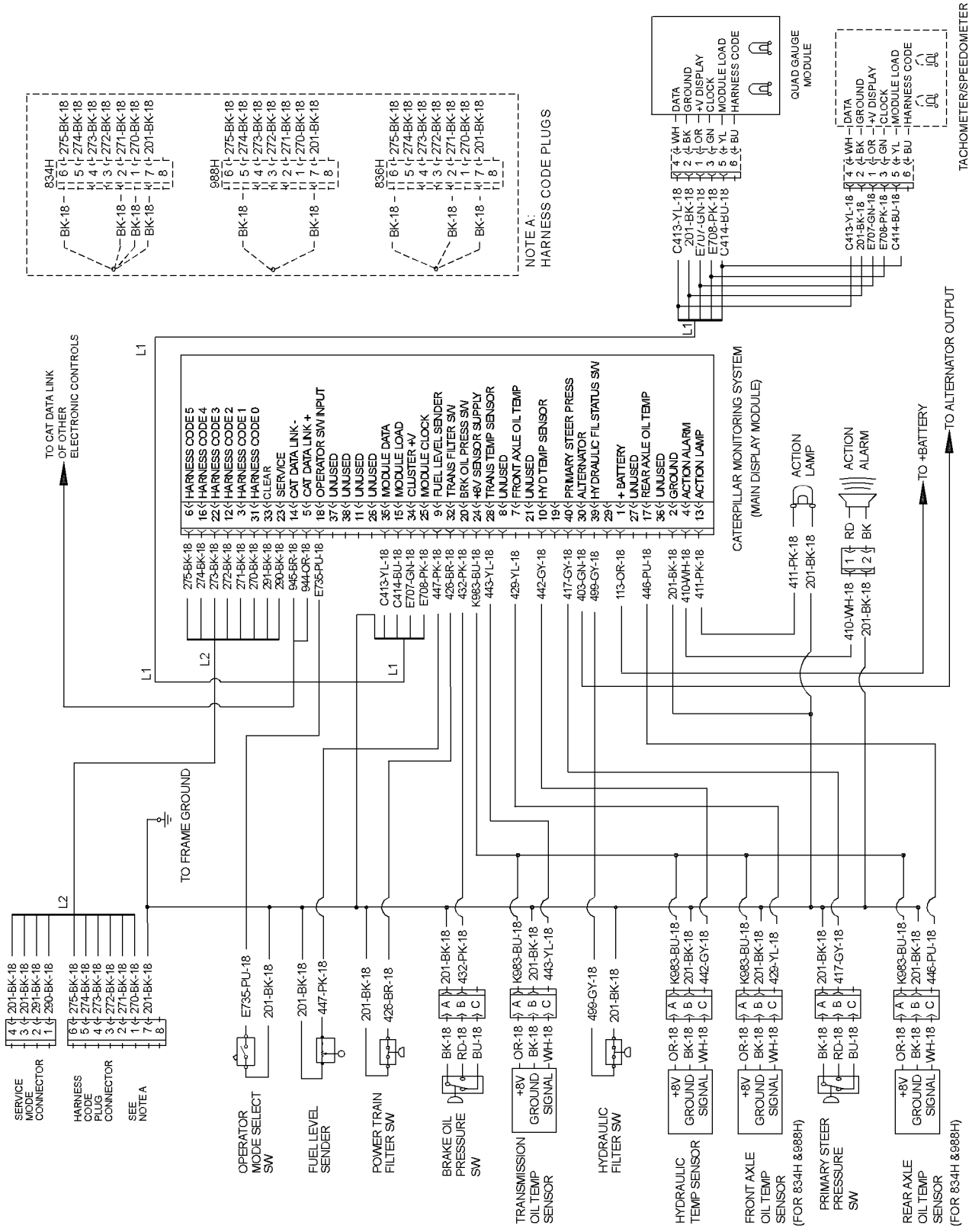
i03879714

System Schematic

SMCS Code: 7566

These schematics are typical schematics for the Caterpillar Monitoring System. The schematics show possible inputs and outputs. On some machines, certain sensors are not part of the system. However, the main display module receives the sensor information over the Cat Data Link from other electronic controls. For an accurate schematic of a particular machine, always see the Electrical System Schematic in the machine Service Manual.

Schematic For 834G, 836G, and 988G


NOTE A:
HARNESS CODE PLUGS
834H
988H
836H
TACHOMETER/SPEEDOMETER MODULE
QUAD GAUGE MODULE
CATERPILLAR MONITORING SYSTEM
(MAIN DISPLAY MODULE)
TO CAT DATA LINK OF OTHER ELECTRONIC CONTROLS
TO FRAME GROUND
TO +BATTERY
TO ALTERNATOR OUTPUT
SERVICE MODE CONNECTOR
HARNESS CODE PLUG CONNECTOR
SEE NOTE A
OPERATOR MODE SELECT SW
FUEL LEVEL SENDER
POWER TRAIN FILTER SW
BRAKE OIL PRESSURE SW
TRANSMISSION OIL TEMP SENSOR
HYDRAULIC FILTER SW
HYDRAULIC TEMP SENSOR
FRONT AXLE OIL TEMP SENSOR (FOR 834H &988H)
PRIMARY STEER PRESSURE SW
REAR AXLE OIL TEMP SENSOR (FOR 834H &988H)
ACTION LAMP
ACTION ALARM
+8V SIGNAL
GROUND
DATA
+V DISPLAY
CLOCK
MODULE LOAD
HARNESS CODE

Schematic For 834H, 836H, and 988H

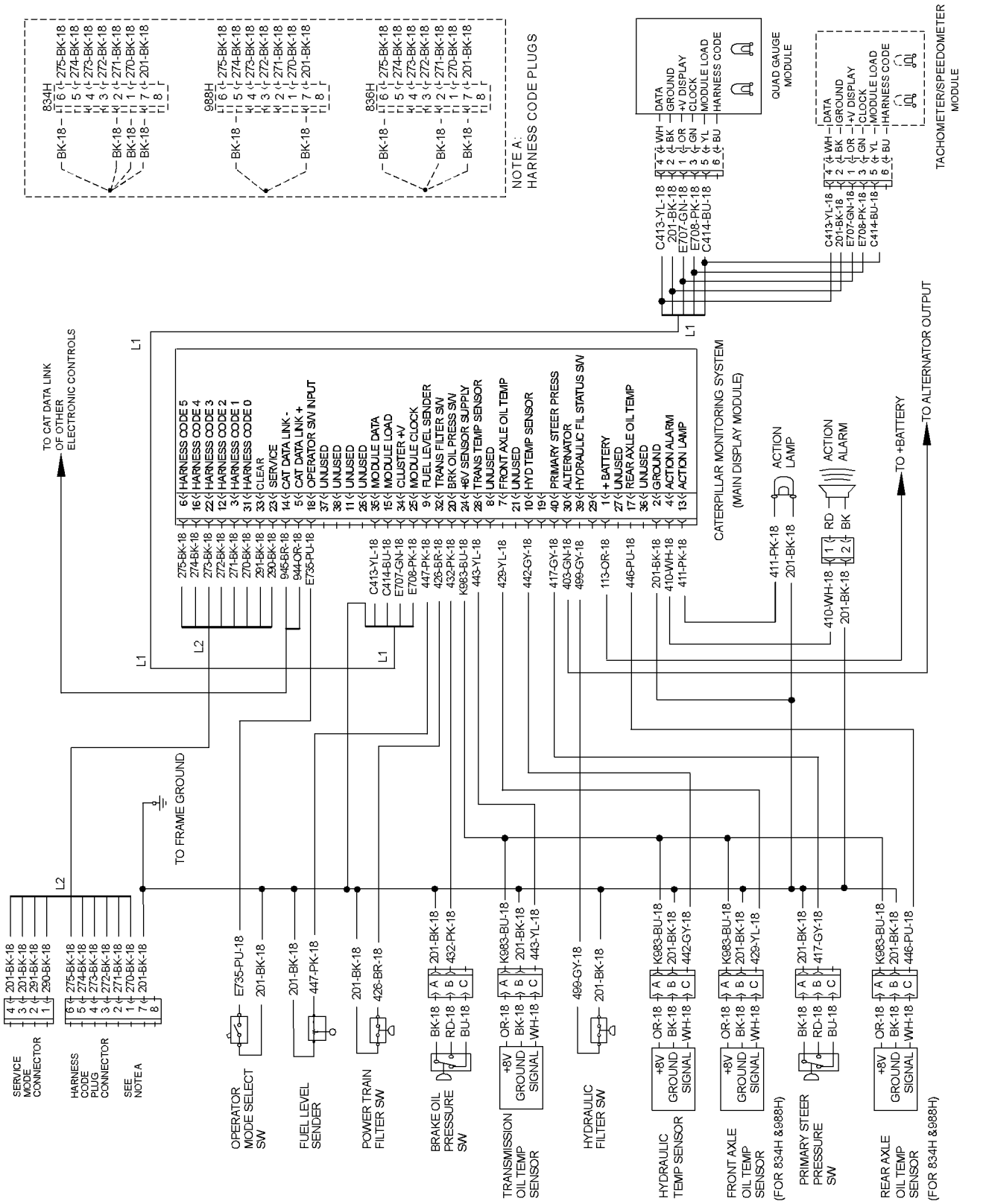


Illustration 136 g02222103

Schematic For 834H Series II, 836H Series II, and 988H Series II

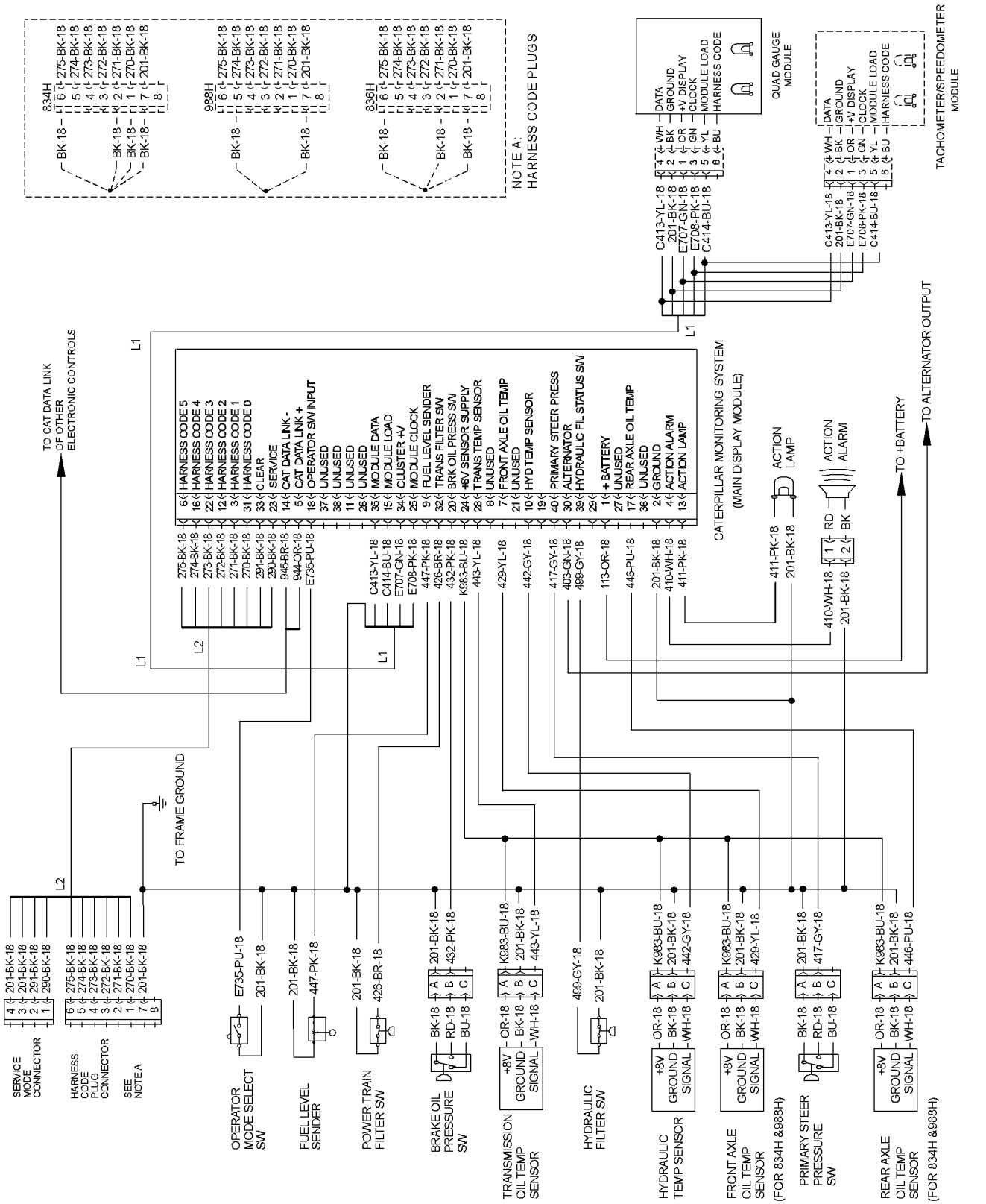


Illustration 137 g02222103

Schematic For 950F Series II, 960F, 966F Series II, and 970F

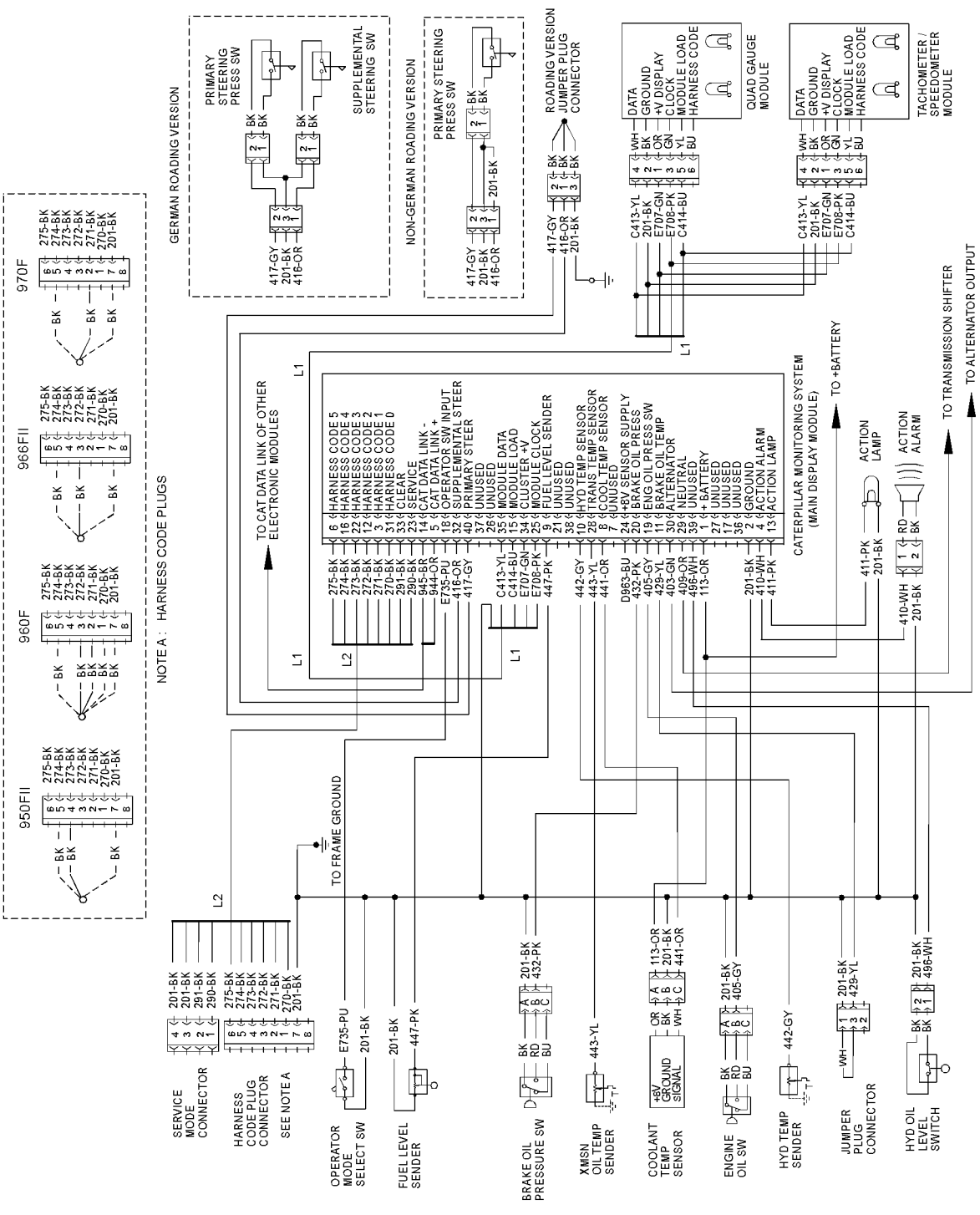


Illustration 138 g02149449

Schematic For 950G, 962G, and IT62G

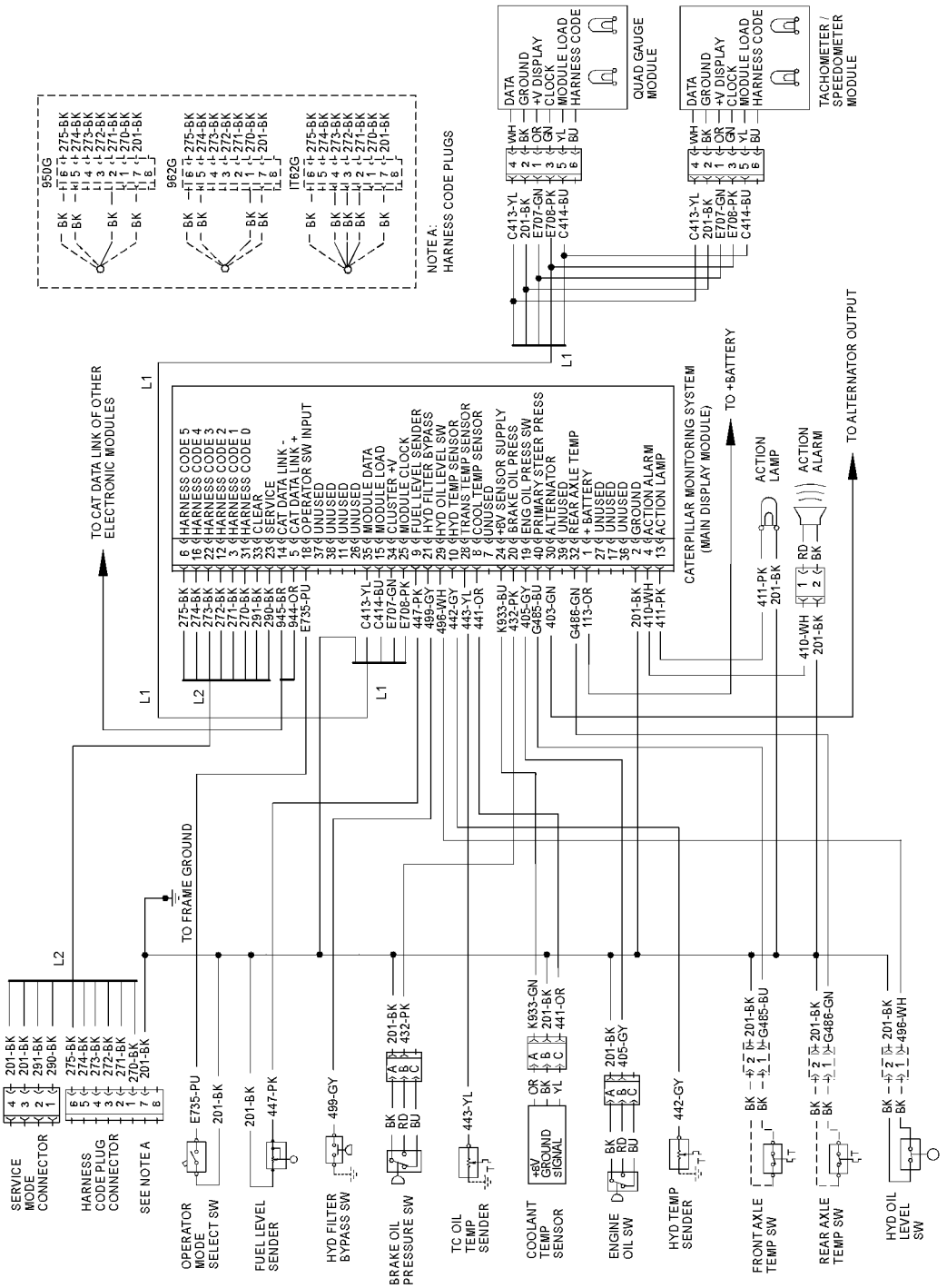


Illustration 139 g02222073

Schematic For 966G and 972G

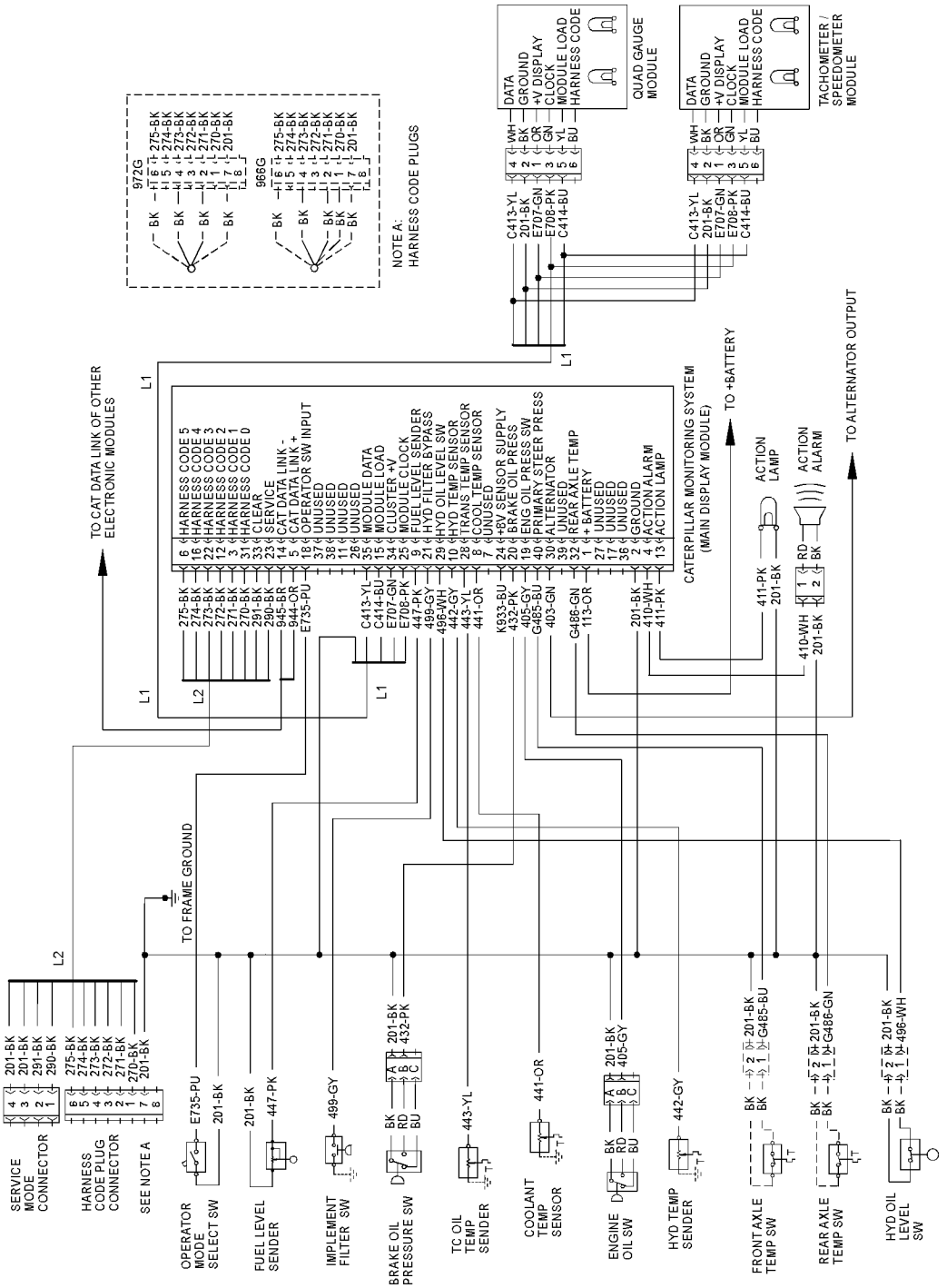


Illustration 140 g02222093

Schematic For 966H and 972H

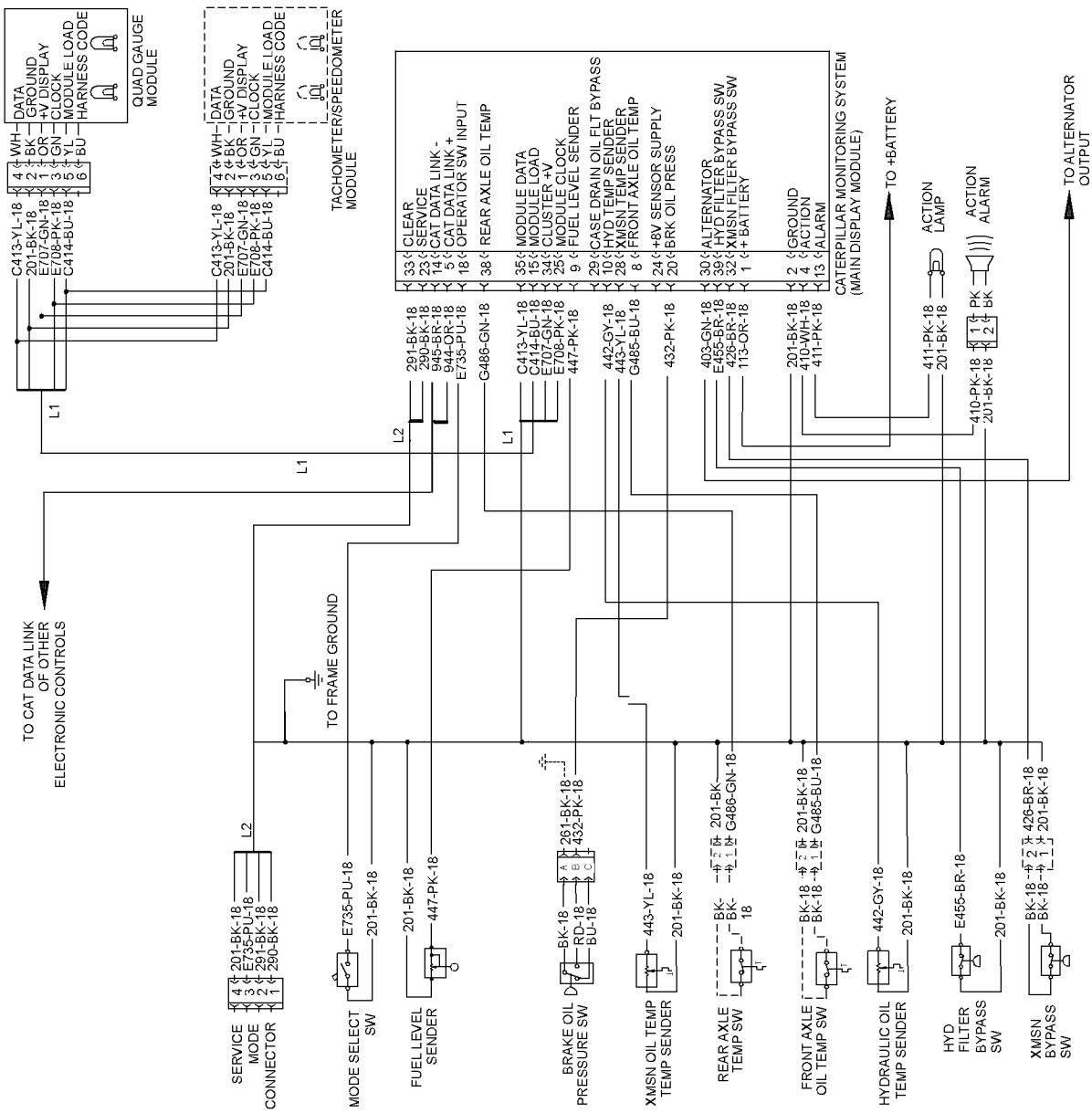


Illustration 141 g01384848

Schematic For 938F and IT38F

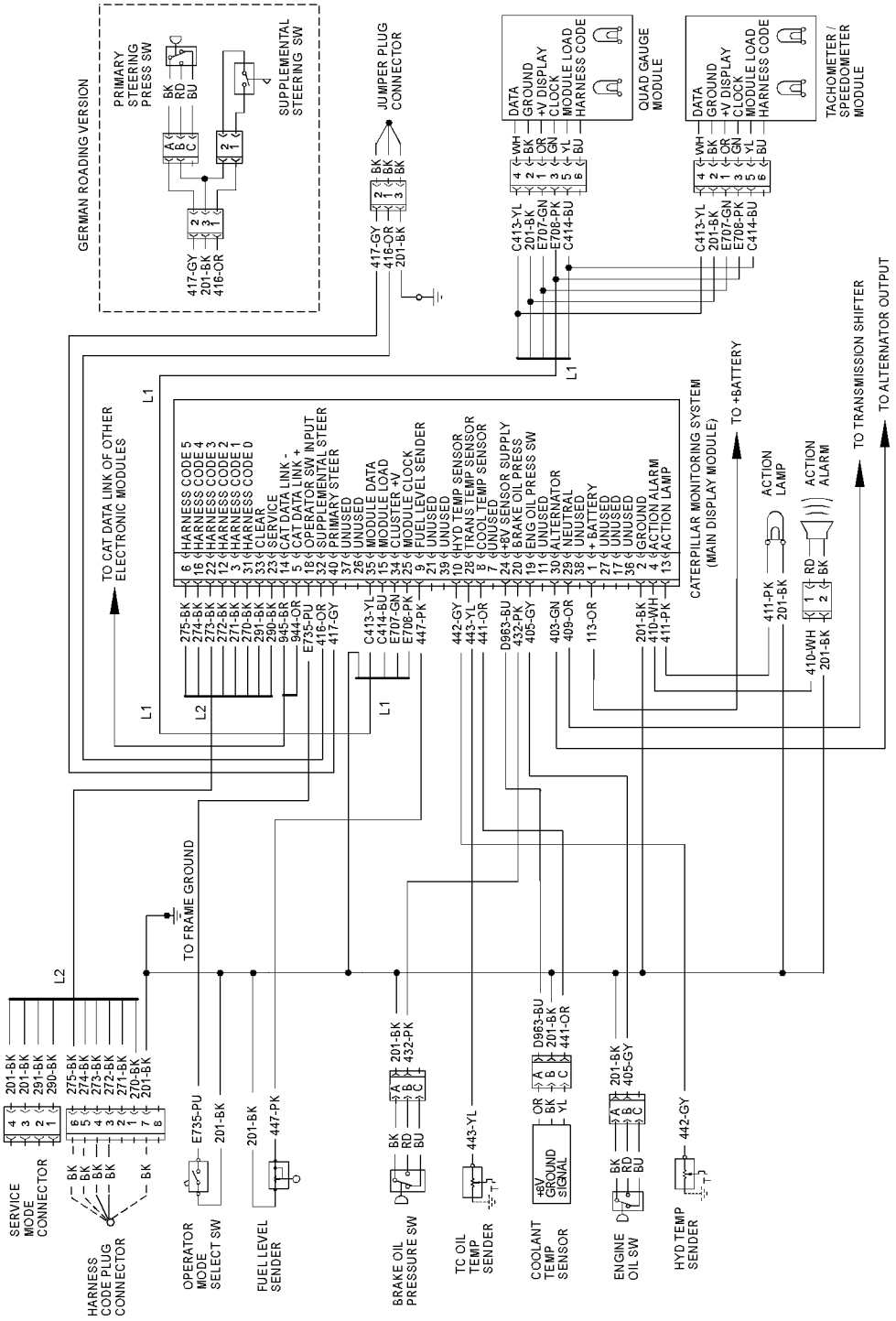


Illustration 142 g02222095

Schematic For 980G, 824G, 825G, and 826G

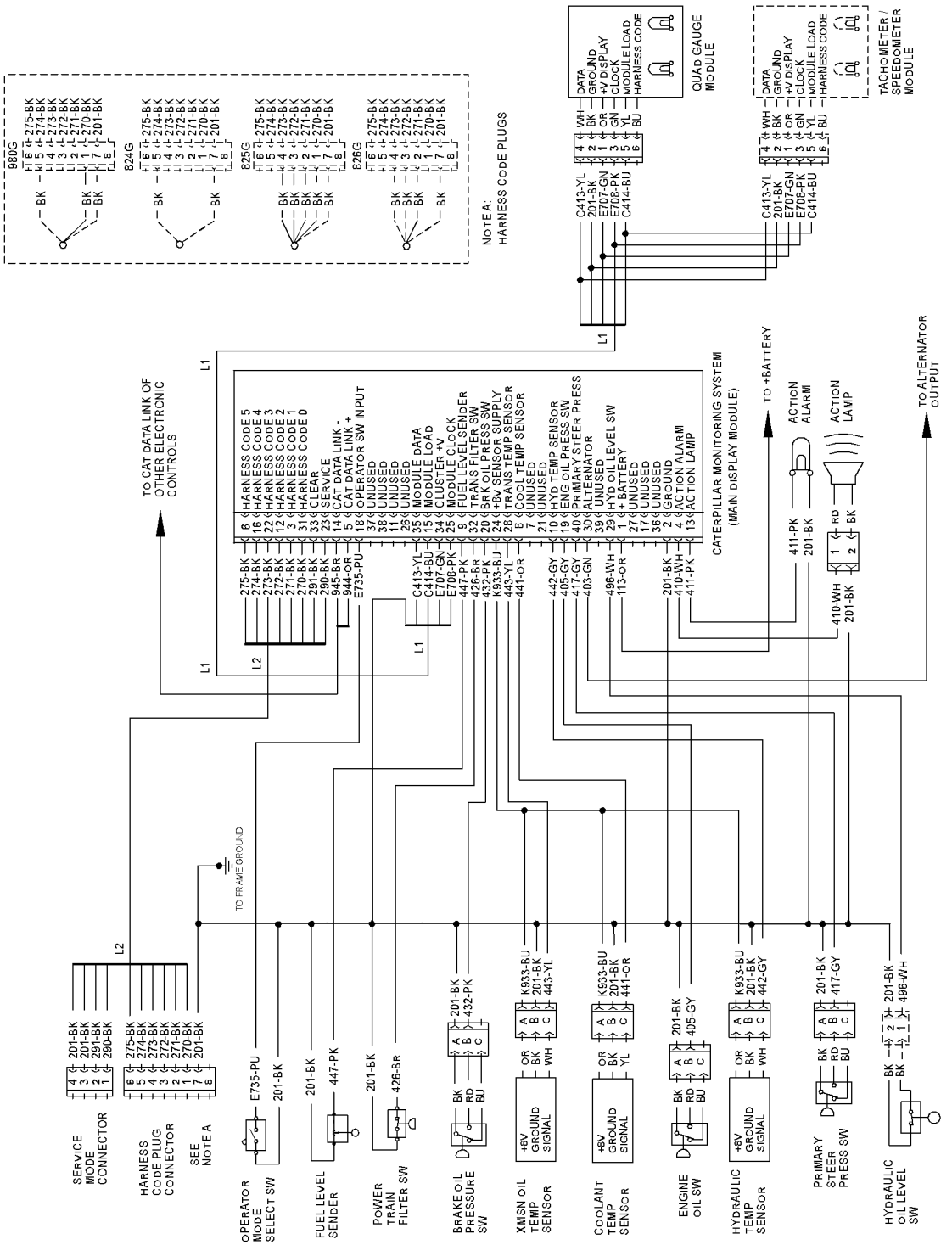
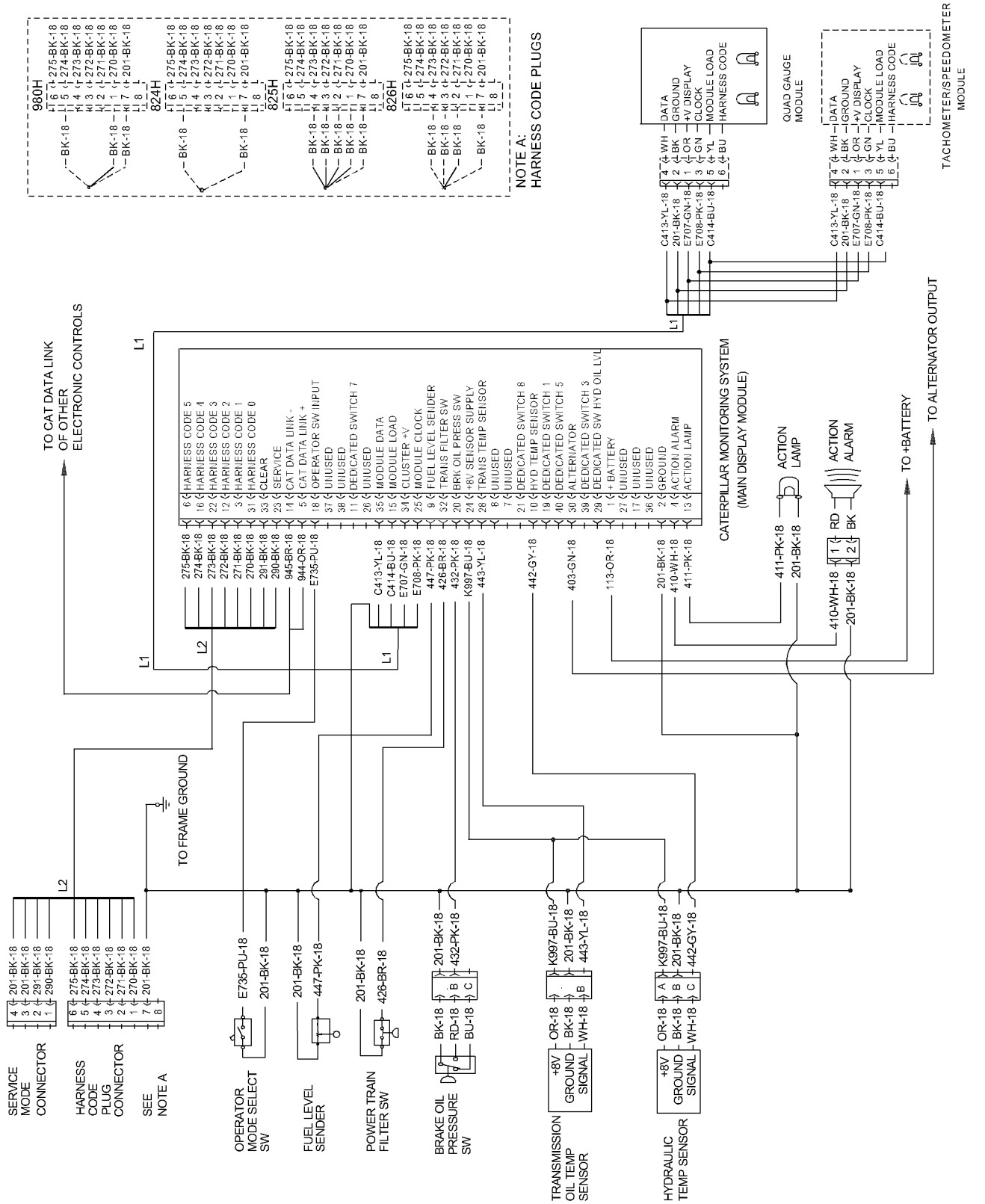


Illustration 143 g02222096

Schematic For 980H, 824H, 825H, and 826H


980H
824H
825H
826H
NOTE A:
HARNESS CODE PLUGS
TO CAT DATA LINK
OF OTHER
ELECTRONIC CONTROLS
TO FRAME GROUND
CATERPILLAR MONITORING SYSTEM
(MAIN DISPLAY MODULE)
QUAD GAUGE
MODULE
TACHOMETER/SPEEDOMETER
MODULE
TO +BATTERY
TO ALTERNATOR OUTPUT
ACTION
LAMP
ACTION
ALARM
SERVICE
MODE
CONNECTOR
HARNESS
CODE
PLUG
CONNECTOR
SEE
NOTE A
OPERATOR
MODE SELECT
SW
FUEL LEVEL
SENDER
POWER TRAIN
FILTER SW
BRAKE OIL
PRESSURE
SW
TRANSMISSION
OIL TEMP
SENSOR
HYDRAULIC
TEMP SENSOR
+8V
GROUND
SIGNAL
DATA
GROUND
+V DISPLAY
CLOCK
MODULE LOAD
HARNESS CODE

Schematic For 515 and 525

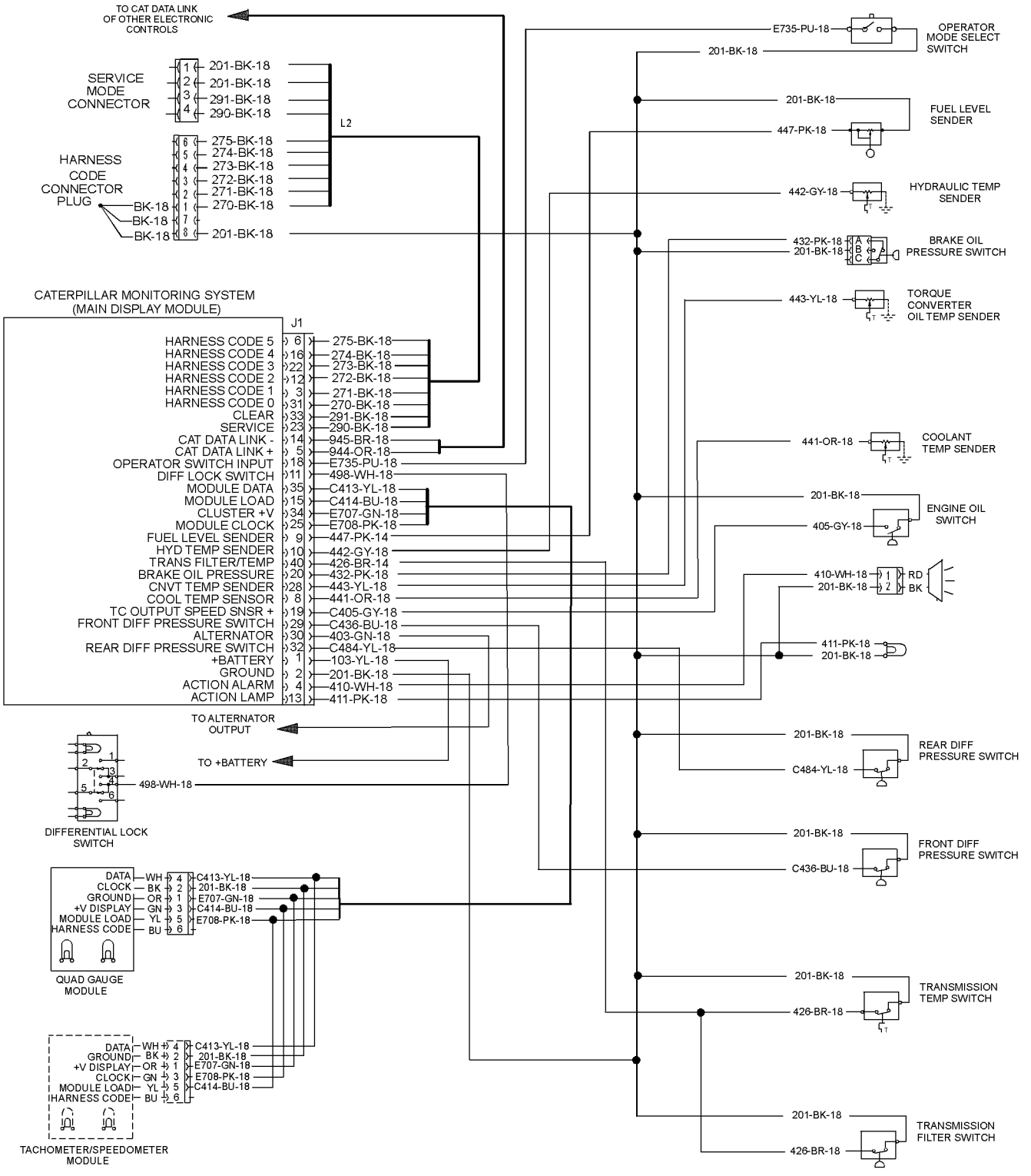


Illustration 145 g02141767

Schematic For 545, 525B, and 535B

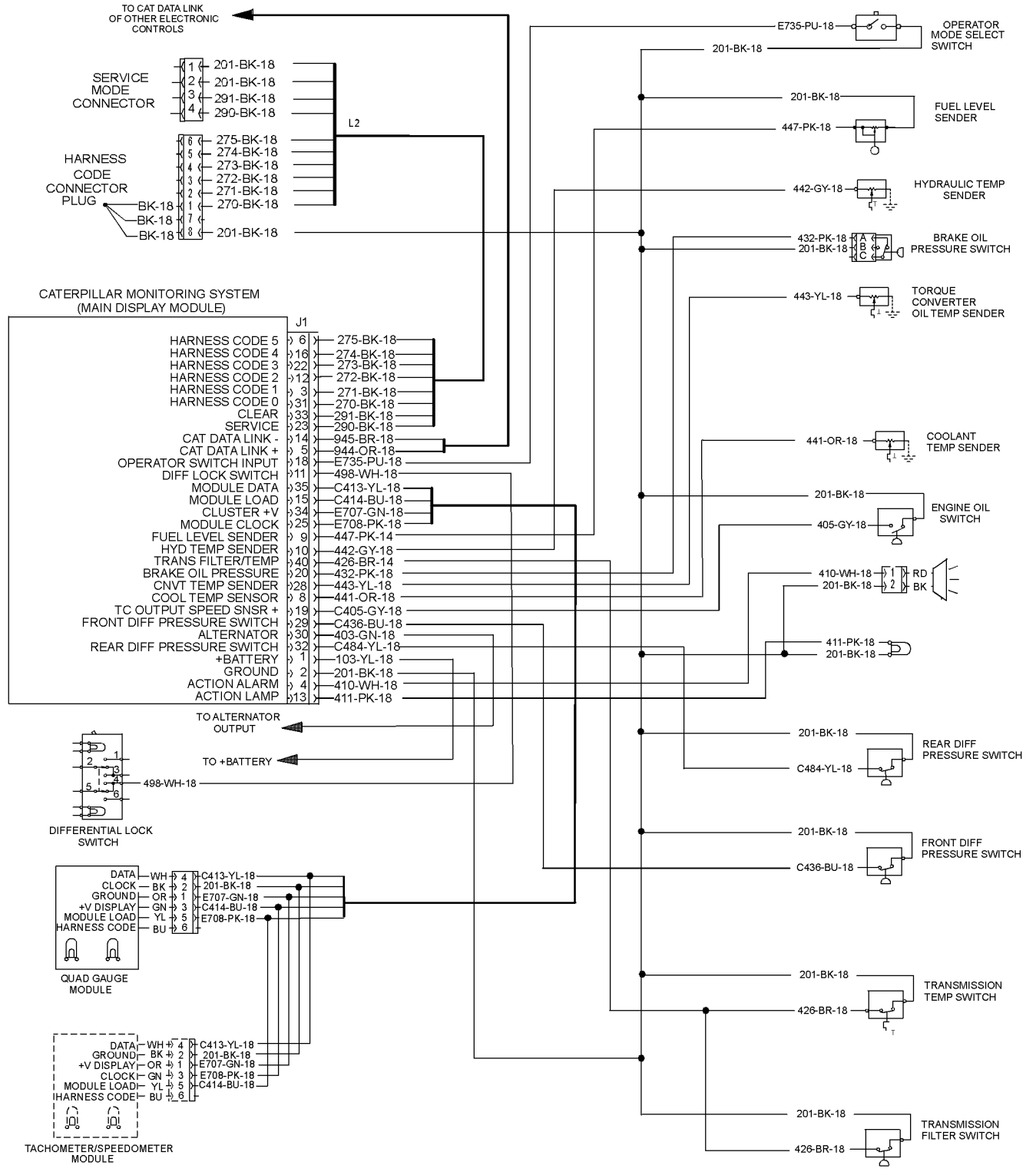


Illustration 146 g02125823

Schematic For 533, 543, TK370, TK371, TK380, and TK381

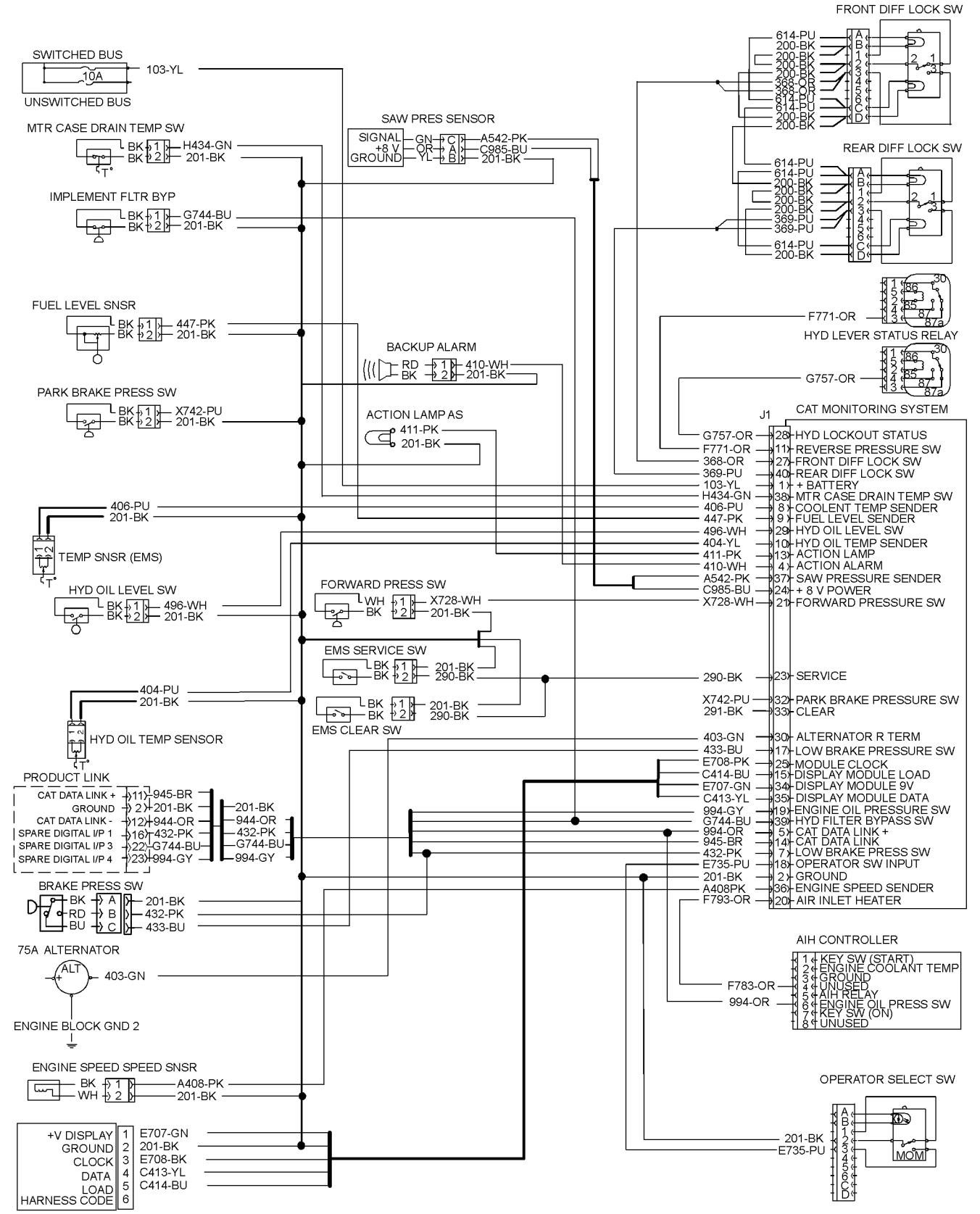


Illustration 147 g02125825

Schematic For 814F, 815F, and 816F

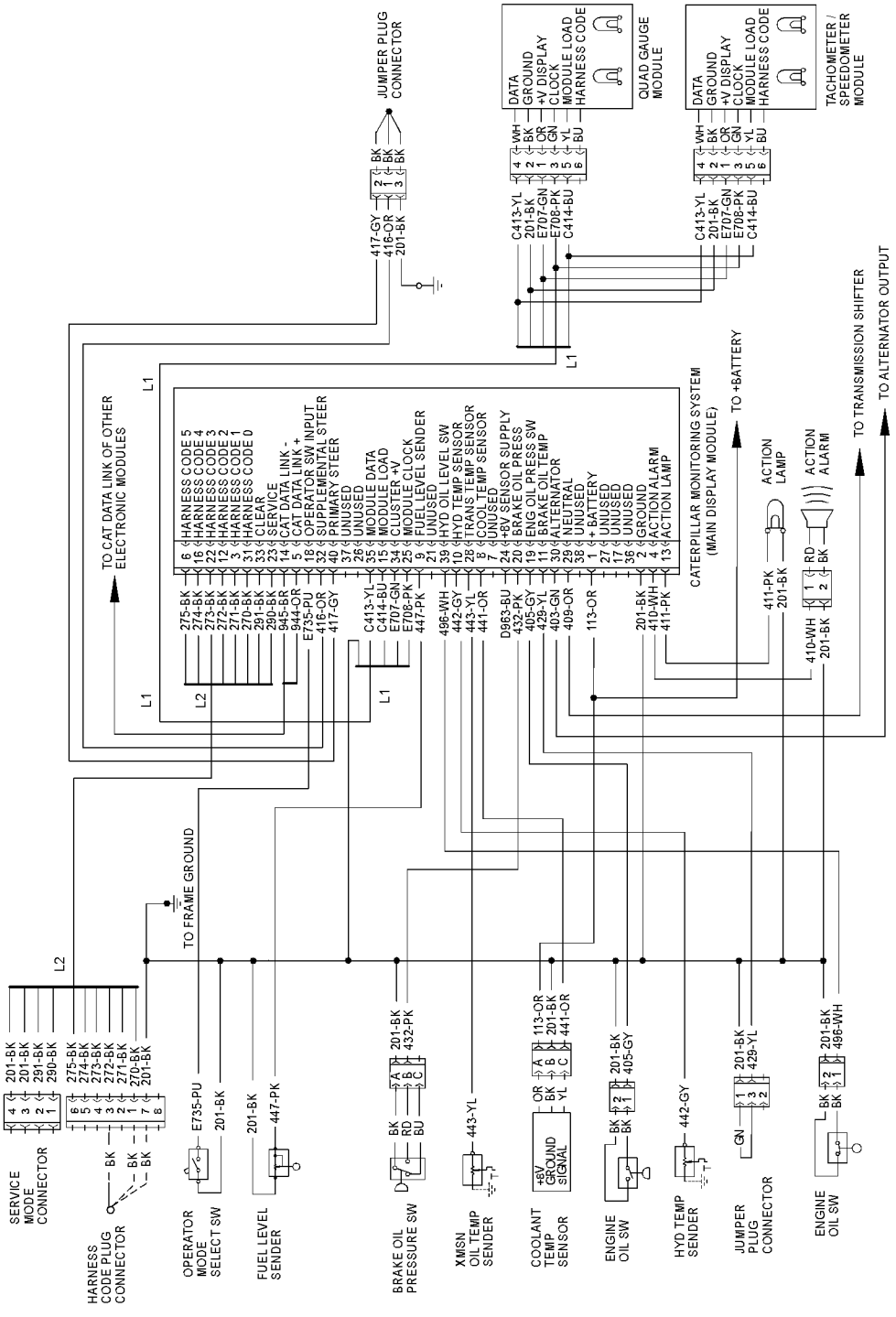


Illustration 148 g02222102

Schematic For 814F, 815F, and 816F Emissions Update

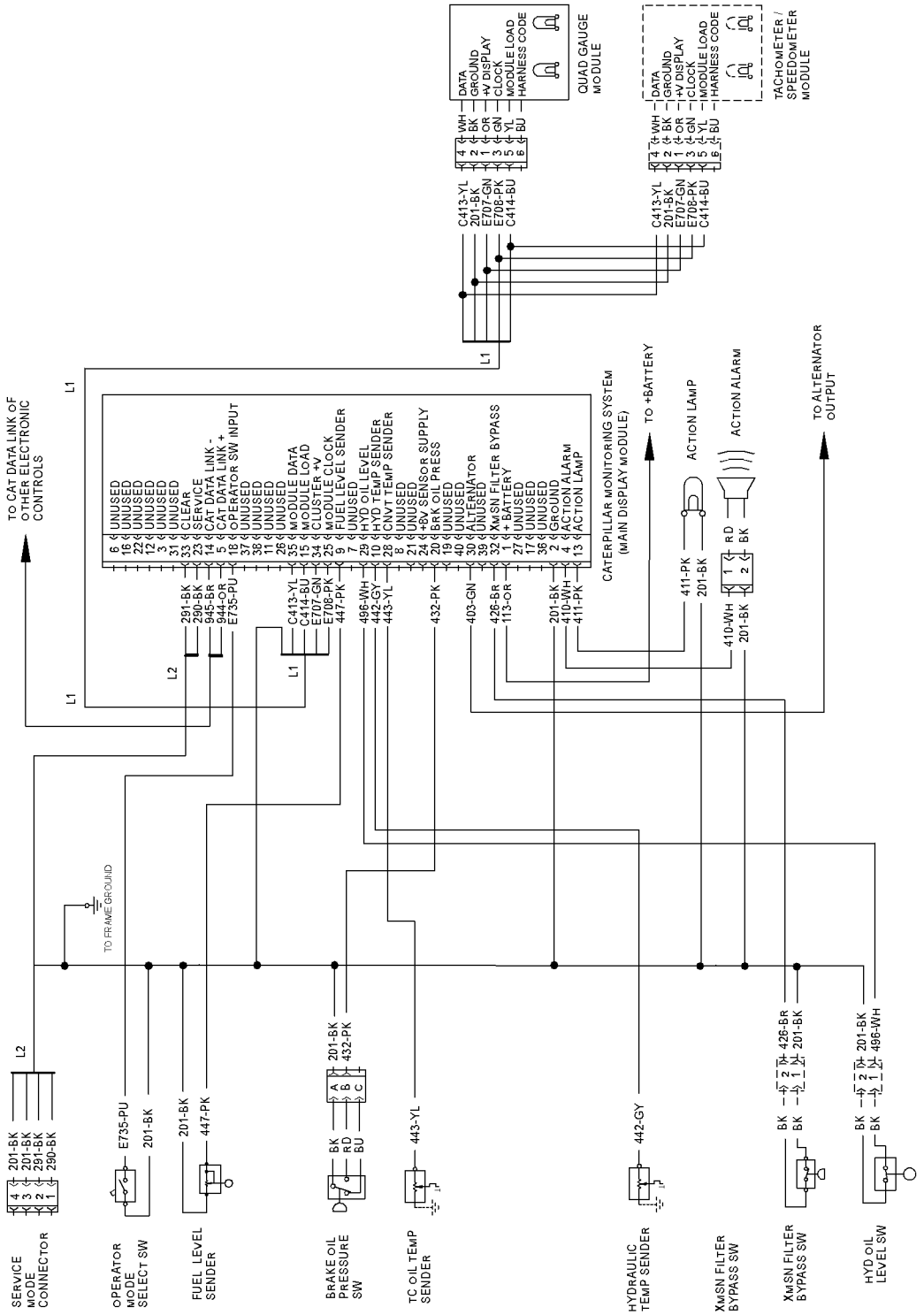


Illustration 149 g02222101

Schematic For 844 and 990

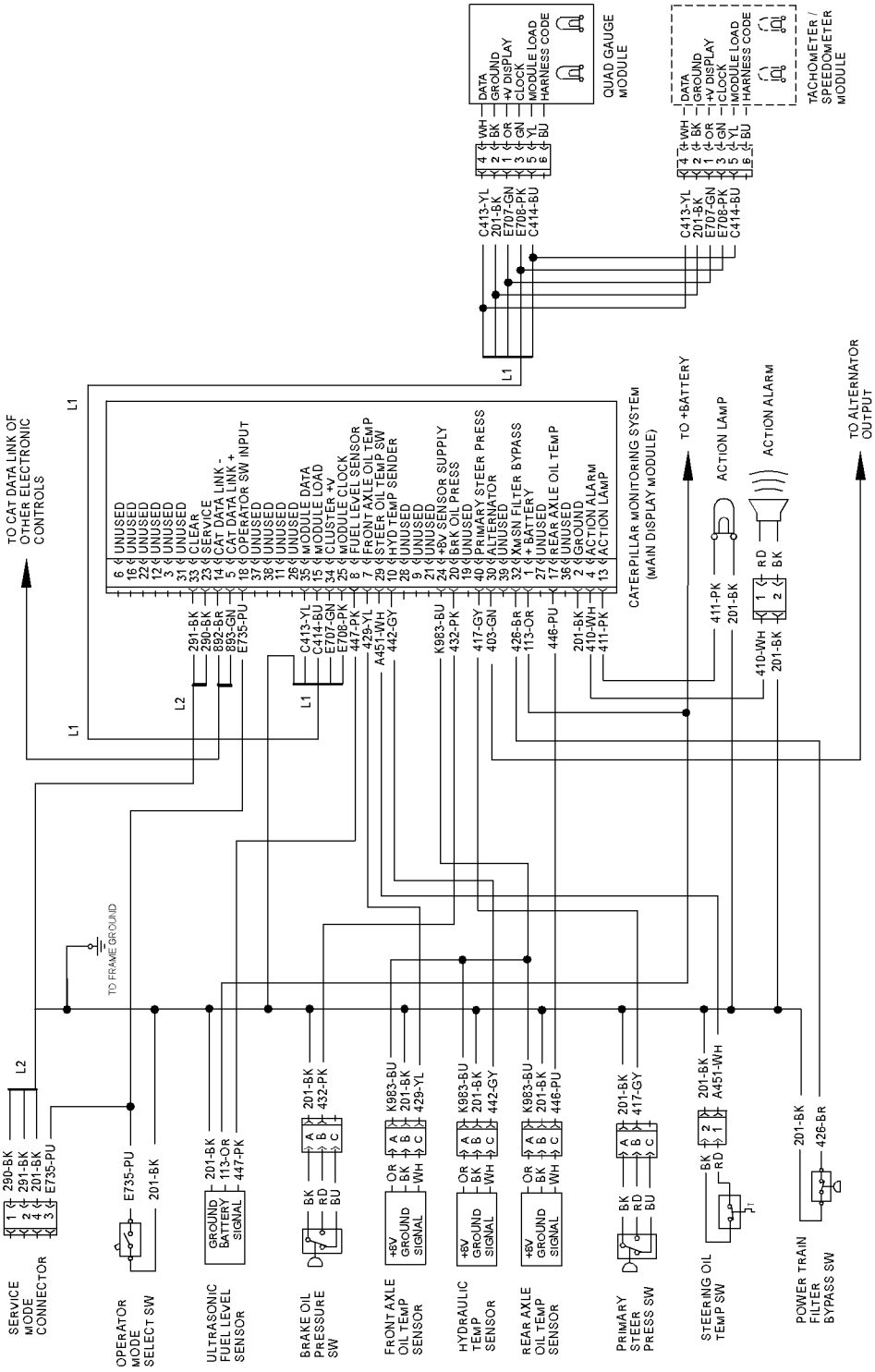


Illustration 150 g02223515

Schematic For 844H and 990H

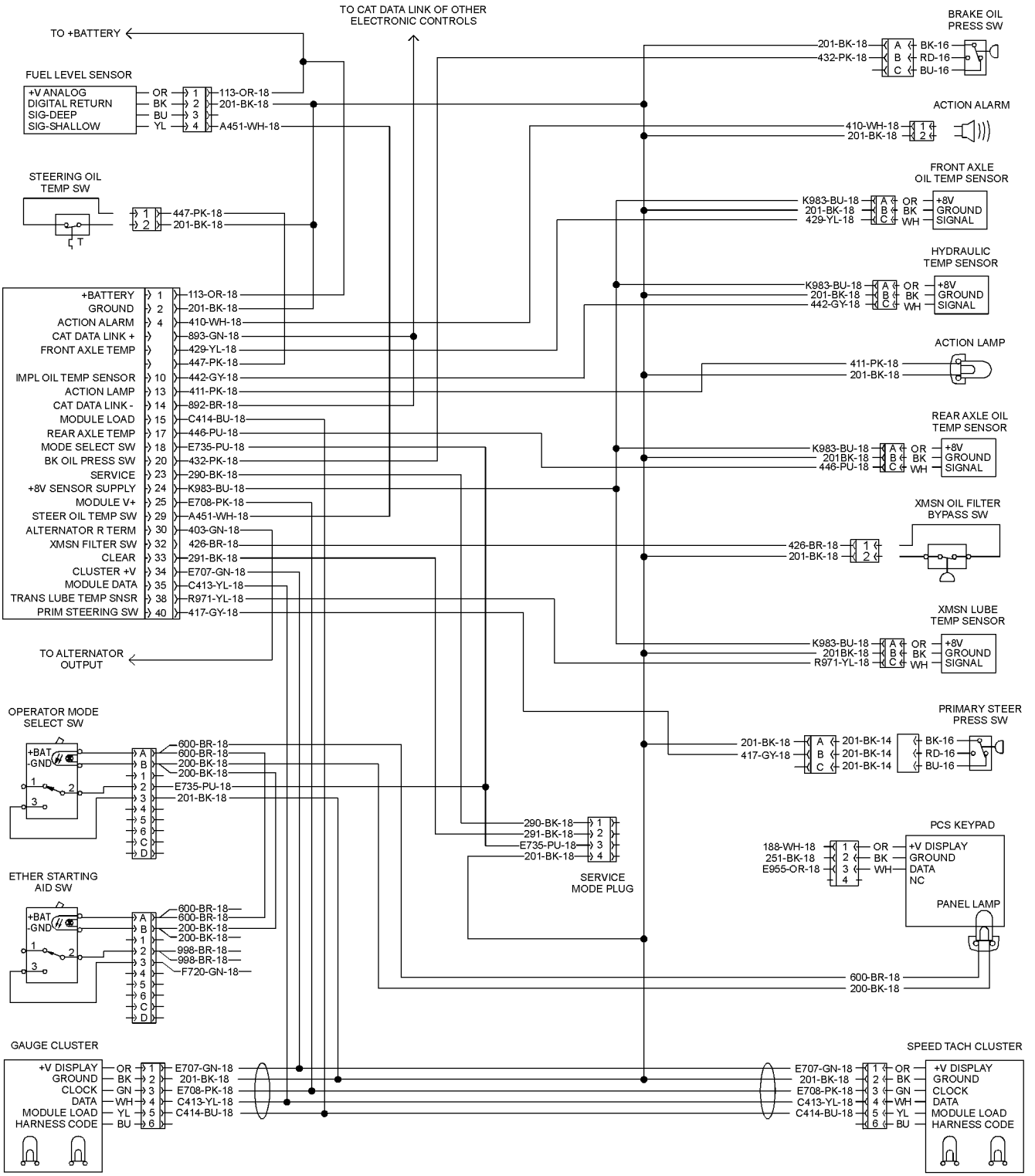


Illustration 151 g01256252

Schematic For 844H Series II and 990H Series II

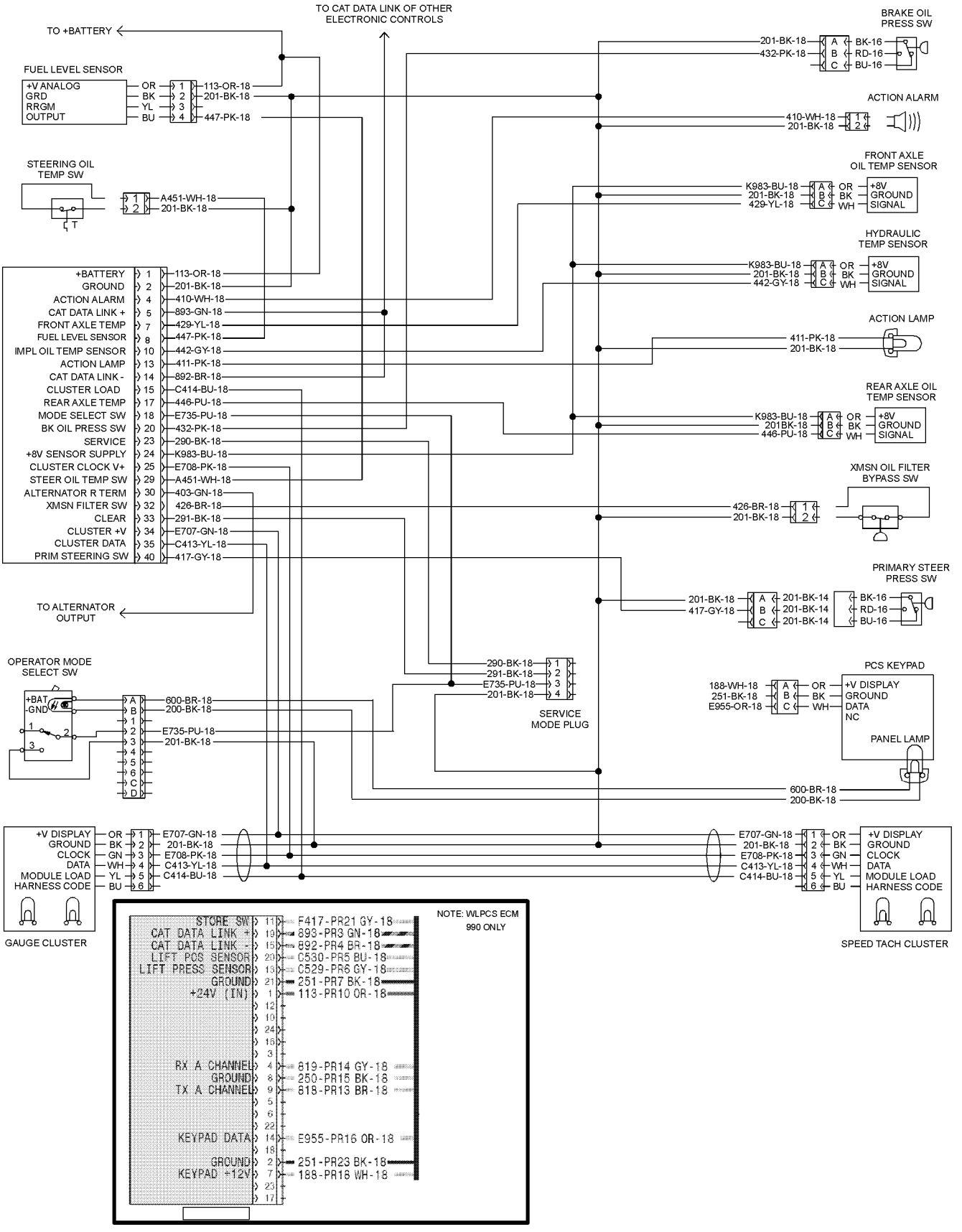


Illustration 152 g01293012

Schematic For 824G, 825G, and 826G
Series II

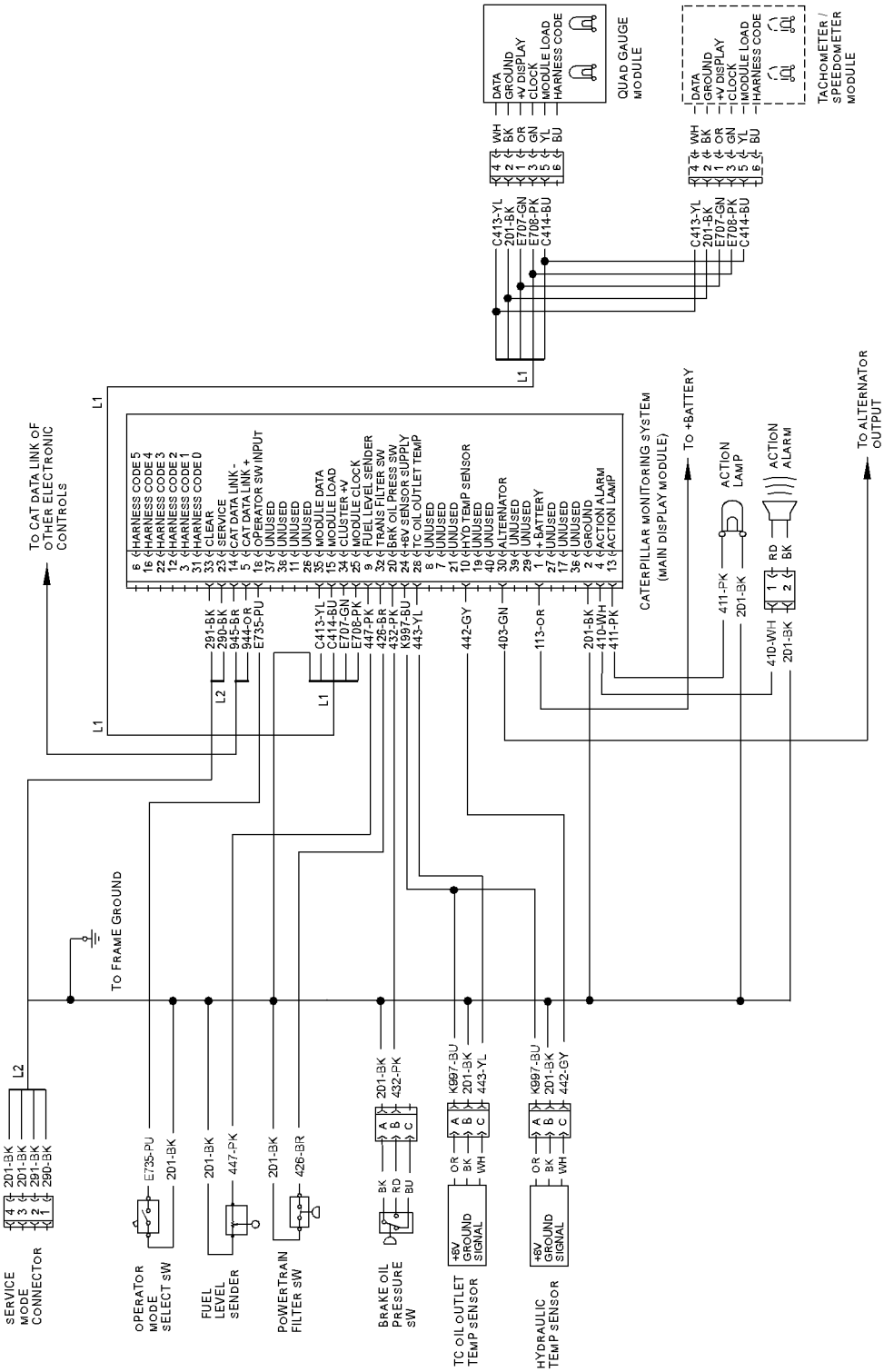


Illustration 153
g02222097

Schematic For 950G, 962G, 966G, 972G, and 980G Series II

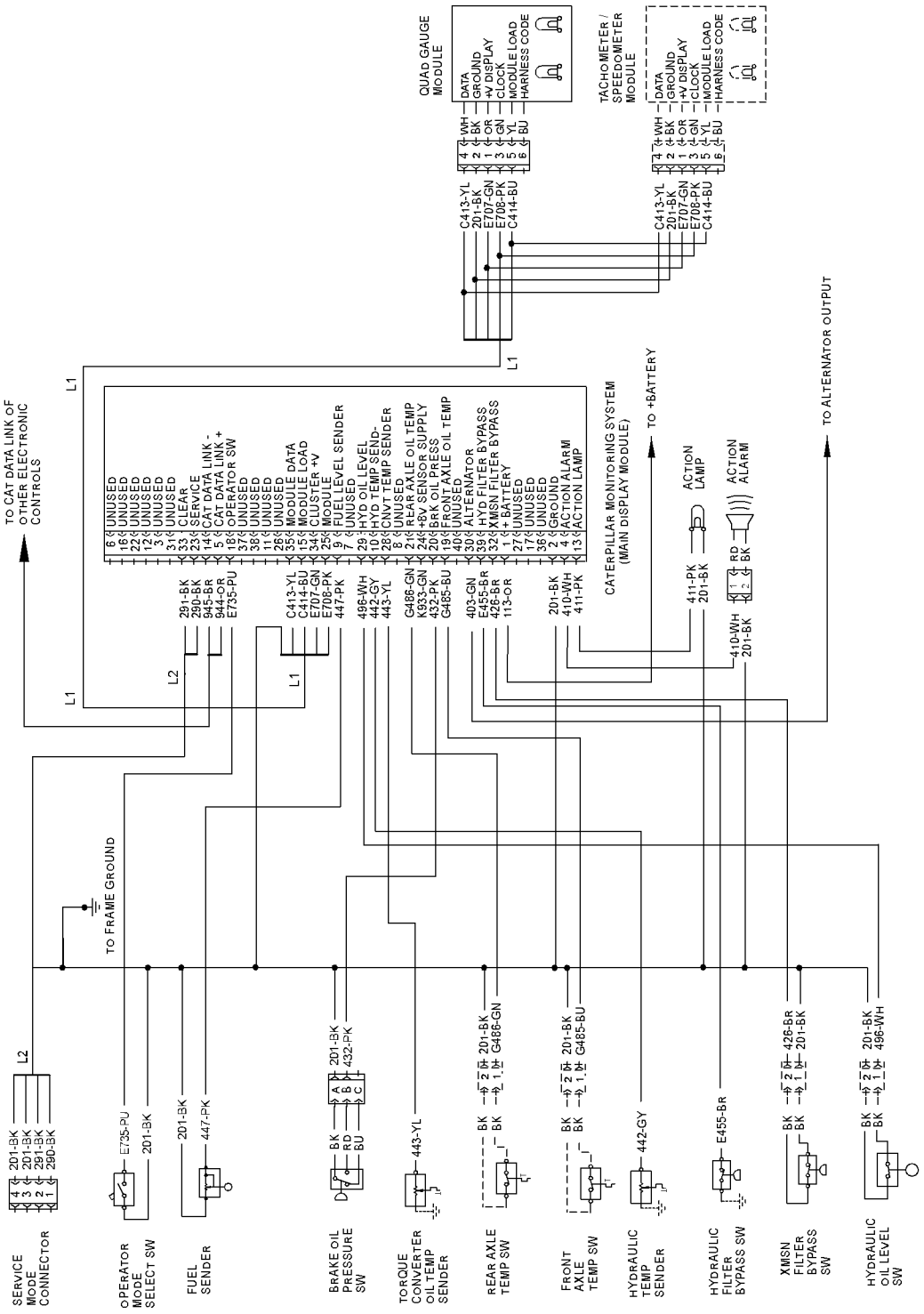


Illustration 154 g02222098

Schematic For 950H Series II, 962H Series II, 972H Series II, and IT62H Series II

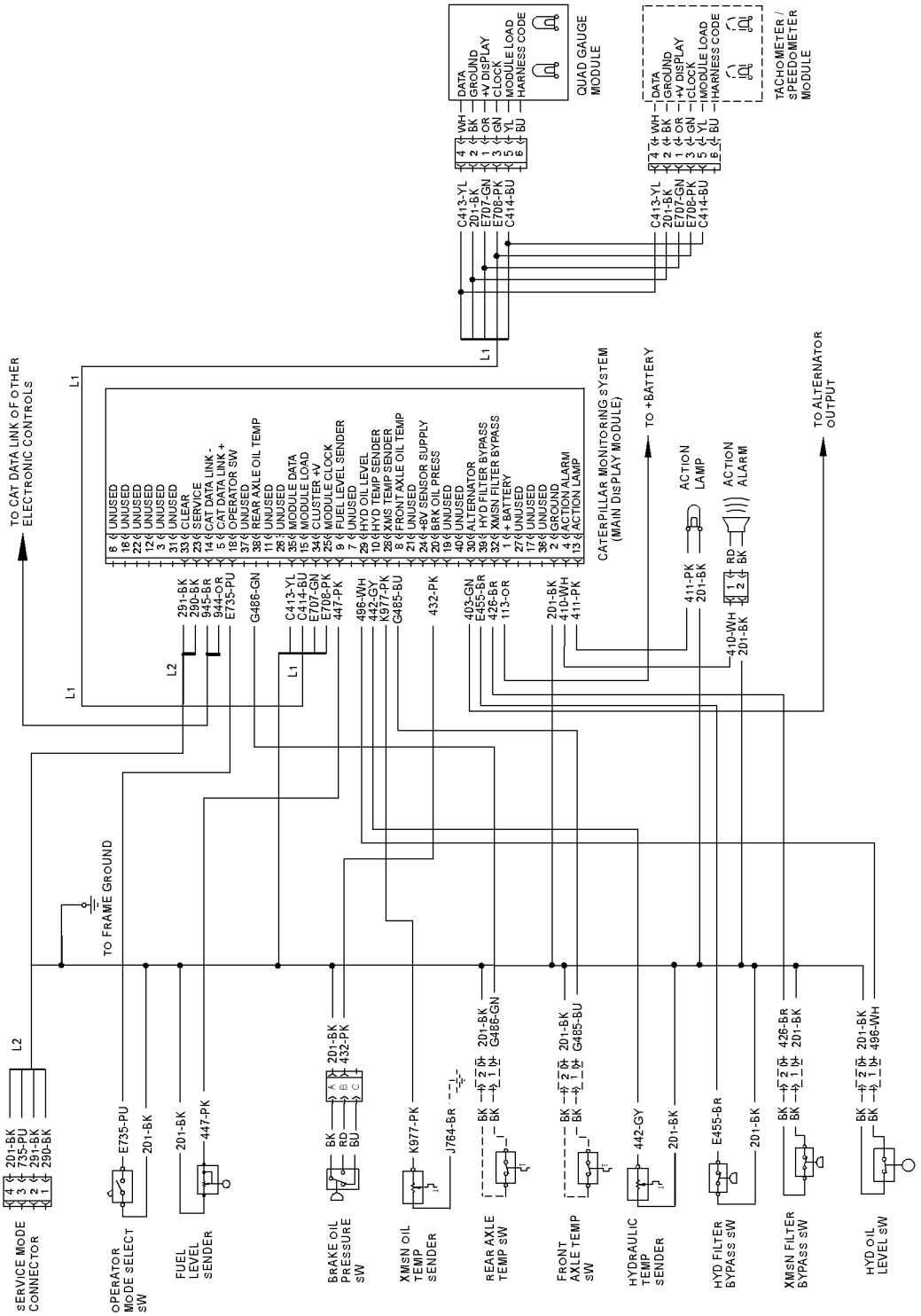


Illustration 155 g02222100

Schematic For R1300G

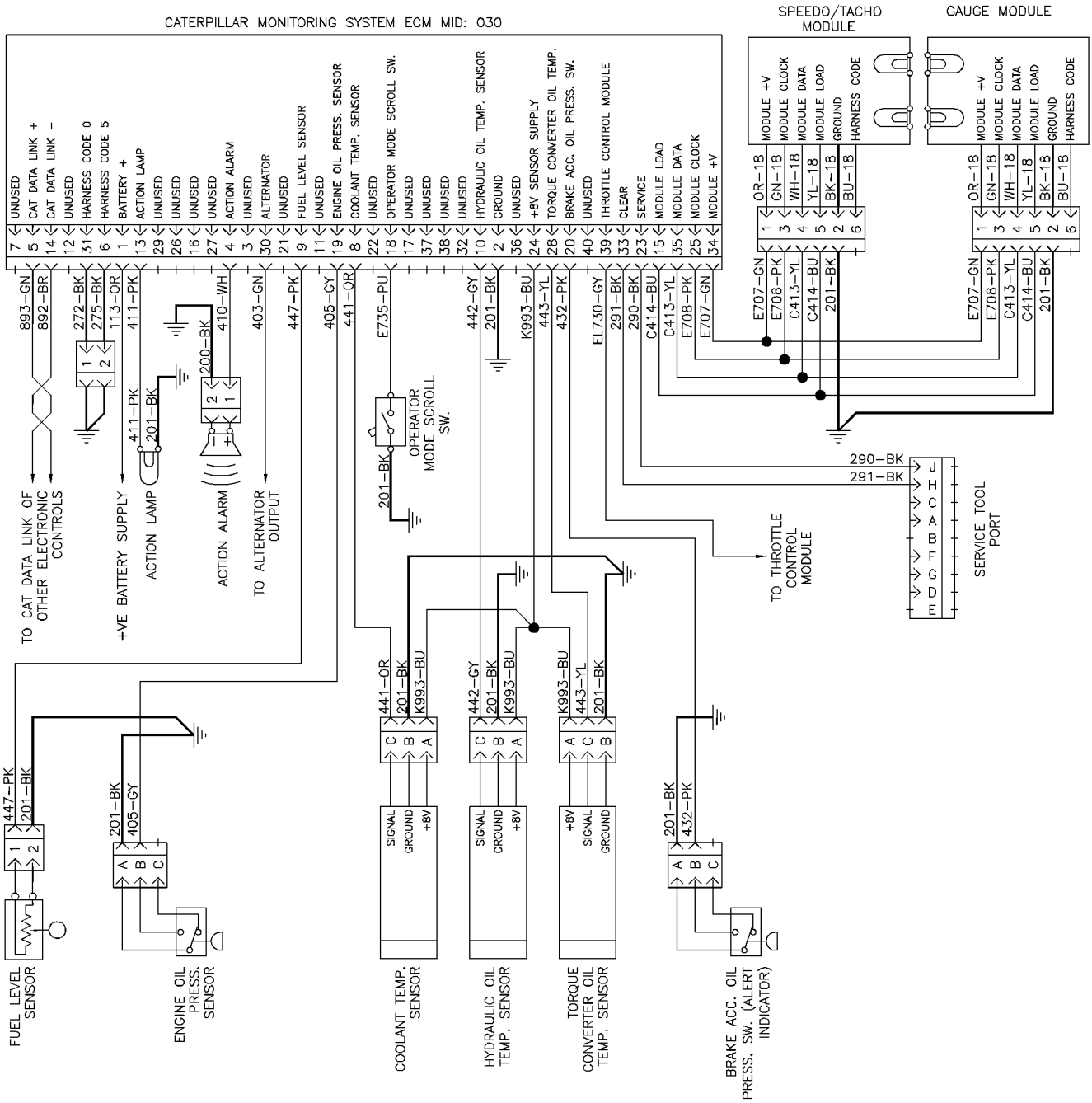


Illustration 156 g01021059

Schematic For R1300G Series II
S/N: RSL1–Up

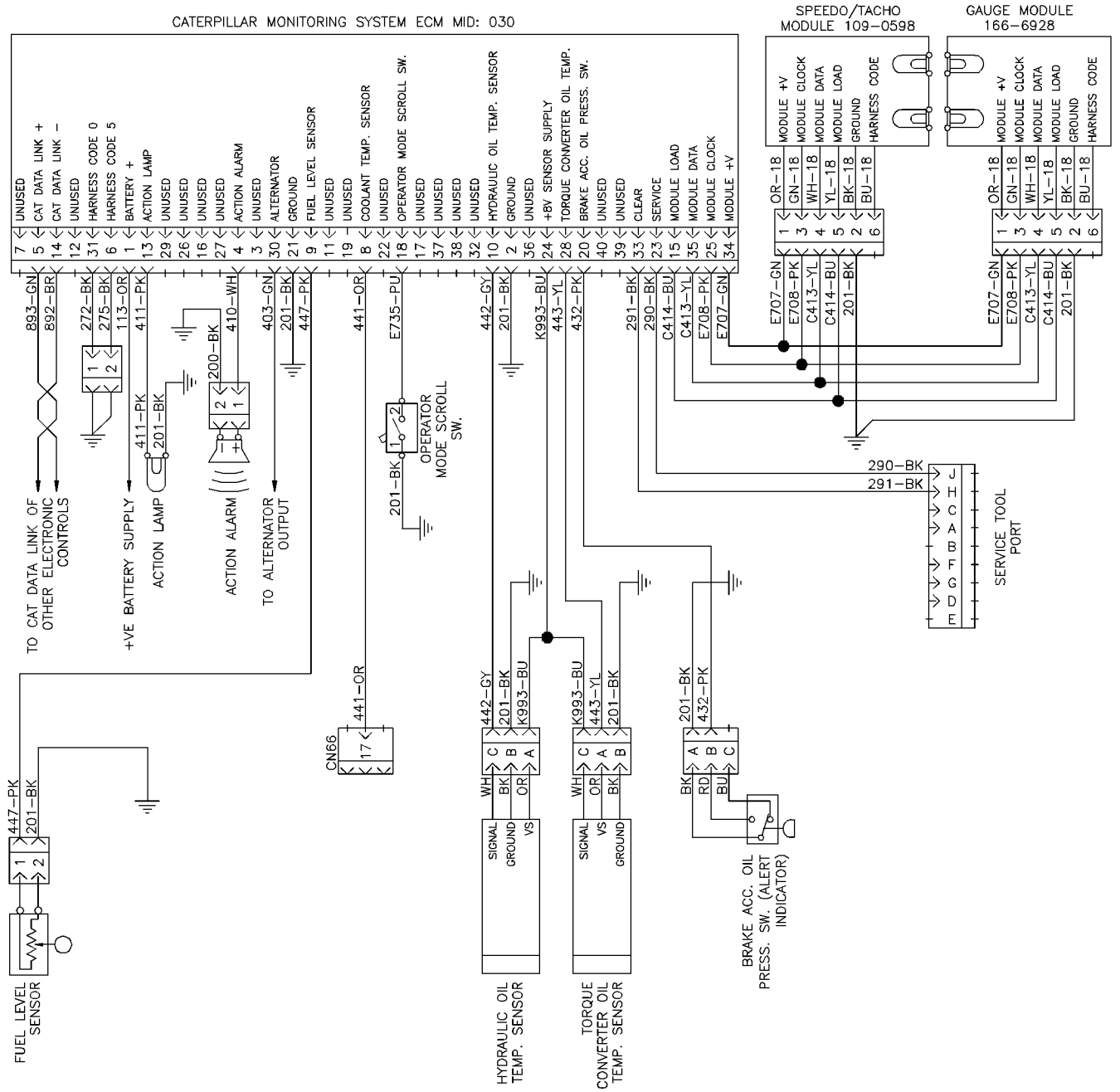


Illustration 157 g01222048

Schematic For R1600G

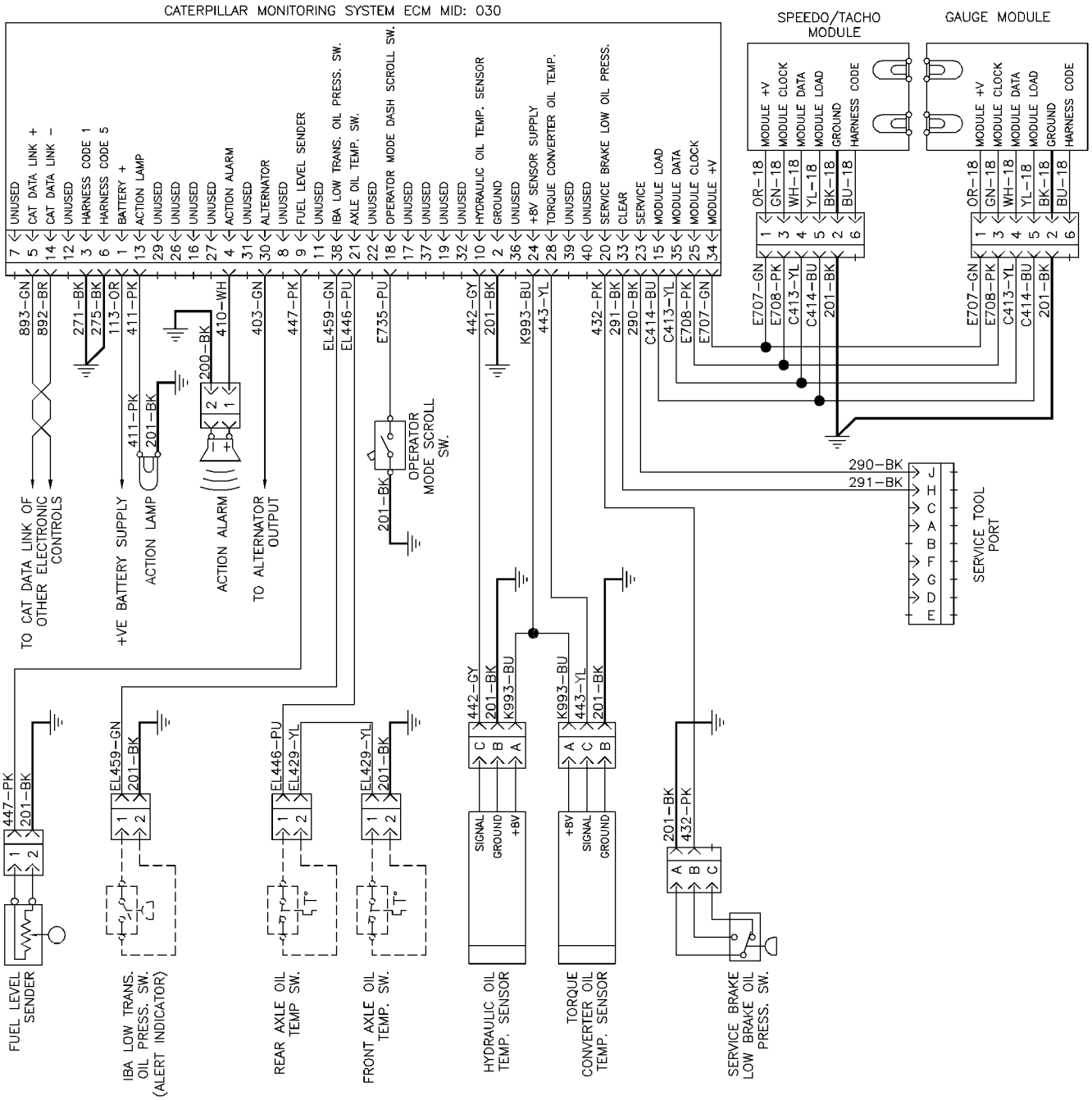


Illustration 158 g01021060

Schematic For R1700G

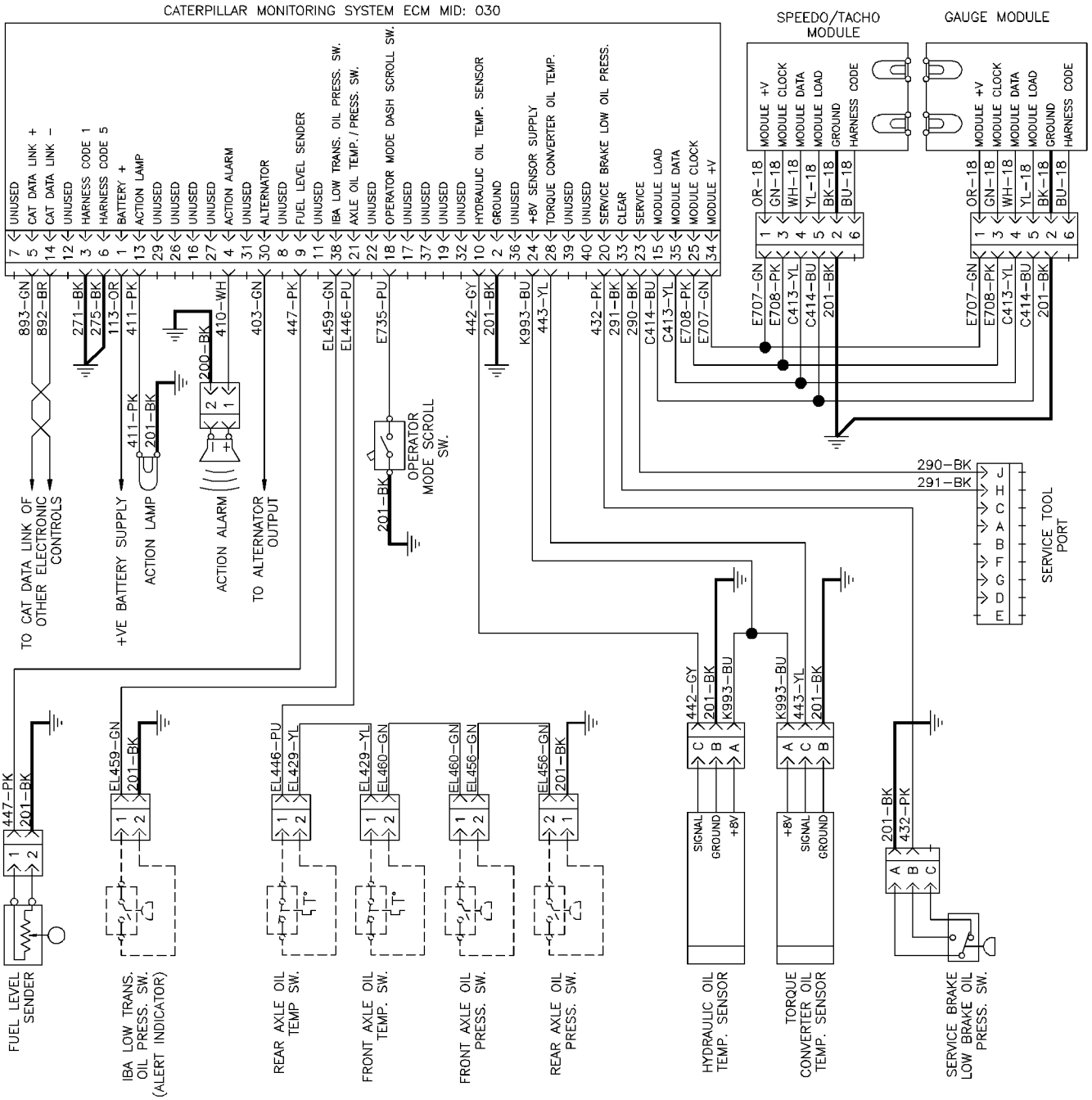


Illustration 159 g01185732

Schematic For R1700G
S/N: SBR1–Up

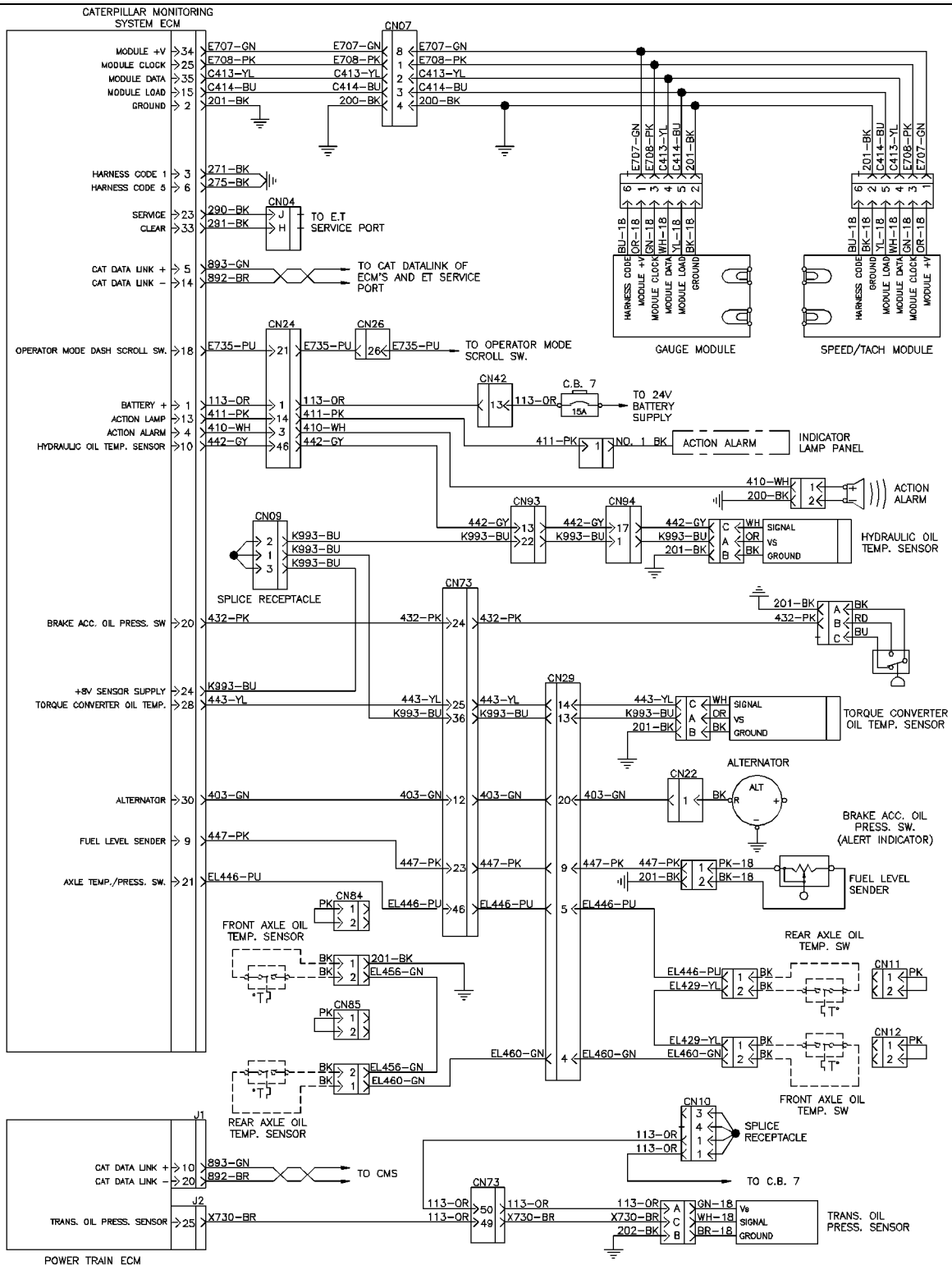


Illustration 160 g02149401

Schematic For R2900G

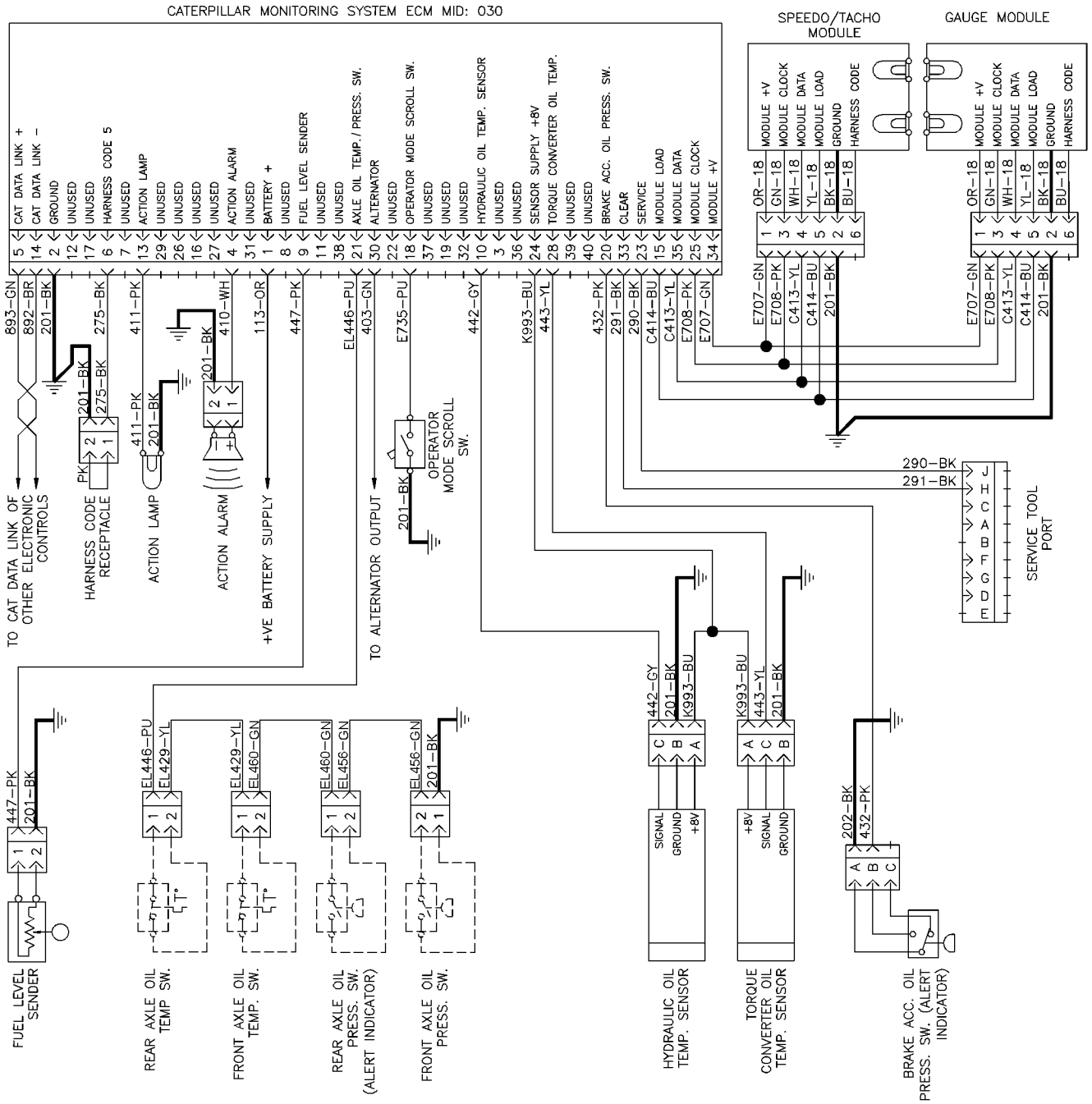


Illustration 161 g01185734

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MID 030 - CID 0324 - FMI 03 85
MID 030 - CID 0324 - FMI 05 85
MID 030 - CID 0324 - FMI 06 86
MID 030 - CID 0427 - FMI 03 87
MID 030 - CID 0427 - FMI 04 89
MID 030 - CID 0427 - FMI 08 91
MID 030 - CID 0428 - FMI 03 91
MID 030 - CID 0428 - FMI 04 93
MID 030 - CID 0428 - FMI 08 95
MID 030 - CID 0600 - FMI 03 95
MID 030 - CID 0600 - FMI 04 97
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MID 030 - CID 0819 - FMI 15 101
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SENR2947-12 (en-us)
August 2019

Systems Operation

Starting and Charging Systems

DJT 1-UP (Machine)
B92 1-UP (Machine)
B54 1-UP (Machine)
B57 1-UP (Machine)
B59 1-UP (Machine)
02X 350-UP (Machine)
4HD 1-UP (Machine)
92X 1-UP (Machine)
6BB 1-UP (Scraper)
4MK 1-UP (Machine)
6YN 1-UP (Machine)
4SN 1-UP (Machine)
7CG 1-UP (Machine)
3BJ 1-UP (Machine)
7FN 1-UP (Machine)
2LR 1-UP (Machine)
2GS 1-UP (Machine)
5YR 1-UP (Machine)
ATS 1-UP (Machine)
B1P 1-UP (Machine)
WWA 1-UP (Machine)
NYY 1-UP (Machine)
HKK 1-UP (Machine)
N9R 1-UP (Machine)
N9F 1-UP (Machine)
N9P 1-UP (Machine)
N9B 1-UP (Machine)
N9M 1-UP (Machine)
N9D 1-UP (Machine)
N9G 1-UP (Machine)
N9J 1-UP (Machine)
N9L 1-UP (Machine)
N9E 1-UP (Machine)
N9T 1-UP (Machine)
N9K 1-UP (Machine)
7PC 1-UP (Machine)
94Z 1-UP (Machine)
4NB 1-UP (Machine)
9WB 1-UP (Machine)
8PB 1-UP (Machine)
7NC 1-UP (Machine)
1DF 1-UP (Machine)
1SG 1-UP (Machine)
7JF 1-UP (Machine)
1XJ 1-UP (Machine)
7HK 1-UP (Machine)
7ZF 1-UP (Machine)
2LM 1-UP (Machine)
7JG 1-UP (Machine)
5CJ 1-UP (Machine)
6AJ 1-UP (Machine)
9BG 1-UP (Machine)
9GJ 1-UP (Machine)
6XJ 1-UP (Machine)
4HK 1-UP (Machine)
8RJ 1-UP (Machine)
7PK 1-UP (Machine)
9RK 1-UP (Machine)
8SK 1-UP (Machine)
5KK 1-UP (Machine)
4TK 1-UP (Machine)
7PL 1-UP (Machine)
4JN 1-UP (Machine)
3CR 1-UP (Machine)
4BR 1-UP (Machine)
9CM 1-UP (Machine)
2SR 1-UP (Machine)
2XS 1-UP (Machine)
RST 1-UP (Machine)
WMR 1-UP (Machine)
PER 1-UP (Machine)
PBA 1-UP (Machine)
T5X 1-UP (Machine)
RJM 1-UP (Machine)
MEJ 1-UP (Machine)
SC6 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

i03498544

General Information

SMCS Code: 0710; 1401; 1405; 1406; 1453

The analyzer performs tests that are identical to a multichannel voltmeter. The lamps for the analyzer illuminate in order to indicate a defect.

The analyzer is used in order to troubleshoot the starting charging system of all 24 volt Caterpillar machines. The analyzer can troubleshoot under the following conditions:

- Machines that were manufactured after July of 1981
- Machine that is equipped with an automotive keyswitch
- Machine that is equipped with a diagnostic connector

It is unnecessary to remove any sheet metal on the machine in order to find test points. The diagnostic connector is connected to the major test points for the starting and the charging system of the machine. The connector is located in an easily accessible location. A person without electrical experience can use the analyzer with the diagnostic connector. Electrical experience is necessary in order to replace a component. The analyzer can be used on all machines that use the diagnostic connector.

6V-2150 Starting/Charging Analyzer Group

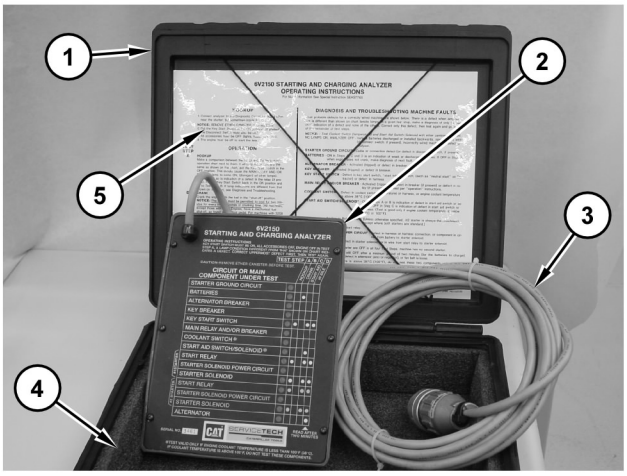


Illustration 1 g01289614

(1) Case
(2) Base
(3) Cable assembly
(4) Packing set
(5) Instruction

Features of the 6V-2150 Starting/ Charging Analyzer Group

Cable Connector – A plug from the analyzer fits into a diagnostic connector. The diagnostic connector is normally in the engine area near the starter. The diagnostic connector can be located inside the cab.

Operation – Less than five minutes are needed in order to connect the analyzer for completing the test of the starting and charging system if a machine can start without assistance. More time is required for a machine that needs to be jumped.

Power supply – The power that is used in order to operate the analyzer comes through the diagnostic connector from the vehicle electrical system.

Rugged – The analyzer is designed in order to conform to various accuracies in field service conditions.

Convenient – The analyzer is easy to use.

The operation of the analyzer is convenient. The following tasks do not need to be performed:

- Remove sheet metal.

- Look for components or test points in a circuit
- Understand a voltmeter reading.
- Have more than one person in order to test a machine.

Less Downtime – The use of the analyzer results in less downtime of the machine. This is possible as the tests that are performed by the analyzer are performed easily. When the analyzer is used in an inspection, the analyzer can identify parts that have an unnoticed defect. Finding and correcting defects early can help in the prevention of future unscheduled downtime.

i02548358

Specifications

SMCS Code: 0710; 1401; 1405; 1406; 1453

Channels – The analyzer has fifteen channels (or readouts) that can check fifteen major components or circuits.

Accuracy – In field service conditions, this analyzer will keep and/or have the accuracy needed for diagnosis of failed or worn parts when used within the operating temperature range specification.

Temperature Range of Ambient Air During Analyzer Operation – Will maintain the needed accuracy from −18 to 60 °C (0 to 140 °F). The analyzer will operate outside this temperature range, but may not have the specified accuracy.

Temperature Range of Ambient Air During Analyzer Storage – −40 to 80 °C (−40 to 176 °F)

Power Required – 10 VDC to 30 VDC at approximately 250 mA using the 24 volt vehicle electrical system as a source.

Cable Length – 5500 mm (217 in).

Operating Position – Any position.

Size – Carrying Case: 394 × 311 × 102 mm (15.5 × 12.25 × 4 in) Analyzer: 254 × 191 × 30 mm (10.0 × 7.5 × 1.19 in)

Weight – Complete Group: 3.2 kg (7 lbs) Analyzer only: 1.8 kg (4 lbs)

i02548489

Basic Operation

SMCS Code: 0710; 1401; 1405; 1406; 1453

The analyzer can indicate that the components have a defect and the machine will continue to start without a problem. Also, the machine will continue to operate without problems.

This normally indicates that the components that include the wiring harness and/or the harness connectors are at the point of being worn. Replacement of these parts may be necessary.

Before making the component replacement, check for loose corroded connectors in the circuit that shows a defect.

If a replacement is necessary, install the new components in order to prevent any unexpected downtime for the machine.

NOTICE
Field service replacement of an original equipment wiring harness with wire of a different gauge can cause incorrect readings from the analyzer.

The complete test that is performed by the analyzer is made in the following four test steps:

- “Test Step A, Hookup”
- “Test Step B, Crank”
- “Test Step C, Start Aid”
- “Test Step D, High Idle”

See Systems Operation, “Analyzer Test Description” for more information.

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Test Setup A, Hookup

SMCS Code: 0710; 1401; 1405; 1406; 1453

This is a test of the machine with the engine and all accessories in the SHUT OFF position. The key start switch is in the ON position.

In this Test Step, the 6V-2150 Starting/Charging Analyzer performs the following checks:

1. At the battery, the analyzer checks the open circuit voltage as an indication of the battery charge level.
2. At the alternator circuit breaker, the analyzer checks for an activated breaker.

3. At the key circuit breaker, the analyzer checks for an activated breaker.

4. At the key start switch, the analyzer checks if the START position of the switch is open.

5. If equipped, at the main relay, the analyzer checks for closed contacts. The analyzer also checks that the breaker is not activated.

6. The analyzer checks the position of the coolant switch. The switch should be CLOSED. While the engine is cooling down, switch closes at 27 °C (80 °F). While the engine is warming up, the switch opens at 38 °C (100 °F).

Note: It is possible that the machine does NOT have components for starting aid.

7. The analyzer checks the starting aid switch. The switch should be OPEN. The coil for the starting aid solenoid should not be open.

Note: For machines that have dual starting motors, Test steps 8 and 9 apply to both starting motors.

The number 2 starting motor is always the attachment unless a dual starting system is standard equipment.

8. The analyzer checks the contacts of the start relay. The start relay should be OPEN.

9. The analyzer checks the starting solenoid. The contacts of the starting solenoid should be OPEN.

Note: If all three of the lamps for the second starting motor are OFF, this may indicate that there is no second starting motor on the machine.

i02548682

Test Step B, Crank

SMCS Code: 0710; 1401; 1405; 1406; 1453

Shut off the fuel supply in order to prevent the engine from starting during this test.

This test will activate all of the cranking circuits, so that the 6V-2150 Starting/Charging Analyzer can measure the voltage, in relation to the components on the following circuits. The analyzer performs the following checks:

1. The analyzer checks for an excessive voltage drop on the starter ground circuit.

2. The analyzer checks that the battery voltage is within the expected range for cranking.

3. The analyzer checks the alternator circuit breaker for an excessive voltage drop. The analyzer also checks if the breaker is activated.

4. The analyzer checks the key circuit breaker for an excessive voltage drop. The analyzer also checks if the breaker is activated.

5. A check for an excessive voltage drop is performed on the key start switch. The switch or the harness could be open.

6. If equipped, the main relay is checked for closed contacts. The breaker is checked for activation.

7. The analyzer checks if the coolant switch is CLOSED.

Note: It is possible that the machine does NOT have components for starting aid. Also, the machine may have an automatic starting aid system.

8. The analyzer checks that the starting aid switch is open. Also, the starting aid solenoid should have a closed circuit.

9. The analyzer checks if the start relay is CLOSED. The analyzer also checks if there is an excessive voltage drop across the contacts.

10. The analyzer checks the power circuit of the starter solenoid. A check for an excessive voltage drop is performed.

11. The analyzer checks if the starter solenoid contacts are CLOSED. The analyzer also checks if there is an excessive voltage drop across the contacts.

i02548751

Test Step C, Start Aid

SMCS Code: 0710; 1401; 1405; 1406; 1453

Note: It is not necessary to perform this test if the machine is not equipped with a starting aid switch on the dash panel of the machine. It is not necessary if the machine has a Caterpillar 3500 Engine with an automatic ether injection system. Proceed to Systems Operation, “Test Step D, High Idle”.

If the machine is equipped with a starting aid switch on the dash panel, see the procedure that follows. The indications of the lamps and the test procedures are identical to test step 1 until the starting aid switch is pushed. After the starting aid switch is pushed the analyzer performs the following checks by measuring voltage drops:

1. The analyzer checks if the coolant switch is closed. The analyzer also checks if there is an excessive voltage drop across the contacts.

2. The analyzer checks if the starting aid switch has CLOSED. The analyzer also checks if there is an excessive voltage drop across the contacts for the starting aid solenoid.

i02548767

Test Step D, High Idle

SMCS Code: 0710; 1401; 1405; 1406; 1453

The indications of the lamps and the test procedures are identical to “Test Setup A, Hookup” . There are two exceptions. The exceptions are listed below.

1. The analyzer measures the battery voltage of the alternator. The voltage should be within the charging limits.

Note: There are times when a battery needs over two minutes to charge up to an acceptable range. This is true if the machine is jump started.

2. The alternator that was tested is good. Turn ON all of the electrical loads. This will permit the analyzer to test for an excessive voltage drop across the contacts for the main relay and across the contacts for the breaker.

The breaker for the alternator is tested. The test is for an excessive voltage drop across the breaker. An excessive voltage drop is caused by the current of the alternator that is going through a faulty breaker.

Note: Excessive alternator output voltage will completely shut off the analyzer. The indicator lamp for the alternator will turn to ON. Then, the lamp will turn OFF. Then, the analyzer will turn OFF. The output of the alternator is more than 30 volts. The high output of the alternator put the analyzer in a safety SHUTOFF mode.

Panel for the Analyzer

The analyzer has a panel.

i02548867

Test Considerations

SMCS Code: 0710; 1401; 1405; 1406; 1453

Test Steps for a Machine That Cannot Start

To diagnose the problem(s) on a machine that has dead batteries, use the following procedure.

1. Connect the batteries of the machine that does not start to the batteries of the booster.

Note: See the section on jumping the engine with starter cables in the OMM for the correct machine.

2. Connect the 6V-2150 Starting/Charging Analyzer to the diagnostic connector.

3. Complete the first three test steps for the analyzer in order to obtain the necessary diagnosis.

The following test steps should be performed:

- “Test Setup A, Hookup”
- “Test Step B, Crank”
- “Test Step C, Start Aid”

4. Start the engine of the machine that did not start. Disconnect the booster from the machine. See the section on jumping the engine with starter cables in the OMM for the correct machine.

5. Perform “Test Step D” in order to obtain the necessary diagnosis.

The voltage of the former dead batteries should start to increase and the indicator lamp for the alternator should illuminate. The lamp indicates proper operation of the alternator. Stop the engine. Perform test step A through D in order to obtain the diagnosis of the defect according to the test results.

Note: The lamps for the analyzer may not give a correct indication while the booster is connected to the dead batteries.

Test Steps for Machines That are Equipped with a 3208 Engine

The fuel system on a 3208 Engine does not have a mechanical shutoff. The 3208 engines have an electrically operated shutoff solenoid that is located on the fuel pump housing.

The electrically operated shutoff solenoid is automatically activated for approximately thirty seconds when the key start switch is turned OFF. Older models activate the shutoff solenoid for approximately seventy seconds.

Use the following procedure in order to keep the engine from starting during “Test Step B, Crank” .

1. Use a piece of 14 GA, 16 GA, or 18 GA wire that is approximately 2000 mm (79 in) in length to make a jumper wire.

Install a #63 clip or an equivalent clip to one end of the wire. Install a 46-A clip for a battery or an equivalent clip to the other end of the wire.

2. Connect the jumper wire to the “MOTOR” terminal of the starter solenoid and to “BATTERY” terminal of the shutoff solenoid.

Note: The jumper wire will activate the shutoff solenoid when the engine is cranking. The jumper wire will prevent the engine from starting during “Test Step B, Crank” .

NOTICE
Check starter cycle: Thirty seconds of cranking requries two mintues of cool down.

Do NOT connect the shutdown solenoid directly to 24 volts. This could damage the coil.

3. Connect the 6V-2150 Starting/Charging Analyzer to the diagnostic connector. Complete the first three test steps for the analyzer in order to obtain the necessary diagnosis for any machine.

The following test steps should be performed:

- “Test Setup A, Hookup”
- “Test Step B, Crank”
- “Test Step C, Start Aid”

4. Disconnect the jumper wire. Complete “Test Step D, High Idle.” .

Test Steps for Machines That are Equipped with Energize-to-Run Fuel Shutoff Solenoids

Note: This test does not apply to 3208 Engines.

The fuel system on some later engines does not have a mechanical fuel shutoff. Older engines have an electrically operated energize-to-run solenoid.

Disconnect the blue wire at the fuel solenoid on the fuel pump. This will prevent the engine from starting during “Test Step B, Crank” . Insulate the wire.

Make sure that the wire does not touch the chassis while the tests are performed. Disconnect the connector if the solenoid has a two-pin connector.

NOTICE
Check starter cycle: Thirty seconds of cranking requires two minutes of cool down.

Connect the 6V-2150 Starting/Charging Analyzer to the diagnostic connector. Complete the first three test steps for the analyzer.

The following test steps should be performed:

- “Test Setup A, Hookup”
- “Test Step B, Crank”
- “Test Step C, Start Aid”

Reconnect the blue wire at the solenoid on the fuel pump. Complete “Test Step D, High Idle.” .

i02569889

Analyzer Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

Explanation of the Tests for the Analyzer

Note: The voltages that are listed in this manual are direct current volts with two exceptions. The basic schematic that follows is typical of all Caterpillar machines that have a diagnostic connector. The following is an explanation of the two exceptions:

1. All of the machines will not be equipped with all of the components that are shown on the schematic. The starting aid, the main relay, and the two starters are examples of such components.

The wire connections of the components in the schematic are identical for all machines that contain the same components.

2. The harness connectors that are used to connect the components are not shown on the schematic.

All of the harness connectors are not shown on the schematic. The harness connectors are considered when a machine is tested for defects. The tests by the analyzer include the connectors in the circuit.

Compare the basic schematic with the wiring diagram of the machine that is tested. Determine the connectors and the wiring harnesses that are within the test points of the analyzer.

A basic machine illustrates each circuit test that is made by the analyzer in the topics that follow. The schematic with each topic shows only the circuit for that part of the test.

Reference the wiring diagram for the machine in order to see the actual machine wiring.

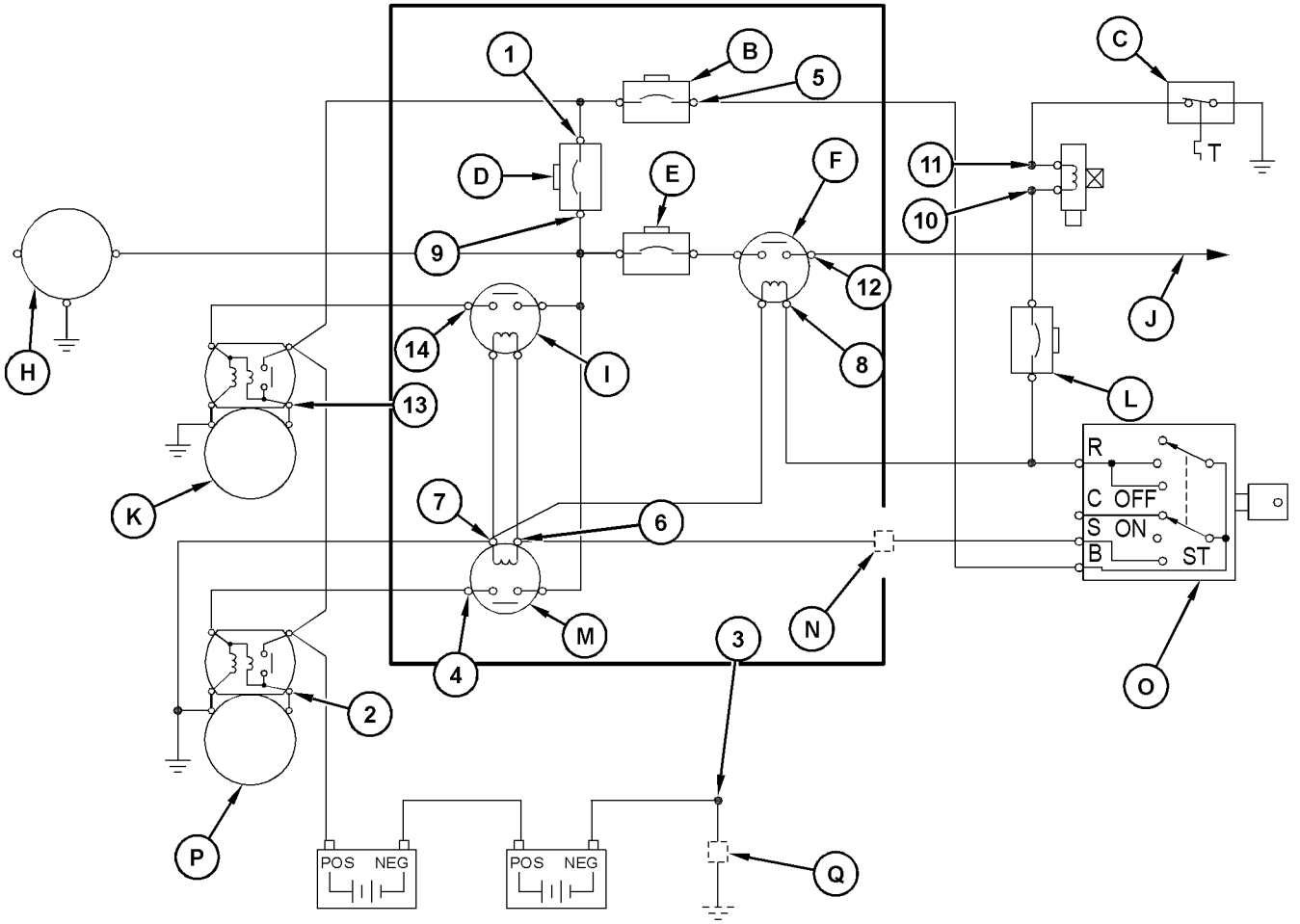


Illustration 2 g01275680

(A) Enclosure for Breaker
(B) Key Circuit Breaker
(C) Coolant Switch
(D) Alternator Circuit Breaker
(E) Main Breaker
(F) Main Relay
(G) Starting Aid Solenoid
(H) Alternator
(I) Start Relay 2
(J) The loads for the vehicle
(K) Starter 2
(L) Starting Aid Switch
(M) Start Relay 1
(N) Starter Switch
(O) Key Start Switch
(P) Starter 1
(Q) Disconnect Switch (if equipped)
(1) Test Point
(2) Test Point
(3) Test Point
(4) Test Point
(5) Test Point
(6) Test Point
(7) Test Point
(8) Test Point
(9) Test Point
(10) Test Point
(11) Test Point
(12) Test Point
(13) Test Point
(14) Test Point

Note: The location numbers for the test points on the schematic are identical to the pin numbers on the diagnostic connector. For example, Test point 1 on the schematic is Pin 1 on the connector.

i02549169

Starter Ground Circuit Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

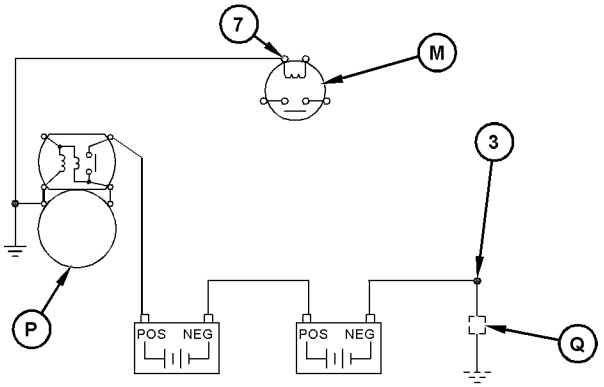


Illustration 3 g01275957

Specification

This test measures the voltage drop in the ground lead of the starter (R). The voltage drop is measured across test point (7) and test point (3).

A voltage drop will cause the indicator lamp for the starter ground circuit to turn ON. The voltage drop must be larger than 1.30 ± 0.15 volts. The lamp turned ON in order to signal a defect.

A defect can only be indicated during “Test Step B, Crank” .

The possible causes of this condition are listed:

- Disconnect switch with an excessive voltage drop
- Cable connections to the frame with excessive voltage drops

Note: Disconnected switches will be tested as part of the starter ground circuit.

Information for Other Circuits

There are three ways to wire a circuit for the starter ground.

1. Connect a single cable from the negative battery terminal directly to the negative post of the starter. Test point 1 is tied to test point 2. The analyzer does not check the voltage drop.

2. A disconnect switch is located in the ground cable. The switch is between the negative battery terminal and the negative starter terminal. The analyzer checks the disconnect switch. Also, the analyzer checks the cable for the switch to the starter.

3. The negative starter terminal is tied to the frame. The negative battery terminal is tied to the frame in a different location. This type of connection includes a disconnect switch. The analyzer checks the connections and the switch. Cleaning the connections for the cable at the frame will usually correct the defect.

i02549615

Batteries Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

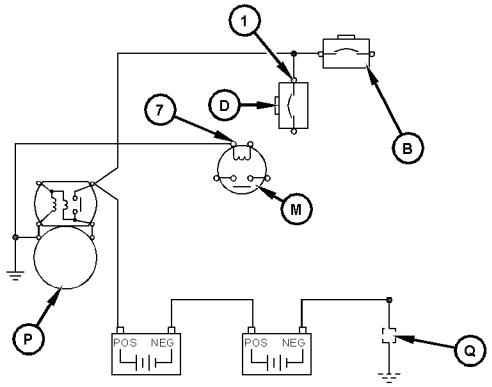


Illustration 4 g01276069

Specification

This test measures the terminal voltage of the batteries. The voltage is measured across test point (1) and test point (7).

A voltage drop during the “Test Setup A, Hookup” will cause the indicator lamp for the batteries to turn ON. The voltage drop must be below 23.10 ± 0.15 volts. The lamp turned ON in order to indicate a low state of charge.

The batteries do not have enough power in order to crank the engine in this condition. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- No alternator output
- Worn out batteries that will not hold a charge
- Light was left ON while the machine was shut down.

Specification

It is normal for the battery voltage to go below 23.1 volts when the engine is cranking. The lamp will turn ON when this happens. The batteries will crank the engine momentarily if the battery voltage goes below 12.50 ± 0.15 volts. The lamp will turn OFF in order to indicate a very low voltage.

The possible causes of this condition are listed:

- Batteries with low voltage
- Faulty starter
- Excessive drag of the engine or friction

Information for Other Circuits

To find the defect that is the cause of problem, check the alternator.

No Alternator Output

Jump start the machine in order to check the output of the alternator. For more information, see the explanation of the test in the Systems Operation, “Test Step D, High Idle” section.

Check the batteries if the alternator is operating correctly. Charge the batteries if it is necessary. For more information, see the explanation in Special Instruction, SEHS7633, “Battery Test Procedure”.

Note: See the section on jumping the engine with a booster and starter cables in the OMM for the correct machine.

i02549733

Alternator Breaker Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

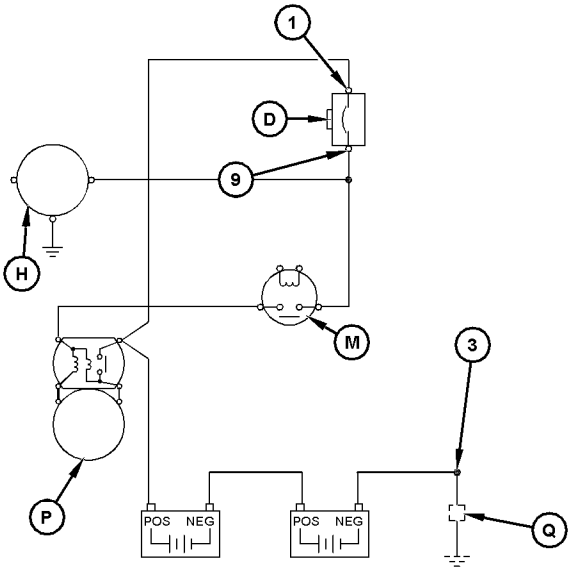


Illustration 5 g01276092

Specification

This test measures a voltage drop of either polarity across the alternator circuit breaker. The voltage drop is measured across test point 1 and test point 9.

A voltage drop will cause the indicator lamp for the lamp for the alternator circuit breaker to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect in the circuit. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Activated breaker
- Closed breaker with excessive voltage drop

Information for Other Circuits

In the steps “Test Setup A, Hookup” , “Test Step B, Crank” , and “Test Step C, Start Aid” test point (1) will be positive and test point (9) will be negative. Test point (1) and test point (9) are this way because the battery is sourcing current through the alternator circuit breaker (D) to the circuits for cranking.

The voltage will reverse polarity at test point (1) and test point (9) during “Test Step D, High Idle” . Test point (1) will be negative and test point (9) will be positive. The polarity reverses because the battery is receiving current through alternator circuit breaker (D) from alternator circuit breaker (H).

The batteries cannot get a full charge if the charging circuit has an excessive voltage drop.

The indicator for the alternator circuit breaker blinks for a few seconds. The indicator may turn ON for a few seconds. The indicator will turn OFF and the indicator for the alternator will turn ON. This is acceptable during engine start-up.

i02549754

Key Breaker Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

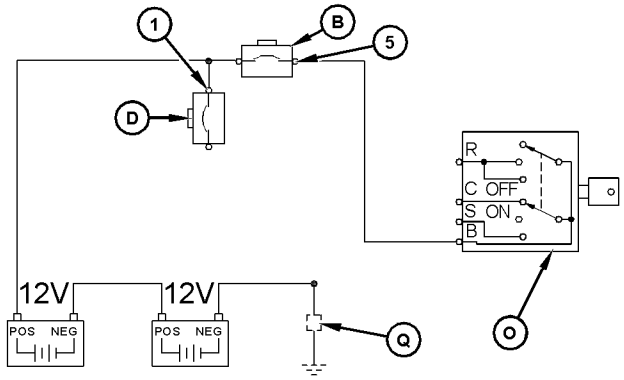


Illustration 6 g01276108

Specification

This test measures the voltage drop of the key circuit breaker. The voltage is measured across test point (1) and test point (5). Test point (1) is the positive contact and test point (5) is the negative contact.

A voltage drop will cause the indicator lamp for the key circuit breaker to turn ON. The voltage drop must be larger than 0.75 ± 0.15 volts. The lamp turned ON in order to indicate a low state of charge. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Activated circuit breaker
- Closed circuit breaker with an excessive voltage drop

i02549832

Key Start Switch Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

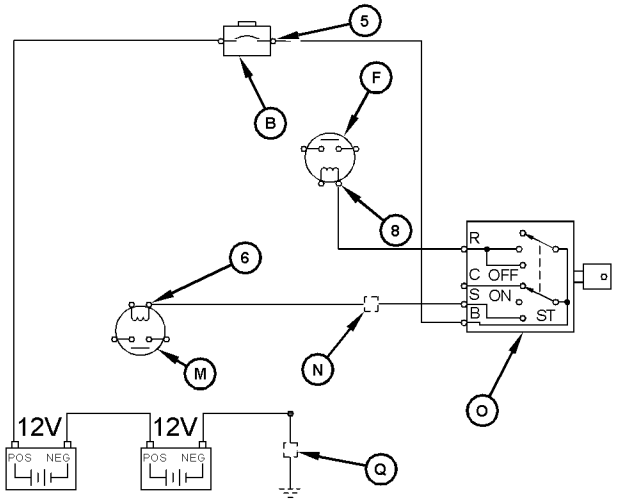


Illustration 7 g01276592

Specification

This test measures the voltage drop across two of the poles for the key start switch. The voltage drop between test point (5) and test point (6) represents the “STAR” pole. The voltage drop between test point (5) and test point (8) represents the “RELAY” pole.

A voltage drop will cause the indicator lamp for the key start switch to turn ON. The voltage drop can be across one or both of the poles. The voltage drop must be larger than 2.50 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Open pole on the switch
- Closed switches with excessive voltage drops
- Poles on the switch with welded contacts

Note: The keyswitch START position is open for three of the tests. The three tests are “Test Setup A, Hookup” , “Test Step C, Start Aid” , and “Test Step D, High Idle” . The indicator for the keyswitch is turned ON during the steps. This is correct.

Information for Other Circuits

An inhibitor for the key start switch instead of the key start switch can cause a failure during the “Test Step B, Crank” . Direct drive machines use a neutral start switch to inhibit the starting of the engine.

Switches that inhibit the starting of the engine (N) are always installed between test point 5 and test point 6.

The wiring harness and the connections for the wiring harness are also checked in this test. Refer to the wiring schematic for the machine that is being serviced for the location of the components. An open in the harness will indicate a defect.

i02550586

Main Relay and/or Breaker Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

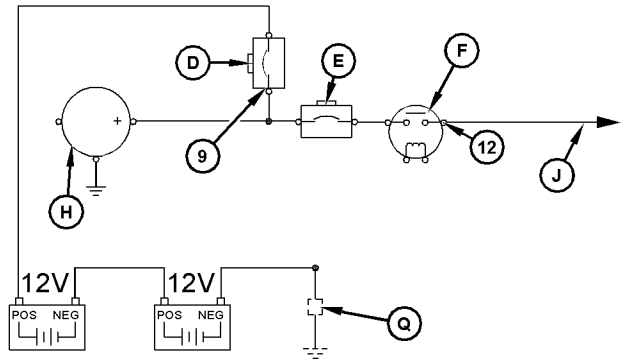


Illustration 8 g01276599

Specification

This test measures the voltage drop across the main relay and/or the circuit breaker. The voltage drop is measured across test point (9) and test point (12). Test point (9) is the positive contact and test point (12) is the negative contact.

A voltage drop will cause the indicator lamp for the main relay and/or the circuit breaker to turn ON. The voltage drop must be larger than 1.30 ± 0.15 volts. The lamp turned ON in order to indicate a low state of charge. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Activated circuit breaker
- Closed circuit breaker with an excessive voltage drop
- Open relay contact
- Closed relay with excessive voltage drop
- Relay with welded contacts

Note: It is necessary to find the two components that have a defect if a machine fails this test.

Use a digital multimeter in order to find the faulty components. Check for an excessive voltage drop across the man relay (F) and the main circuit breaker (E). Use the multimeter to troubleshoot the conditions for the test step that caused the analyzer to show a defect.

Information for Other Circuits

It is possible that a machine will have both of the components. It is also possible that a machine will not have either component.

Test point 12 is connected directly to test point 9 on machines that do not have either component. This type of connection will never indicate a defect on the analyzer.

Replace the component(s) that is faulty if a machine has a main circuit breaker and/or a main relay.

Refer to the wiring schematic for the machine that is being serviced. Use the schematic in order to determine the components that are used in the electrical circuit that is under the test.

i02550613

Coolant Switch Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

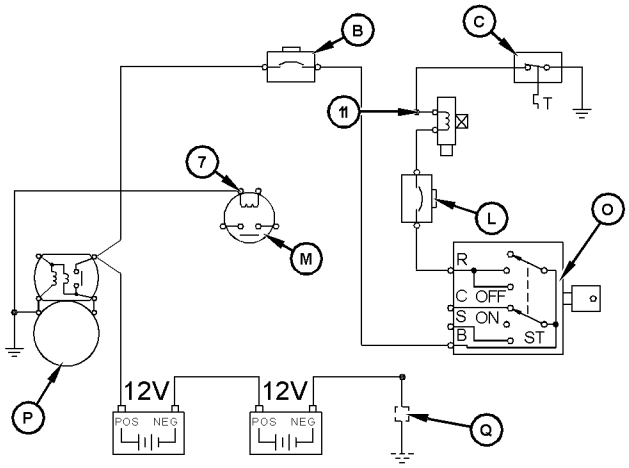


Illustration 9 g01276763

Specification

This test measures the voltage drop across the coolant switch. The voltage drop is measured across test point (11) and test point (7). Test point (11) is the positive contact and test point (7) is the negative contact.

A voltage drop will cause the indicator lamp for the coolant to turn ON. The voltage drop must be larger than 1.30 ± 0.15 volts. The lamp turned ON in order to indicate a defect.

The possible causes of this condition are listed:

- Open switch
- Closed switch with excessive voltage drop
- Switch with welded contacts

Information for Other Circuits

The coolant switch opens when the engine coolant temperature reaches 38°C (100°F).

This switch prevents the use of a starting aid in a warm engine. The use of a starting aid in a warm engine may cause possible damage.

The engine coolant must be below a temperature of 38°C (100°F) in order for this test to be valid. A warm engine must first cool down to a temperature of 27°C (80°F) in order to close the coolant switch.

i02550852

Start Aid Switch/Solenoid Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

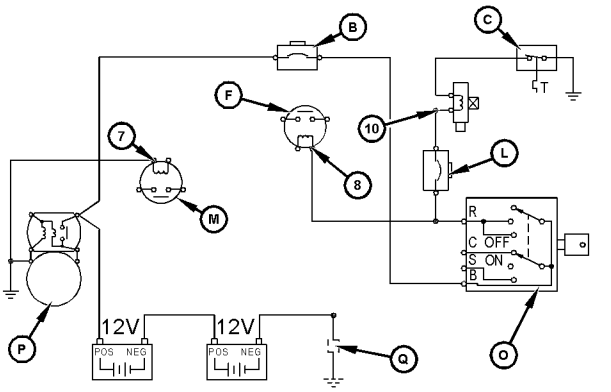


Illustration 10 g01276888

Specification

This test measures the voltage drop across the starting aid switch or the solenoid. The voltage drop is measured across test point (8) and test point (10). Test point (8) is the positive contact and test point (10) is the negative contact.

A voltage drop will cause the indicator lamp for the starting aid switch or the solenoid to turn OFF. The voltage drop must be larger than 2.50 ± 0.15 volts. The lamp turned OFF in order to indicate a defect. A defect may be indicated during any Test Step.

This test also measures the resistance across the starting aid switch or the solenoid circuit. The resistance is measured across test point (7) and test point (10).

A voltage drop will cause the indicator lamp for the starting aid switch/solenoid to turn OFF or ON. The resistance must be less than 300 Ohms in order for the lamp to stay OFF. The resistance must be greater than 3600 Ohms in order for the lamp to turn ON. The lamp turned ON in order to indicate a defect. A defect may be indicated during the following Test Steps:

- “Test Setup A, Hookup”
- “Test Step B, Crank”
- “Test Step D, High Idle”

The starting aid switch can cause this defect from the following:

- Open switch
- Closed switch with an excessive voltage drop
- Switch with welded contacts

The starting aid solenoid can cause this defect from the following:

- Open solenoid circuit

Information for Other Circuits

The lamp for the starting aid circuit is turned ON and the switch is not activated. The switch has a defect. The contacts for the switch could be welded. The solenoid and/or the harness could be open.

Disconnect the analyzer and use a digital multimeter in order to check the continuity of the test points. Check the continuity from test point 10 to test point 7 or the machine ground. The resistance from test point 10 to test point 7 should be greater than 8 Ohms. The switch has probably failed if the resistance is less than 8 Ohms.

Welded contacts on the switch can cause the solenoid coil to open. An open in the solenoid coil is a failure.

The wiring harness and the connections for the wiring harness are also checked in this test. Refer to the wiring schematic for the machine that is being serviced for the location of the components. An open in the harness will indicate a defect.

Note: The engine coolant must be below 38°C (100° F) in order to perform this test. A warm engine must first cool down to a temperature of 27°C (80°F) in order to perform this test.

i02550914

Start Relay (Starter One) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

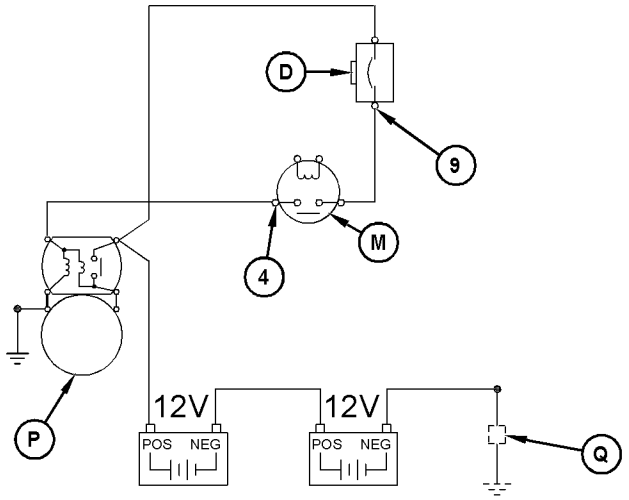


Illustration 11 g01276975

Specification

This test measures the voltage drop across the starter relay 1. The voltage drop is measured across test point (9) and test point (4). Test point (9) is the positive contact and test point (4) is the negative contact.

A voltage drop will cause the indicator lamp for the starting aid switch or the solenoid to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The open relay can cause this defect from the following:

- Burned contacts
- Open relay coils

The closed relay can cause this defect from the following:

- Relay with excessive voltage drop

i02550947

Starter Solenoid Power Circuit (Starter One) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

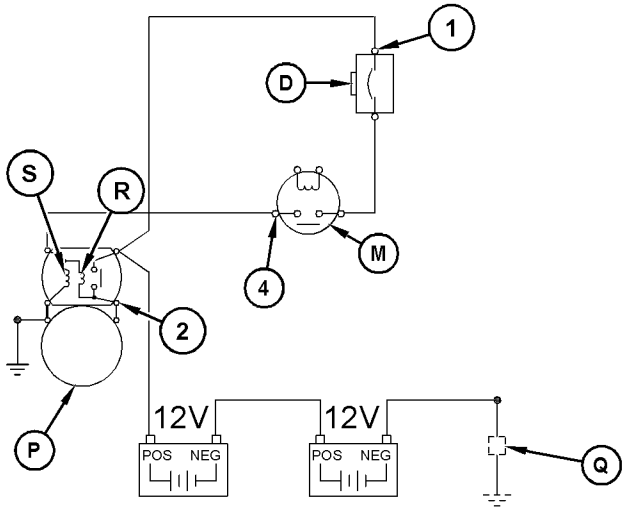


Illustration 12 g01285461

Specification

This test measures the voltage drop of the coil (R) for the starter solenoid “PULL-IN” . The voltage drop is measured between test point (2) and test point (4). Test point (2) is the positive contact and test point (4) is the negative contact.

A voltage drop will cause the indicator lamp for the starter solenoid power circuit to turn ON. The voltage drop must be larger than 1.00 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated only during “Test Step B, Crank” .

The possible causes of this condition are listed:

- Alternator circuit breaker with excessive voltage drop
- Start relay with excessive voltage drop

Note: The alternator circuit breaker or the start relay may have an excessive voltage drop that is within specified range.

Information for Other Circuits

The starter solenoid has two coils. The “PULL-IN” coil is coil (R). The “HOLD-IN” coil is coil (S). Both of the coils will receive power when the start relay closes. Battery voltage is applied to the high end of both coils at test point (4). The “LOW” end of the coil (S) is permanently grounded to the ground post of the starter.

The grounding for the low end of coil (R) is momentary. The grounding takes place through the direct current resistance of the starter. The contacts of the solenoid close after the magnetic force is built in both coils. The temporary ground is removed from the coil (R) and battery voltage is applied to both ends.

The solenoid closes. The solenoid is closed by the coil (R) and coil (S).

Coil (W) is out of the circuit since a battery voltage is present on both ends of the coil. The voltage across the “PULL-IN” coil is nearly zero. It is possible that test point (4) is more negative than test point (2). If test point (4) is more negative than test point (2) by one or more volts, the current flows backward. The current flows backward through the “PULL-IN” coil and the solenoid releases.

Test point (2) grounds the “PULL-IN” coil when the solenoid releases. The solenoid releases several times in a second. The contacts are burned to an open condition. The contacts become burned unless the problem is found. Replacing the solenoid returns the machine to work. Replacing the solenoid does not fix the problem.

Resolving the Problem

During the cranking of the engine, the voltage drop is incorrect. The voltage drop that is across test point (1) and test point (4) is greater than the voltage drop that is across test point (1) and test point (2). The analyzer shows that the alternator circuit breaker and the start relay are within the specifications. Replacing one or both of the components can reduce the voltage drop to an acceptable range between test point (1) and test point (2). The harness connectors can have an effect on the test of the circuit. For more information on the circuit, see the complete System Schematic for the machine that is being serviced. The lamp for the power circuit of the starter solenoid is OFF in order to indicate the acceptable limits.

i02566459

Starter Solenoid (Starter One) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

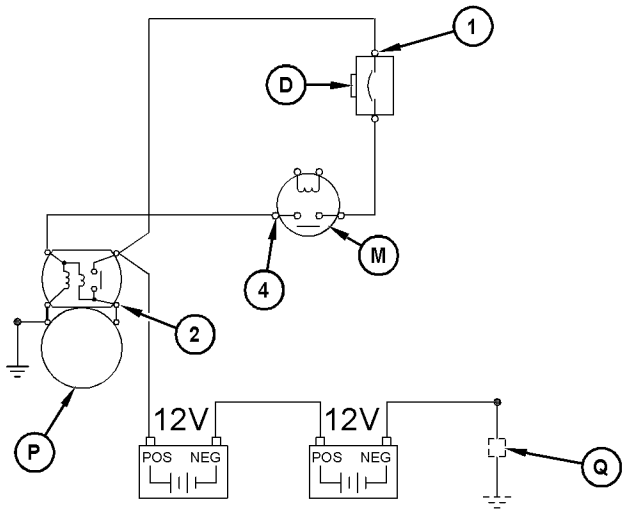


Illustration 13 g01285385

Specification

This test measures the voltage drop across the starter solenoid. The voltage drop is measured across test point (1) and test point (2). Test point (1) is the positive contact and test point (2) is the negative contact.

A voltage drop will cause the indicator lamp for the starting solenoid to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The possible causes of this condition are listed:

- Open solenoid contacts
- Closed solenoid contacts with excessive voltage drop

Information for Other Circuits

A wire that is open from test point 4 to the starter solenoid will give an indication of a faulty solenoid. For more information on the circuit, see the complete System Schematic for the machine that is being serviced.

i02566514

Start Relay (Starter Two) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

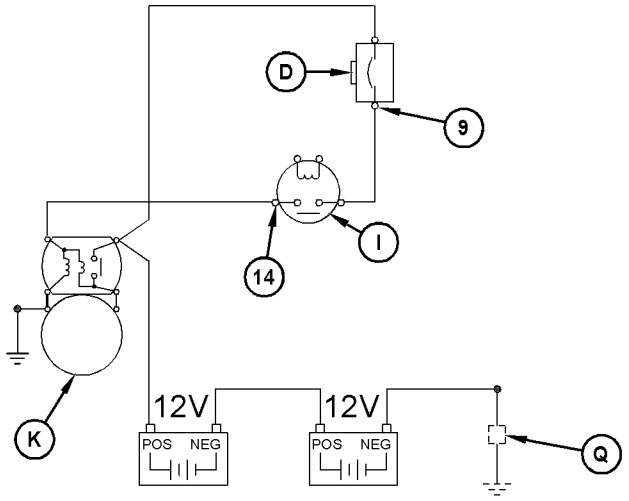


Illustration 14 g01285410

Specification

This test measures the voltage drop across the starter relay. The voltage drop is measured across test point (9) and test point (14). Test point (9) is the positive contact and test point (14) is the negative contact.

A voltage drop will cause the indicator lamp for the starting solenoid to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The possible causes of this condition are listed:

- Open solenoid contacts
- Closed solenoid contacts with excessive voltage drop

i02566524

Starter Solenoid Power Circuit (Starter Two) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

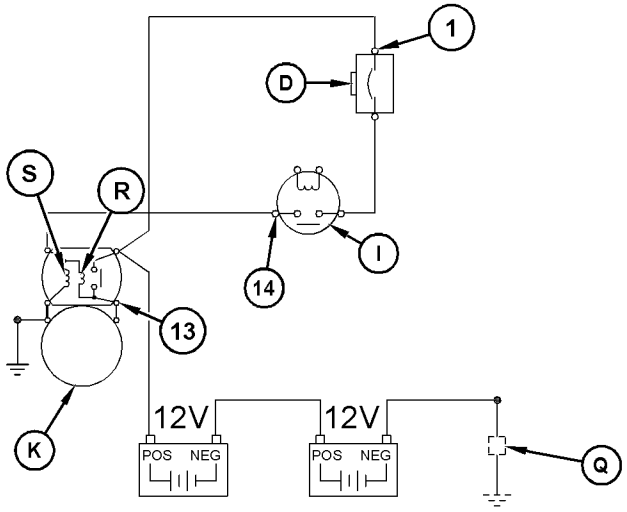


Illustration 15 g01285462

Specification

This test measures the voltage drop of the coil (R) for the starter solenoid “PULL-IN” . The voltage drop is measured between test point 13 and test point 14. Test point 13 is the positive contact and test point 14 is the negative contact.

A voltage drop will cause the indicator lamp for the starter solenoid power circuit to turn ON. The voltage drop must be larger than 1.00 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated only during “Test Step B, Crank” .

The possible causes of this condition are listed:

- Alternator circuit breaker with excessive voltage drop
- Start relay with excessive voltage drop

Note: The alternator circuit breaker or the start relay may have an excessive voltage drop that is within specified range.

Information for Other Circuits

The starter solenoid has two coils. The “PULL-IN” coil is coil (R). The “HOLD-IN” coil is coil (S). Both of the coils will receive power when the start relay closes. Battery voltage is applied to the high end of both coils at test point 14. The “LOW” end of the coil (S) is permanently grounded to the ground post of the starter.

The grounding for the low end of coil (R) at test point 13 is momentary. The grounding takes place through the direct current resistance of the starter. The contacts of the solenoid close after the magnetic force is built in both coils. The temporary ground is removed from the coil (R) and battery voltage is applied to both ends.

The solenoid closes. The solenoid is closed by the coil (R) and coil (S).

Coil (W) is out of the circuit since a battery voltage is present on both ends of the coil. The voltage across the “PULL-IN” coil is nearly zero. It is possible that test point 14 is more negative than test point 13. If test point 14 is more negative than test point 13 by one or more volts, the current flows backward. The current flows backward through the “PULL-IN” coil and the solenoid releases.

Test point 13 grounds the “PULL-IN” coil when the solenoid releases. The solenoid releases several times in a second. The contacts are burned to an open condition. The contacts become burned unless the problem is found. Replacing the solenoid returns the machine to work. Replacing the solenoid does not fix the problem.

Resolving the Problem

During the cranking of the engine, the voltage drop is incorrect. The voltage drop that is across test point 1 and test point 14 is greater than the voltage drop that is across test point 1 and test point 13. The analyzer shows that the alternator circuit breaker and the start relay are within the specifications. Replacing one or both of the components can reduce the voltage drop to an acceptable range between test point 1 and test point 13. The harness connectors can have an effect on the test of the circuit. For more information on the circuit, see the complete System Schematic for the machine that is being serviced. The lamp for the power circuit of the starter solenoid is OFF in order to indicate the acceptable limits.

i02567459

Starter Solenoid (Starter Two) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

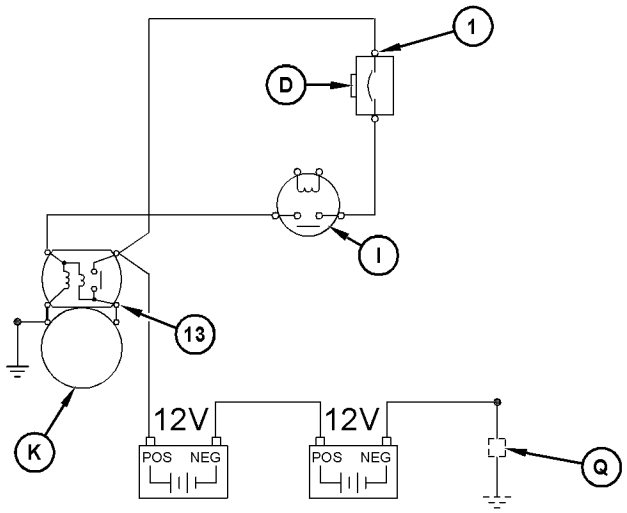


Illustration 16 g01286027

Specification

This test measures the voltage drop across the starter solenoid. The voltage drop is measured across test point (1) and test point (13). Test point (1) is the positive contact and test point (13) is the negative contact.

A voltage drop will cause the indicator lamp for the starting solenoid to turn ON. The voltage drop must be larger than 0.75 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The possible causes of this condition are listed:

- Open solenoid contacts
- Closed solenoid contacts with excessive voltage drop

Information for Other Circuits

A wire that is open from test point (4) to the starter solenoid will give an indication of a faulty solenoid. For more information on the circuit, see the complete System Schematic for the machine that is being serviced.

i02569979

Alternator Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

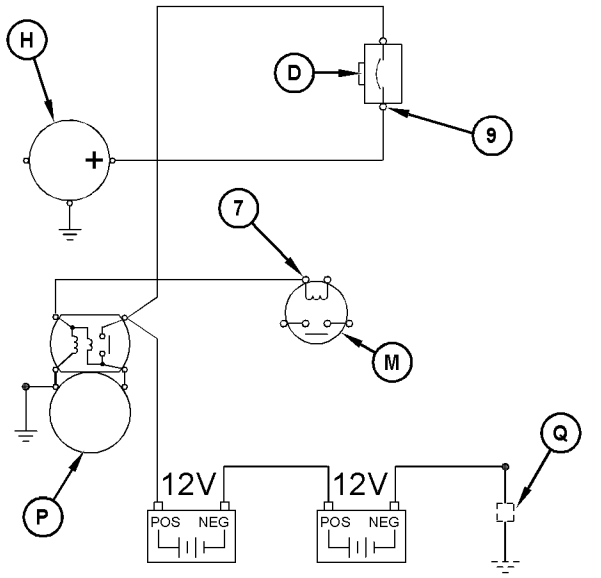


Illustration 17 g01287589

Specification

This test measures the voltage drop of the alternator output. The voltage drop is measured across test point (9) and test point (7). Test point (9) is the positive contact and test point (7) is the negative contact.

Voltage measurement that is less than 26.2 ± 0.15 volts

A voltage measurement that is between the two test points causes the lamp for the alternator to stay OFF if the voltage is less than 26.2 ± 0.15 volts. The lamp is OFF after a minimum of two minutes in order to indicate a defect. The defect indicates that the alternator is charging inadequately.

The defect can be caused by the following:

- Loose belts on fan
- Loose belts on alternator
- Ground cable from the starter to the engine block is damaged, loose, or missing.
- Faulty alternator
- Faulty batteries

Voltage measurement that is more than 28.9 ± 0.15 volts

A voltage measurement that is between the two test points causes the lamp for the alternator to turn OFF if the voltage measurement is more than 28.9 ± 0.15 volts. The lamp is ON for one minute and turns OFF in order to indicate a defect. The defect indicates that the alternator is charging at an excessive rate.

The defect can be caused by the following:

- Alternator

Information for Other Circuits

Inadequate Charge

A faulty alternator causes the lamp to turn ON. Then, the lamp turns OFF when all of the electrical loads are turned ON. The lamp does not turn ON again.

In the event of such a condition, use a ammeter in order to verify the correct output amperage of the alternator. For the correct alternator output, refer to the service manual for the machine that is under the test.

Excessive Charge

The analyzer shuts down to a safe mode when the alternator is excessively charging at a severe output. The safe mode is indicated when all of the lamps for the analyzer turn OFF.

An overcharge can be confirmed. Slowly reduce the engine speed to idle. The analyzer turns ON. The lamp for the alternator is OFF. Then, the lamp turns ON. The overcharge is confirmed. An overcharge can also be confirmed if low amounts of water are found in every cell of the batteries.

i02548849

Troubleshooting

SMCS Code: 0710; 1401; 1405; 1406; 1453

Panel of the Analyzer



Illustration 18 g01289644

Troubleshooting the 6V-2150 Starting/Charging Analyzer During Operation with an Indication of a Defect in the Analyzer

There is an indication of a defect in the analyzer. This procedure will aid in the location of the problem.

1. Repair work that was completed on the machine such as removal of the engine or replacement of the wiring harness could have caused the problem. The following is a list of possible problems:

- Errors in connections of the machine wiring harness
- Error in wiring of the diagnostic connector

Note: When an error in the wiring is the problem, use a digital multimeter to perform a test on the correct wiring harness. For more information, see the explanation of the tests on the analyzer in the Systems Operation, “Test Considerations” section.

2. The machine wiring is correct and the analyzer does not show the expected results. Use an analyzer that is known to be good and then repeat the tests.

If the analyzer has a defect, see Systems Operation, “Reference Information”.

i02570382

Reference Information

SMCS Code: 0710; 1401; 1405; 1406; 1453

Repair Information

The repair of the analyzer will be performed by Advanced Technology Services.

Warranty Policy

Analyzers that are less than one year old are repaired under Caterpillar Warranty except in the event of abuse. If the repair is being returned under Caterpillar warranty, follow the standard Caterpillar Warranty Claim Procedure in order to regain expenses. Obtain an authorization number from the Caterpillar Service Technology Group Hotline if the claim is over $200.

Telephone

Caterpillar Service Technology Group Hotline

In Illinois call 1-800-542-8665

Outside Illinois call 1-800-541-8665

Canada call 1-800-523-8665

Advanced Technology Services

For 24 hour customer care call 1-800-328-7287

Outside North America call 1-309-693-4170

Write

E-mail: CSR@AdvancedTech.com

Address: 8201 N. University Peoria, IL 61615 Attn: Caterpillar Diagnostic Tool Repair

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SENR2947
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SEBU7893-11 (en-us)
August 2018

Operation and Maintenance Manual

844H Wheel Dozer

BTW 1-UP (844H)

Language: Original Instructions

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Foreword

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

WARNING – This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.

WARNING – This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

Literature Information

This manual should be stored in the operator's compartment in the literature holder or seat back literature storage area.

This manual contains safety information, operation instructions, transportation information, lubrication information, and maintenance information.

Some photographs or illustrations in this publication show details or attachments that can be different from your machine. Guards and covers might have been removed for illustrative purposes.

Continuing improvement and advancement of product design might have caused changes to your machine which are not included in this publication. Read, study, and keep this manual with the machine.

Whenever a question arises regarding your machine, or this publication, please consult your Cat dealer for the latest available information.

Safety

The safety section lists basic safety precautions. In addition, this section identifies the text and locations of warning signs and labels used on the machine.

Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance, and repair on this machine.

Operation

The operation section is a reference for the new operator and a refresher for the experienced operator. This section includes a discussion of gauges, switches, machine controls, attachment controls, transportation, and towing information.

Photographs and illustrations guide the operator through correct procedures of checking, starting, operating, and stopping the machine.

Operating techniques outlined in this publication are basic. Skill and techniques develop as the operator gains knowledge of the machine and its capabilities.

Maintenance

The maintenance section is a guide to equipment care. The Maintenance Interval Schedule (MIS) lists the items to be maintained at a specific service interval. Items without specific intervals are listed under the "When Required" service interval. The Maintenance Interval Schedule lists the page number for the step-by-step instructions required to accomplish the scheduled maintenance. Use the Maintenance Interval Schedule as an index or "one safe source" for all maintenance procedures.

Maintenance Intervals

Use the service hour meter to determine servicing intervals. Calendar intervals shown (daily, weekly, monthly, etc.) can be used instead of service hour meter intervals if the calendar intervals provide more convenient servicing schedules and approximate the indicated service hour meter reading. Perform the recommended service at the interval that occurs first.

Under severe, dusty, or wet operating conditions, more frequent lubrication than is specified in the maintenance intervals chart might be necessary.

Perform service on items at multiples of the original requirement. For example, at every 500 service hours or 3 months, also service those items listed under every 250 service hours or monthly and every 10 service hours or daily.

Certified Engine Maintenance

Proper maintenance and repair are essential to keep the engine and machine systems operating correctly. As the heavy-duty off-road diesel engine owner, you are responsible for the performance of the required maintenance listed in the Owner Manual, Operation and Maintenance Manual, and Service Manual.

It is prohibited for any person engaged in the business of repairing, servicing, selling, leasing, or trading engines or machines to remove, alter, or to render inoperative, any emission-related device or element of design installed on or in an engine or machine that is in compliance with all applicable regulations of the intended country to which it has been shipped. Certain elements of the machine and engine such as the exhaust system, fuel system, electrical system, intake air system, and cooling system may be emission-related and should not be altered unless approved by Caterpillar.

Machine Capacity

Additional attachments or modifications may exceed machine design capacity which can adversely affect performance characteristics. Included would be stability and system certifications such as brakes, steering, and rollover protective structures (ROPS). Contact your Cat dealer for further information.

Product Identification Number

Effective First Quarter 2001 the Product Identification Number (PIN) has changed from 8 to 17 characters. To provide uniform equipment identification, construction equipment manufacturers are moving to comply with the latest version of the product identification numbering standard. Non-road machine PINs are defined by ISO 10261. The new PIN format will apply to all machines and generator sets. The PIN plates and frame marking will display the 17 character PIN. The new format will look like the following:

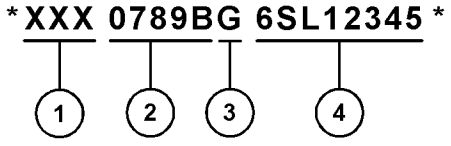


Illustration 1 g03891925

Where:

1. World Manufacturing Code (characters 1-3)

2. Machine Descriptor (characters 4-8)

3. Check Character (character 9)

4. Machine Indicator Section (MIS) or Product Sequence Number (characters 10-17). These were previously referred to as the Serial Number.

Machines and generator sets produced before First Quarter 2001 will maintain their 8 character PIN format.

Components such as engines, transmissions, axles, and work tools will continue to use an 8 character Serial Number (S/N).

Safety Section

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Safety Messages

SMCS Code: 7000

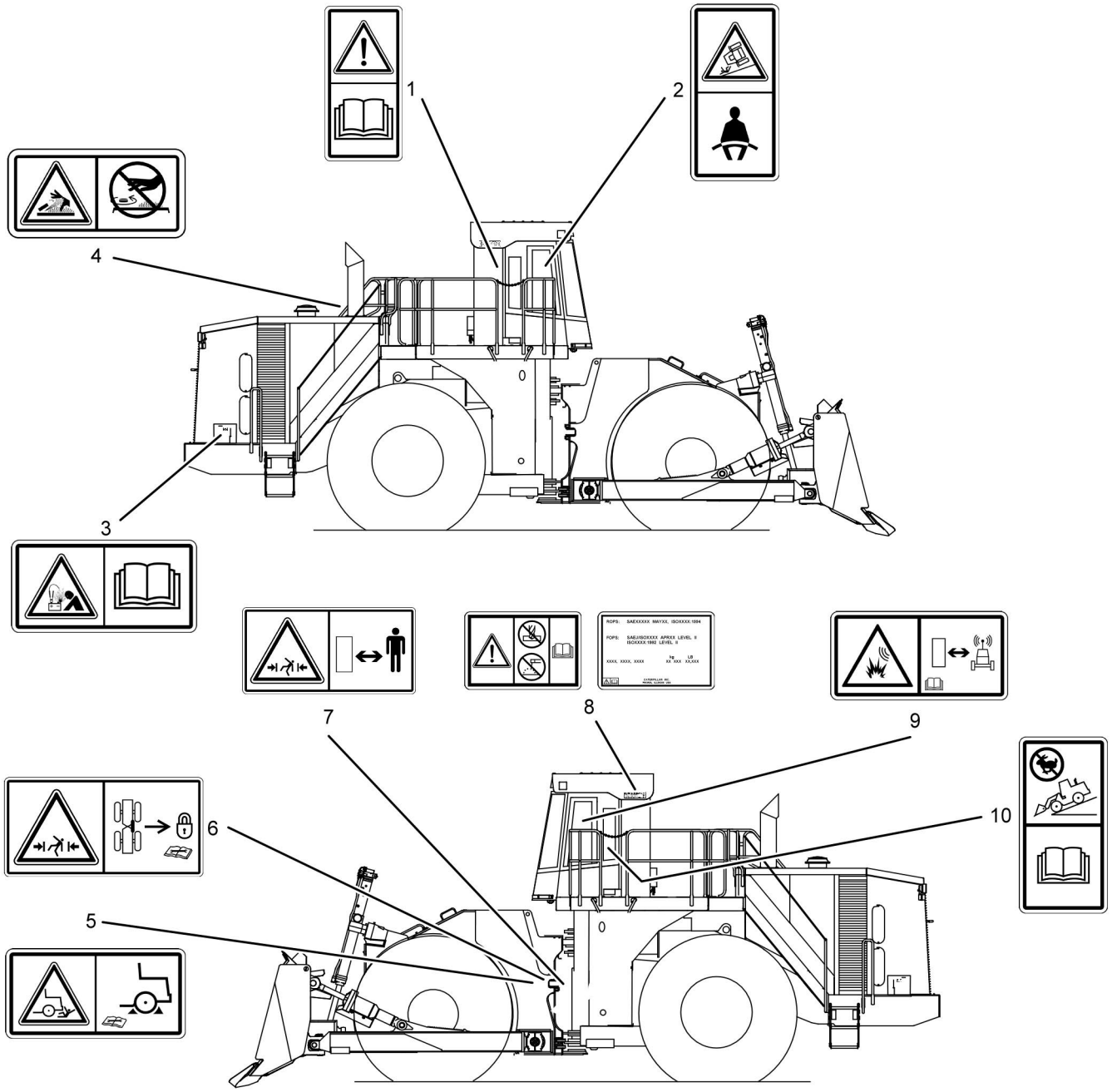


Illustration 2 g02151061

There are several specific safety messages on this machine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiarized with all safety messages.

Make sure that all of the safety messages are legible. Clean the safety messages or replace the safety messages if you cannot read the words. Replace the illustrations if the illustrations are not legible. When you clean the safety messages, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety message. Loose adhesive will allow the safety message to fall.

Replace any safety message that is damaged or missing. If a safety message is attached to a part that is replaced, install a safety message on the replacement part. Any Caterpillar dealer can provide new safety messages.

Do Not Operate (1)

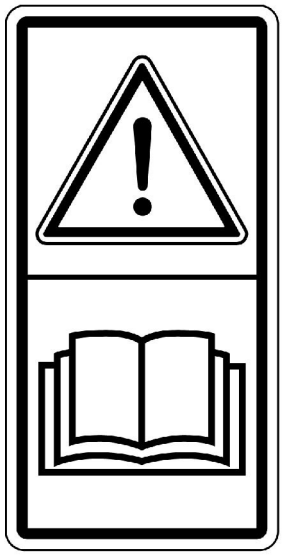


Illustration 3 g01379128

This warning label is located in the cab on the inside of the front door post.

⚠ WARNING

DO NOT OPERATE OR WORK ON THIS MACHINE UNLESS YOU HAVE READ AND UNDERSTAND THE INSTRUCTIONS AND WARNINGS IN THE OPERATION AND MAINTENANCE MANUALS. FAILURE TO FOLLOW THE INSTRUCTIONS OR HEED THE WARNINGS COULD RESULT IN INJURY OR DEATH. CONTACT ANY CATERPILLAR DEALER FOR REPLACEMENT MANUALS. PROPER CARE IS YOUR RESPONSIBILITY.

Seat Belt (2)

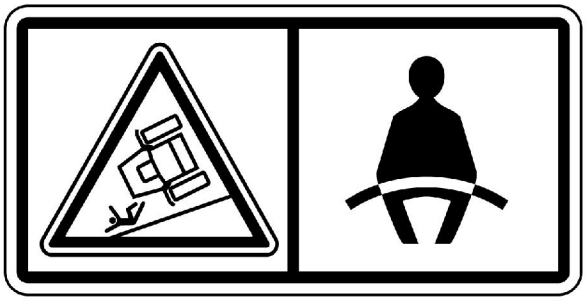


Illustration 4 g01370908

This warning label is located in the cab near the cup holder.

⚠ WARNING

A seat belt should be worn at all times during machine operation to prevent serious injury or death in the event of an accident or machine overturn. Failure to wear a seat belt during machine operation may result in serious injury or death.

Improper Connections Of The Jump Start Cable (3)

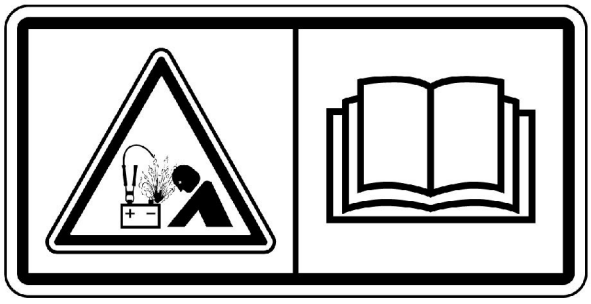


Illustration 5 g01370909

This warning label is located in the battery compartment.

⚠ WARNING

Explosion Hazard! Improper jumper cable connections can cause an explosion resulting in serious injury or death. Batteries may be located in separate compartments. Refer to the Operation and Maintenance Manual for the correct jump starting procedure.

Pressurized System (4)



Illustration 6 g01371640

This warning label is located on the back side of the access door for the radiator filler cap.

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

Parking Brake (5)

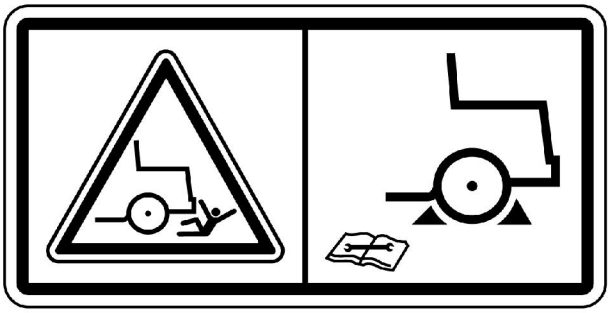


Illustration 7 g01435623

This warning is located near the articulation joint on the cover for the parking brake.

⚠ WARNING

BEFORE MANUALLY RELEASING PARKING BRAKE-Stop the engine and block wheels to prevent machine movement which could result in personal injury.

BEFORE DISSASSEMBLING BRAKE-Relieve brake oil pressure by repeatedly applying brakes until brake oil pressure gauge indicates zero.

TO MANUALLY RELEASE PARKING BRAKE-Remove three bolts from the storage holes [ ] in the retainer plate. Install them in the three threaded holes [X] and tighten until solid resistance is felt.

BEFORE OPERATING THE MACHINE-Remove the three bolts and install in the storage holes [ ].

Crushing Hazard (6)

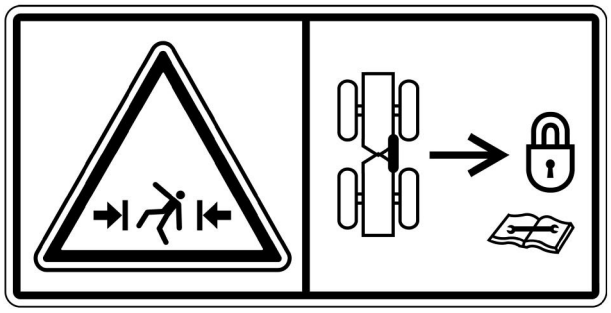


Illustration 8 g01371647

This warning label is located on both sides of the machine at the articulation joint.

⚠ WARNING

Crushing Hazard. There is no clearance for a person in this area when the machine turns. Severe injury or death from crushing could occur. Connect the steering frame lock between front and rear frames before lifting, transporting, or servicing the machine in the articulation area.

Disconnect the steering lock and secure before resuming operation.

No Clearance (7)

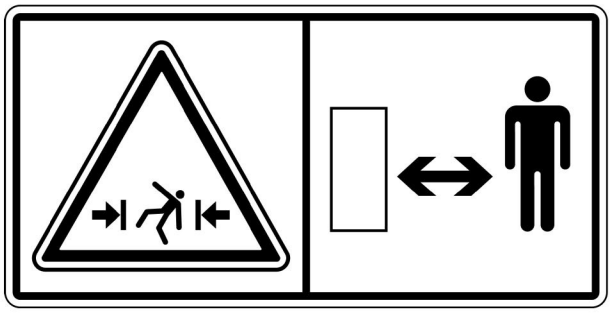


Illustration 9 g01371644

This warning label is located on both sides of the machine at the articulation joint.

⚠ WARNING

Crushing Hazard! Stay back a safe distance. There is no clearance for a person in this area when the machine turns. Failure to follow these instructions could cause serious injury or death.

ROPS/FOPS Structure (2)

This warning label is located on the outside of the cab on the left side below the window.

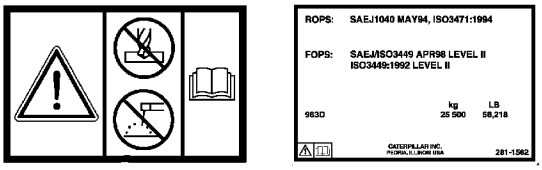


Illustration 10 g01347695

⚠ WARNING

Structural damage, an overturn, modification, alteration, or improper repair can impair this structure's protection capability thereby voiding this certification. Do not weld on or drill holes in the structure. This will void the certification. Consult a Caterpillar dealer to determine this structure's limitations without voiding its certification.

This machine has been certified to the standards that are listed on the certification film. The maximum mass of the machine, which includes the operator and the attachments without a payload, should not exceed the mass on the certification film.

A typical example of the warning film and certification film are shown above.

Product Link (9)

This warning label is located inside the cab.

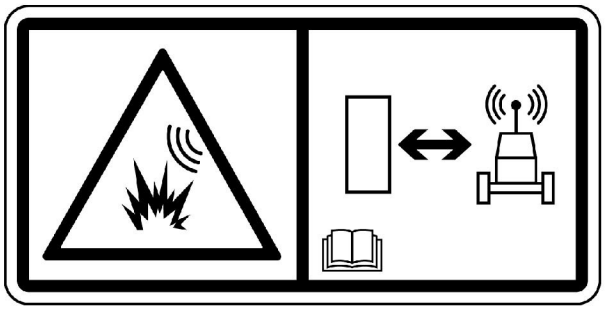


Illustration 11 g01370917

⚠ WARNING

This machine is equipped with a Caterpillar Product Link communication device. When electric/electronic detonators are used, this communication device should be deactivated within 12 m (40 ft) of a blast site, or within the distance mandated under applicable legal requirements. Failure to do so could cause interference with blasting operations and result in serious injury or death.

Down Hill Travel (10)

This warning label is located in the cab on the inside of the front door post.

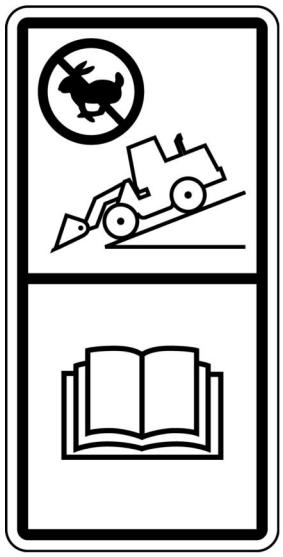


Illustration 12 g02151383

WARNING

This wheel loader is not equipped with a retarder and should not be used for high speed, down-grade hauling operations. If the service brakes are overused when traveling downhill, the service brakes may overheat and fail which could result in serious injury or death. When traveling down-hill, downshift to the proper gear and use engine braking to prevent excessive speed buildup and excessive use of the service brakes. When using the service brakes for downhill travel, always use the right brake pedal.

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Additional Messages

SMCS Code: 7000

There are several specific messages on this machine. The exact location of the messages and the description of the messages are reviewed in this section. Please become familiarized with all messages.

Make sure that all of the messages are legible. Clean the messages or replace the messages if you cannot read the words. Replace the illustrations if the illustrations are not legible. When you clean the messages, use a cloth, water and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the messages. Loose adhesive will allow the messages to fall.

Replace any message that is damaged, or missing. If a message is attached to a part that is replaced, install a message on the replacement part. Any Caterpillar dealer can provide new messages.

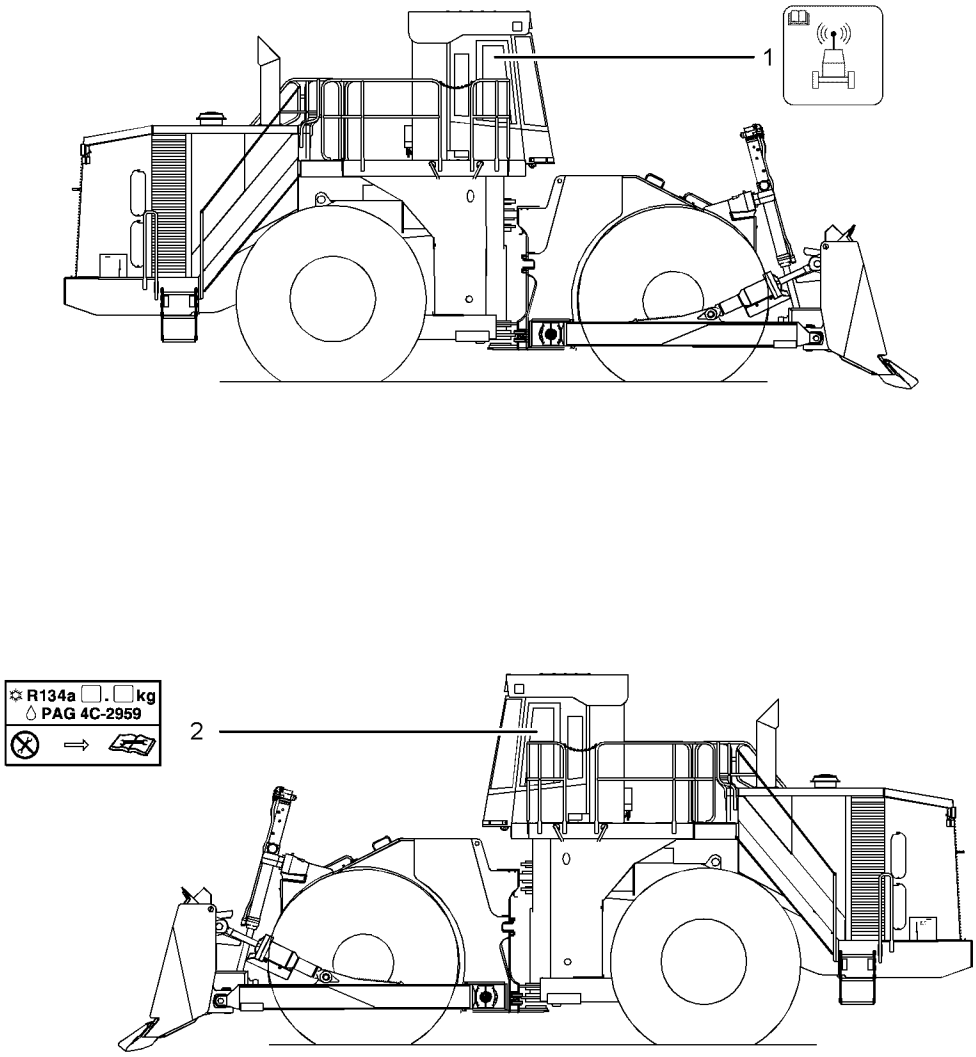


Illustration 13 g01445576

Data Privacy (1)

This message is located in the cab.



Illustration 14 g01418953

The Product Link is a satellite based communication device that transmits information regarding the machine to Caterpillar, Caterpillar dealers, and Caterpillar customers.

Air Conditioner (2)

This message is located in the cab.

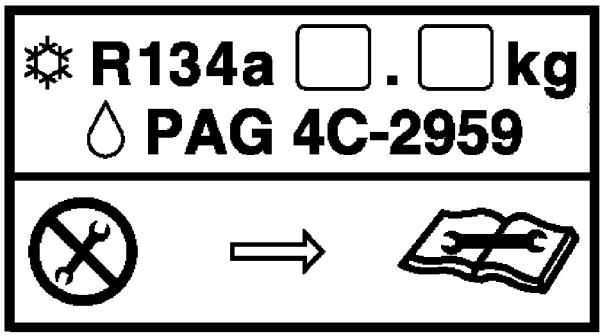


Illustration 15 g00990500

Read the service manual before you perform any maintenance on the air conditioner.

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General Hazard Information

SMCS Code: 7000

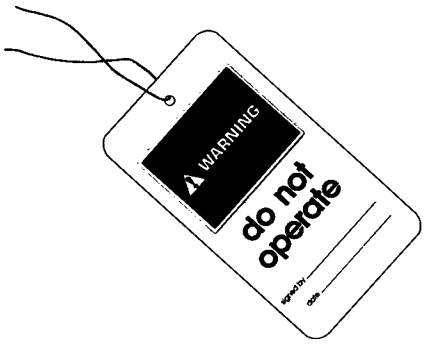


Illustration 16 g00104545
Typical example

Attach a “Do Not Operate” warning tag or a similar warning tag to the start switch or to the controls. Attach the warning tag before you service the equipment or before you repair the equipment. Warning tag SEHS7332 is available from your Cat dealer.

⚠ WARNING

Operating the machine while distracted can result in the loss of machine control. Use extreme caution when using any device while operating the machine. Operating the machine while distracted can result in personal injury or death.

Know the width of your equipment in order to maintain proper clearance when you operate the equipment near fences or near boundary obstacles.

Be aware of high voltage power lines and power cables that are buried. If the machine comes in contact with these hazards, serious injury or death may occur from electrocution.

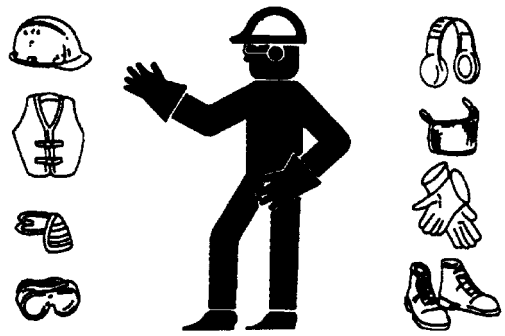


Illustration 17 g00702020

Wear a hard hat, protective glasses, and other protective equipment, as required.

Do not wear loose clothing or jewelry that can snag on controls or on other parts of the equipment.

Make sure that all protective guards and all covers are secured in place on the equipment.

Keep the equipment free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps.

Secure all loose items such as lunch boxes, tools, and other items that are not a part of the equipment.

Know the appropriate work site hand signals and the personnel that are authorized to give the hand signals. Accept hand signals from one person only.

Do not smoke when you service an air conditioner. Also, do not smoke if refrigerant gas may be present. Inhaling the fumes that are released from a flame that contacts air conditioner refrigerant can cause bodily harm or death. Inhaling gas from air conditioner refrigerant through a lighted cigarette can cause bodily harm or death.

Never put maintenance fluids into glass containers. Drain all liquids into a suitable container.

Obey all local regulations for the disposal of liquids.

Use all cleaning solutions with care. Report all necessary repairs.

Do not allow unauthorized personnel on the equipment.

Unless you are instructed otherwise, perform maintenance with the equipment in the servicing position. Refer to Operation and Maintenance Manual for the procedure for placing the equipment in the servicing position.

When you perform maintenance above ground level, use appropriate devices such as ladders or man lift machines. If equipped, use the machine anchorage points and use approved fall arrest harnesses and lanyards.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. The debris and/or hot water could result in personal injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the nozzle is deadheaded and the nozzle is used with an effective chip deflector and personal protective equipment. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Avoid direct spraying of water on electrical connectors, connections, and components. When using air for cleaning, allow the machine to cool to reduce the possibility of fine debris igniting when re-deposited on hot surfaces.

Trapped Pressure

Pressure can be trapped in a hydraulic system. Releasing trapped pressure can cause sudden machine movement or attachment movement. Use caution if you disconnect hydraulic lines or fittings. High-pressure oil that is released can cause a hose to whip. High-pressure oil that is released can cause oil to spray. Fluid penetration can cause serious injury and possible death.

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the machine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the Service Manual for any procedures that are required to relieve the hydraulic pressure.

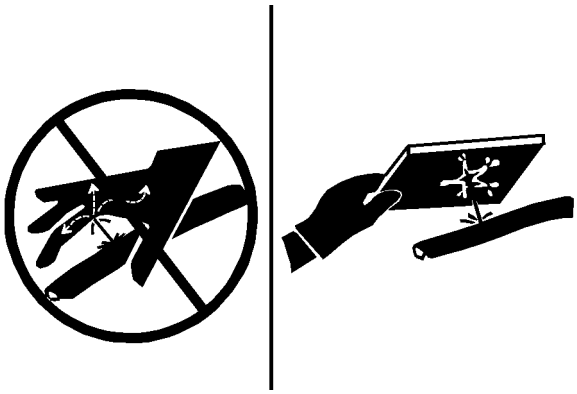


Illustration 18 g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the equipment. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component that contains fluids.

Refer to Special Publication, NENG2500, “Cat dealer Service Tool Catalog” for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Inhalation



Illustration 19 g02159053

Exhaust

Use caution. Exhaust fumes can be hazardous to your health. If you operate the machine in an enclosed area, adequate ventilation is necessary.

Asbestos Information

Cat equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Cat replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.

- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in “29 CFR 1910.1001”. In Japan, use the requirements found in the “Ordinance on Prevention of Health Impairment due to Asbestos” in addition to the requirements of the Industrial Safety and Health Act.
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

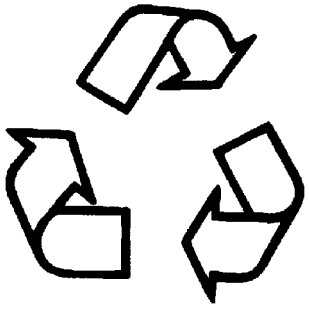


Illustration 20 g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

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Crushing Prevention and Cutting Prevention

SMCS Code: 7000

Support the equipment properly before you perform any work or maintenance beneath that equipment. Do not depend on the hydraulic cylinders to hold up the equipment. Equipment can fall if a control is moved, or if a hydraulic line breaks.

Do not work beneath the cab of the machine unless the cab is properly supported.

Unless you are instructed otherwise, never attempt adjustments while the machine is moving or while the engine is running.

Never jump across the starter solenoid terminals in order to start the engine. Unexpected machine movement could result.

Whenever there are equipment control linkages the clearance in the linkage area will change with the movement of the equipment or the machine. Stay clear of areas that may have a sudden change in clearance with machine movement or equipment movement.

Stay clear of all rotating and moving parts.

If it is necessary to remove guards in order to perform maintenance, always install the guards after the maintenance is performed.

Keep objects away from moving fan blades. The fan blade will throw objects or cut objects.

Do not use a kinked wire cable or a frayed wire cable. Wear gloves when you handle wire cable.

When you strike a retainer pin with force, the retainer pin can fly out. The loose retainer pin can injure personnel. Make sure that the area is clear of people when you strike a retainer pin. To avoid injury to your eyes, wear protective glasses when you strike a retainer pin.

Chips or other debris can fly off an object when you strike the object. Make sure that no one can be injured by flying debris before striking any object.

i04760300

Burn Prevention

SMCS Code: 7000

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the oil system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings, or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level only after the engine has been stopped.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Remove the hydraulic tank filler cap only after the engine has been stopped. The filler cap must be cool enough to touch with a bare hand. Follow the standard procedure in this manual in order to remove the hydraulic tank filler cap.

Batteries

The liquid in a battery is an electrolyte. Electrolyte is an acid that can cause personal injury. Do not allow electrolyte to contact the skin or the eyes.

Do not smoke while checking the battery electrolyte levels. Batteries give off flammable fumes which can explode.

Always wear protective glasses when you work with batteries. Wash hands after touching batteries. The use of gloves is recommended.

i06180998

Fire Prevention and Explosion Prevention

SMCS Code: 7000



Illustration 21 g00704000

General

All fuels, most lubricants, and some coolant mixtures are flammable.

To minimize the risk of fire or explosion, Caterpillar recommends the following actions.

Always perform a Walk-Around Inspection, which may help you identify a fire hazard. Do not operate a machine when a fire hazard exists. Contact your Cat dealer for service.

Understand the use of the primary exit and alternative exit on the machine. Refer to Operation and Maintenance Manual, “Alternative Exit”.

Do not operate a machine with a fluid leak. Repair leaks and clean up fluids before resuming machine operation. Fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. A fire may cause personal injury or death.

Remove flammable material such as leaves, twigs, papers, trash, and so on. These items may accumulate in the engine compartment or around other hot areas and hot parts on the machine.

Keep the access doors to major machine compartments closed and access doors in working condition in order to permit the use of fire suppression equipment, in case a fire should occur.

Clean all accumulations of flammable materials such as fuel, oil, and debris from the machine.

Do not operate the machine near any flame.

Keep shields in place. Exhaust shields (if equipped) protect hot exhaust components from oil spray or fuel spray in case of a break in a line, in a hose, or in a seal. Exhaust shields must be installed correctly.

Do not weld or flame cut on tanks or lines that contain flammable fluids or flammable material. Empty and purge the lines and tanks. Then clean the lines and tanks with a nonflammable solvent prior to welding or flame cutting. Ensure that the components are properly grounded in order to avoid unwanted arcs.

Dust that is generated from repairing nonmetallic hoods or fenders may be flammable and/or explosive. Repair such components in a well ventilated area away from open flames or sparks. Use suitable Personal Protection Equipment (PPE).

Inspect all lines and hoses for wear or deterioration. Replace damaged lines and hoses. The lines and the hoses should have adequate support and secure clamps. Tighten all connections to the recommended torque. Damage to the protective cover or insulation may provide fuel for fires.

Store fuels and lubricants in properly marked containers away from unauthorized personnel. Store oily rags and flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.



Illustration 22 g03839130

Use caution when you are fueling a machine. Do not smoke while you are fueling a machine. Do not fuel a machine near open flames or sparks. Do not use cell phones or other electronic devices while you are refueling. Always stop the engine before fueling. Fill the fuel tank outdoors. Properly clean areas of spillage.

Avoid static electricity risk when fueling. Ultra low sulfur diesel (ULSD) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur content. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure that the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

Never store flammable fluids in the operator compartment of the machine.

Battery and Battery Cables



Illustration 23 g03839133

Caterpillar recommends the following in order to minimize the risk of fire or an explosion related to the battery.

Do not operate a machine if battery cables or related parts show signs of wear or damage. Contact your Cat dealer for service.

Follow safe procedures for engine starting with jump-start cables. Improper jumper cable connections can cause an explosion that may result in injury. Refer to Operation and Maintenance Manual, “Engine Starting with Jump Start Cables” for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas. Do not use cell phones or other electronic devices in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter in order to check the battery charge.

Daily inspect battery cables that are in areas that are visible. Inspect cables, clips, straps, and other restraints for damage. Replace any damaged parts. Check for signs of the following, which can occur over time due to use and environmental factors:

- Fraying
- Abrasion
- Cracking
- Discoloration
- Cuts on the insulation of the cable
- Fouling
- Corroded terminals, damaged terminals, and loose terminals

Replace damaged battery cable(s) and replace any related parts. Eliminate any fouling, which may have caused insulation failure or related component damage or wear. Ensure that all components are reinstalled correctly.

An exposed wire on the battery cable may cause a short to ground if the exposed area comes into contact with a grounded surface. A battery cable short produces heat from the battery current, which may be a fire hazard.

An exposed wire on the ground cable between the battery and the disconnect switch may cause the disconnect switch to be bypassed if the exposed area comes into contact with a grounded surface. This may result in an unsafe condition for servicing the machine. Repair components or replace components before servicing the machine.

⚠ WARNING

Fire on a machine can result in personal injury or death. Exposed battery cables that come into contact with a grounded connection can result in fires. Replace cables and related parts that show signs of wear or damage. Contact your Cat dealer.

Wiring

Check electrical wires daily. If any of the following conditions exist, replace parts before you operate the machine.

- Fraying
- Signs of abrasion or wear
- Cracking
- Discoloration
- Cuts on insulation
- Other damage

Make sure that all clamps, guards, clips, and straps are reinstalled correctly. This will help to prevent vibration, rubbing against other parts, and excessive heat during machine operation.

Attaching electrical wiring to hoses and tubes that contain flammable fluids or combustible fluids should be avoided.

Consult your Cat dealer for repair or for replacement parts.

Keep wiring and electrical connections free of debris.

Lines, Tubes, and Hoses

Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install any lines that are bent or damaged. Use the appropriate backup wrenches in order to tighten all connections to the recommended torque.

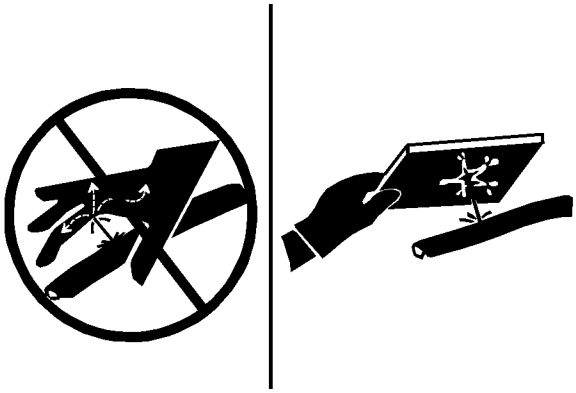


Illustration 24 g00687600

Check lines, tubes, and hoses carefully. Wear Personal Protection Equipment (PPE) in order to check for leaks. Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Replace the affected parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are swelling or ballooning.
- Flexible parts of the hoses are kinked.

- Outer covers have exposed embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During machine operation, this will help to prevent vibration, rubbing against other parts, excessive heat, and failure of lines, tubes, and hoses.

Do not operate a machine when a fire hazard exists. Repair any lines that are corroded, loose, or damaged. Leaks may provide fuel for fires. Consult your Cat dealer for repair or for replacement parts. Use genuine Cat parts or the equivalent, for capabilities of both the pressure limit and temperature limit.

Ether

Ether (if equipped) is commonly used in cold-weather applications. Ether is flammable and poisonous.

Only use approved Ether canisters for the Ether dispensing system fitted to your machine, do not spray Ether manually into an engine, follow the correct cold engine starting procedures. Refer to the section in the Operation and Maintenance Manual with the label “Engine Starting” .

Use ether in ventilated areas. Do not smoke while you are replacing an ether cylinder.

Do not store ether cylinders in living areas or in the operator compartment of a machine. Do not store ether cylinders in direct sunlight or in temperatures above 49° C (120.2° F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Fire Extinguisher

As an additional safety measure, keep a fire extinguisher on the machine.

Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Follow the recommendations on the instruction plate.

Consider installation of an aftermarket Fire Suppression System, if the application and working conditions warrant the installation.

i00977136

Fire Extinguisher Location

SMCS Code: 7000

Make sure that a fire extinguisher is on the machine. Make sure that you are familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher on a regular basis. Obey the recommendations on the instruction plate.

The recommended location for mounting the fire extinguisher is on the platform behind the cab.

If the fire extinguisher is mounted on the ROPS, strap the mounting plate to a leg of the ROPS. If the weight of the fire extinguisher is more than 4.5 kg (10 lb), mount the fire extinguisher as low as possible on one leg. Do not mount the fire extinguisher on the upper one-third area of the leg.

Note: Do not weld the ROPS in order to install the fire extinguisher. Also, do not drill holes in the ROPS in order to mount the fire extinguisher on the ROPS.

i06164462

Tire Information

SMCS Code: 7000

Explosions of air inflated tires have resulted from heat-induced gas combustion inside the tires. Explosions can be caused by heat that is generated by welding, by heating rim components, by external fire, or by excessive use of brakes.

A tire explosion is much more violent than a blowout. The explosion can propel the tire, the rim components, and the axle components from the machine. Stay out of the trajectory path. Both the force of the explosion and the flying debris can cause property damage, personal injury, or death.

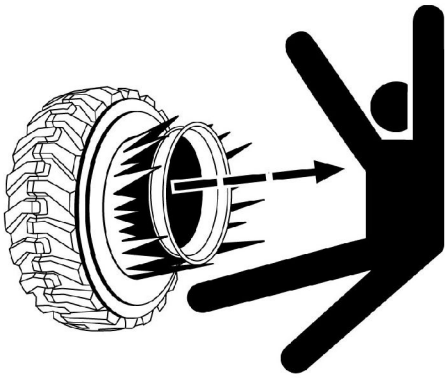


Illustration 25 g02166933

Typical example of tire is shown

Do not approach a hot or an apparently damaged tire.

Caterpillar recommends against using water or calcium as a ballast for the tires except in machines designed for this additional mass. For those applicable machines, the maintenance section will contain instructions on the correct tire inflation and filling procedures. Ballast, such as fluid in the tires, increases overall machine weight and may affect braking, steering, power train components, or the certification of the protective structure such as the ROPS. The use of tire/rim rust preventatives or other liquid additives is not required.

⚠ WARNING

Proper nitrogen inflation equipment, and training in using the equipment, are necessary to avoid over inflation. A tire blowout or rim failure can result from improper or misused equipment and personal injury or death can occur.

A tire blowout and/or rim failure can occur if the inflation equipment is not used correctly, due to the fact that a fully charged nitrogen cylinder's pressure is approximately 15000 kPa (2200 psi).

Dry nitrogen gas is recommended for inflation of tires. If the tires were originally inflated with air, nitrogen is still preferred for adjusting the pressure. Nitrogen mixes properly with air.

Nitrogen inflated tires reduce the potential of a tire explosion because nitrogen does not aid combustion. Nitrogen helps to prevent oxidation of the rubber, deterioration of rubber, and corrosion of rim components.

To avoid overinflation, proper nitrogen inflation equipment and training in the usage of the equipment are necessary. A tire blowout or a rim failure can result from improper equipment or from misused equipment.

When you inflate a tire, stand behind the tread and use a self-attaching chuck.

Servicing tires and rims can be dangerous. Only trained personnel that use proper tools and proper procedures should perform this maintenance. If correct procedures are not used for servicing tires and rims, the assemblies could burst with explosive force. This explosive force can cause serious personal injury or death. Carefully obey the specific instructions from your tire dealer.

i01122596

Electrical Storm Injury Prevention

SMCS Code: 7000

When lightning is striking in the vicinity of the machine, the operator should never attempt the following procedures:

- Mount the machine.
- Dismount the machine.

If you are in the operator's station during an electrical storm, stay in the operator's station. If you are on the ground during an electrical storm, stay away from the vicinity of the machine.

i00934890

Before Starting Engine

SMCS Code: 1000; 7000

The steering frame lock must be in the UNLOCKED position in order to steer the machine.

Start the engine only from the operator compartment. Never short across the starter terminals or across the batteries. Shorting could bypass the engine neutral start system. Shorting could also damage the electrical system.

Inspect the condition of the seat belt and the condition of mounting hardware. Replace any parts that are worn or damaged. Regardless of the appearance, replace the seat belt after three years of use. Do not use a seat belt extension on a retractable seat belt.

Adjust the seat so that there is full pedal travel while the operator's back is against the back of the seat.

Make sure that the machine is equipped with a lighting system that is adequate for the job conditions. Make sure that all lights are working properly.

Before you start the engine or before you move the machine, make sure that no one is on the machine, underneath the machine, or around the machine. Make sure that there are no personnel in the area.

i04862936

Visibility Information

SMCS Code: 7000

Before you start the machine, perform a walk-around inspection in order to ensure that there are no hazards around the machine.

While the machine is in operation, constantly survey the area around the machine in order to identify potential hazards as hazards become visible around the machine.

Your machine may be equipped with visual aids. Some examples of visual aids are Closed Circuit Television (CCTV) and mirrors. Before operating the machine, ensure that the visual aids are in proper working condition and that the visual aids are clean. Adjust the visual aids using the procedures that are located in this Operation and Maintenance Manual. If equipped, the Work Area Vision System shall be adjusted according to Operation and Maintenance Manual, SEBU8157, “Work Area Vision System”. If equipped, the Cat Detect Object Detection shall be adjusted according to the Operation and Maintenance Manual, “Cat Detect Object Detection” for your machine.

It may not be possible to provide direct visibility on large machines to all areas around the machine. Appropriate job site organization is required in order to minimize hazards that are caused by restricted visibility. Job site organization is a collection of rules and procedures that coordinates machines and people that work together in the same area. Examples of job site organization include the following:

- Safety instructions
- Controlled patterns of machine movement and vehicle movement
- Workers that direct safe movement of traffic
- Restricted areas
- Operator training
- Warning symbols or warning signs on machines or on vehicles
- A system of communication
- Communication between workers and operators prior to approaching the machine

Modifications of the machine configuration by the user that result in a restriction of visibility shall be evaluated.

i03687975

Restricted Visibility

SMCS Code: 7000

The size and the configuration of this machine may result in areas that can not be seen when the operator is seated. Illustration 26 provides an approximate visual indication of areas of significant restricted visibility. Illustration 26 indicates restricted visibility areas at ground level inside a radius of 12 m (40 ft) from the operator on a machine without the use of optional visual aids. This illustration does not provide areas of restricted visibility for distances outside a radius of 12 m (40 ft).

This machine may be equipped with optional visual aids that may provide visibility to some of the restricted visibility areas. Refer to this Operation and Maintenance Manual, “Mirror” for more information on additional visibility. If your machine is equipped with cameras, refer to this Operation and Maintenance Manual, “Camera” for more information on additional visibility. For areas that are not covered by the optional visual aids, the job site organization must be utilized to minimize hazards of this restricted visibility. For more information regarding job site organization refer to Operation and Maintenance Manual, “Visibility Information”.

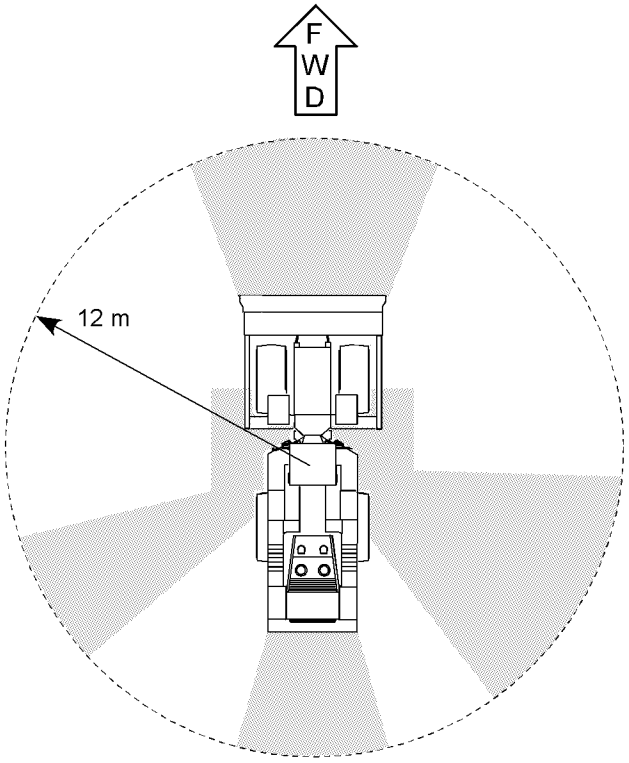


Illustration 26 g01983387

Top view of a typical wheel dozer.

Note: The shaded areas indicate the approximate location of areas with significant restricted visibility.

i03690423

Engine Starting

SMCS Code: 1000; 7000

If a warning tag is attached to the engine start switch or to the controls, do not start the engine and do not move any controls.

Move all hydraulic controls to the HOLD position before you start the engine.

Move the transmission control to the NEUTRAL position.

Engage the parking brake.

Diesel engine exhaust contains products of combustion which can be harmful to your health. Always operate the engine in a well ventilated area. If you are in an enclosed area, vent the exhaust to the outside.

Briefly sound the horn before you start the engine.

Check for the presence of personnel. Ensure that all personnel are clear of the machine.

i07012438

Before Operation

SMCS Code: 7000

Make sure that there are no personnel on the machine or in the area around the machine.

Clear all obstacles from the path of the machine. Beware of hazards such as wires, ditches, etc.

Make sure that all windows are clean. Secure the doors and the windows in the open position or in the shut position.

Adjust the rear view mirrors (if equipped) for the best vision of the area near the machine.

Ensure that the horn, the backup alarm (if equipped), quick coupler alarm (if equipped), and all other warning devices are working properly.

Fasten the seat belt securely.

i02039052

Operation

SMCS Code: 7000

Machine Operating Temperature Range

The standard machine configuration is intended for use within an ambient temperature range of −40 °C (−40 °F) to 50 °C (122 °F). Special configurations for different ambient temperatures may be available. Consult your Caterpillar dealer for additional information on special configurations of your machine.

Operation

Only operate the machine while you are in a seat. The seat belt must be fastened while you operate the machine. Only operate the controls while the engine is running.

Check for proper operation of all controls and protective devices while you operate the machine slowly in an open area.

Before you move the machine, make sure that no one will be endangered.

Do not allow riders on the machine unless the machine has the following equipment:

- additional seat
- additional seat belt
- Rollover Protective Structure (ROPS)

Report any needed repairs that were noted during operation.

Carry attachments close to the ground, approximately 40 cm (15 inches) higher than ground level. Do not go close to the edge of a cliff, an excavation, or an overhang.

If the machine begins to sideslip, perform the following procedure:

- Discard the load.
- Turn the machine downhill.

Be careful to avoid any condition which could lead to tipping. Tipping can occur when you work on hills, banks and slopes. Also, tipping can occur when you cross ditches, ridges or other unexpected obstructions.

Whenever it is possible, operate the machine up the slopes and down the slopes. Avoid operating the machine across the slope, when possible.

Keep the machine under control. Do not overload the machine beyond capacity.

Be sure that the towing devices are adequate.

Never straddle a wire cable or allow other personnel to straddle a wire cable.

Know the maximum dimensions of your machine.

Always keep the Rollover Protective Structure (ROPS) installed during machine operation.

i06299648

Engine Stopping

SMCS Code: 1000; 7000

Do not stop the engine immediately after the machine has been operated under load. Stopping the engine immediately can cause overheating and accelerated wear of engine components.

After the machine is parked and the parking brake is engaged, allow the engine to run at low idle for 5 minutes before shutdown. Running the engine allows hot areas of the engine to cool gradually.

i03907830

Parking

SMCS Code: 7000

Park the machine on a level surface. If you must park the machine on a downgrade, block the tires.

Apply the service brake in order to stop the machine. Move the transmission control to the NEUTRAL position.

Engage the parking brake.

Lower all work tools to the ground. Activate any control locks.

Stop the engine.

Turn the engine start switch to the OFF position and remove the key.

Always turn the battery disconnect switch to the OFF position before leaving the machine.

If the machine will not be operated for a month or more, remove the battery disconnect switch key.

i07378239

Slope Operation

SMCS Code: 7000

Machines that are operating safely in various applications depend on these criteria: the machine model, configuration, machine maintenance, operating speed of the machine, conditions of the terrain, fluid levels, and tire inflation pressures. The most important criteria are the skill and judgment of the operator.

A well trained operator that follows the instructions in the Operation and Maintenance Manual has the greatest impact on stability. Operator training provides a person with the following abilities: observation of working and environmental conditions, feel for the machine, identification of potential hazards and operating the machine safely by making appropriate decisions.

When you work on side hills and when you work on slopes, consider the following important points:

Speed of travel – At higher speeds, forces of inertia tend to make the machine less stable.

Roughness of terrain or surface – The machine may be less stable with uneven terrain.

Direction of travel – Avoid operating the machine across the slope. When possible, operate the machine up the slopes and operate the machine down the slopes. Place the heaviest end of the machine uphill when you are working on an incline.

Mounted equipment – Balance of the machine may be impeded by the following components: equipment that is mounted on the machine, machine configuration, weights, and counterweights.

Nature of surface – Ground that has been newly filled with earth may collapse from the weight of the machine.

Surface material – Rocks and moisture of the surface material may drastically affect the machine's traction and machine's stability. Rocky surfaces may promote side slipping of the machine.

Slippage due to excessive loads – This may cause downhill tracks or downhill tires to dig into the ground, which will increase the angle of the machine.

Width of tracks or tires – Narrower tracks or narrower tires further increase the digging into the ground which causes the machine to be less stable.

Implements attached to the drawbar – This may decrease the weight on the uphill tracks. This may also decrease the weight on the uphill tires. The decreased weight will cause the machine to be less stable.

Height of the working load of the machine – When the working loads are in higher positions, the stability of the machine is reduced.

Operated equipment – Be aware of performance features of the equipment in operation and the effects on machine stability.

Operating techniques – Keep all attachments or pulled loads low to the ground for optimum stability.

Machine systems have limitations on slopes – Slopes can affect the proper function and operation of the various machine systems. These machine systems are needed for machine control.

Note: Operators with lots of experience and proper equipment for specific applications are also required. Safe operation on steep slopes may also require special machine maintenance. Refer to Lubricant Viscosities and Refill Capacities in this manual for the proper fluid level requirements and intended machine use. Fluids must be at the correct levels to ensure that systems will operate properly on a slope.

i01329161

Equipment Lowering with Engine Stopped

SMCS Code: 7000

Before lowering any equipment with the engine stopped, clear the area around the equipment of all personnel. The procedure to use will vary with the type of equipment to be lowered. Keep in mind most systems use a high pressure fluid or air to raise or lower equipment. The procedure will cause high pressure air, hydraulic, or some other media to be released in order to lower the equipment. Wear appropriate personal protective equipment and follow the established procedure in the Operation and Maintenance Manual, “Equipment Lowering with Engine Stopped” in the Operation Section of the manual.

i03306267

Sound Information and Vibration Information

SMCS Code: 7000

Sound Level Information

The operator Equivalent Sound Pressure Level (Leq) is 75 dB(A) when “ANSI/SAE J1166 OCT 98” is used to measure the value for an enclosed cab. This is a work cycle sound exposure level. The cab was properly installed and maintained. The test was conducted with the cab doors and the cab windows closed.

Hearing protection may be needed when the machine is operated with an open operator station for extended periods or in a noisy environment. Hearing protection may be needed when the machine is operated with a cab that is not properly maintained.

The average exterior sound pressure level is 82 dB (A) when the “SAE J88Apr95 - Constant Speed Moving Test” procedure is used to measure the value for the standard machine. The measurement was conducted under the following conditions: distance of 15 m (49.2 ft) and “the machine moving forward in an intermediate gear ratio”.

Sound Level Information for Machines in European Union Countries and in Countries that Adopt the “EU Directives”

The dynamic operator sound pressure level is 74 dB (A) when “ISO 6396:1992” is used to measure the value for an enclosed cab. The cab was properly installed and maintained. The test was conducted with the cab doors and the cab windows closed.

“The European Union Physical Agents (Vibration) Directive 2002/44/EC”

Vibration Data for Wheel Loaders

Information Concerning Hand/Arm Vibration Level

When the machine is operated according to the intended use, the hand/arm vibration of this machine is below 2.5 meter per second squared.

Information Concerning Whole Body Vibration Level

This section provides vibration data and a method for estimating the vibration level for wheel loaders.

Note: Vibration levels are influenced by many different parameters. Many items are listed below.

- Operator training, behavior, mode and stress
- Job site organization, preparation, environment, weather and material
- Machine type, quality of the seat, quality of the suspension system, attachments and condition of the equipment

It is not possible to get precise vibration levels for this machine. The expected vibration levels can be estimated with the information in Table 1 in order to calculate the daily vibration exposure. A simple evaluation of the machine application can be used.

Estimate the vibration levels for the three vibration directions. For typical operating conditions, use the average vibration levels as the estimated level. With an experienced operator and smooth terrain, subtract the Scenario Factors from the average vibration level in order to obtain the estimated vibration level. For aggressive operations and severe terrain, add the Scenario Factors to the average vibration level in order to obtain the estimated vibration level.

Note: All vibration levels are in meter per second squared.

Table 1

“ISO Reference Table A - Equivalent vibration levels of whole body vibration emission for earthmoving equipment.”							
Machine Type	**Typical Operating Activity**	**Vibration Levels**			**Scenario Factors**		
		X axis	**Y axis**	**Z axis**	**X axis**	**Y axis**	**Z axis**
Wheel Loader	load and carry motion	0,84	0,81	0,52	0,23	0,20	0,14
	mining application(1)	1,27	0,97	0,81	0,47	0,31	0,47
	transfer(2)	0,76	0,91	0,49	0,33	0,35	0,17
	V-shape motion(3)	0,99	0,84	0,54	0,29	0,32	0,14

(1) Loading at the face
(2) Travel at high speed on the job site or on public roads
(3) Loading a truck in short cycles

Note: Refer to “ISO/TR 25398 Mechanical Vibration - Guideline for the assessment of exposure to whole body vibration of ride on operated earthmoving machines” for more information about vibration. This publication uses data that is measured by international institutes, organizations and manufacturers. This document provides information about the whole body exposure of operators of earthmoving equipment. Refer to Operation and Maintenance Manual Supplement , SEBU8257 for more information about machine vibration levels.

The Caterpillar suspension seat meets the criteria of “ISO 7096”. This represents vertical vibration level under severe operating conditions. This seat is tested with the input “spectral class EM5”. The seat has a transmissibility factor of “SEAT<0.7”.

The whole body vibration level of the machine varies. There is a range of values. The low value is 0.5 meter per second squared. The machine meets the short term level for the design of the seat in “ISO 7096”. The value is 1.13 meter per second squared for this machine.

Guidelines for Reducing Vibration Levels on Earthmoving Equipment

Properly adjust machines. Properly maintain machines. Operate machines smoothly. Maintain the conditions of the terrain. The following guidelines can help reduce the whole body vibration level:

1. Use the right type and size of machine, equipment, and attachments.

2. Maintain machines according to the manufacturer's recommendations.

a. Tire pressures

b. Brake and steering systems

c. Controls, hydraulic system and linkages

3. Keep the terrain in good condition.

a. Remove any large rocks or obstacles.

b. Fill any ditches and holes.

c. Provide machines and schedule time in order to maintain the conditions of the terrain.

4. Use a seat that meets “ISO 7096”. Keep the seat maintained and adjusted.

a. Adjust the seat and suspension for the weight and the size of the operator.

b. Inspect and maintain the seat suspension and adjustment mechanisms.

5. Perform the following operations smoothly.

a. Steer

b. Brake

c. Accelerate.

d. Shift the gears.

6. Move the attachments smoothly.

7. Adjust the machine speed and the route in order to minimize the vibration level.

a. Drive around obstacles and rough terrain.

b. Slow down when it is necessary to go over rough terrain.

8. Minimize vibrations for a long work cycle or a long travel distance.

a. Use machines that are equipped with suspension systems.

b. Use the ride control system on wheel loaders.

c. If no ride control system is available, reduce speed in order to prevent bounce.

d. Haul the machines between workplaces.

9. Less operator comfort may be caused by other risk factors. The following guidelines can be effective in order to provide better operator comfort:

a. Adjust the seat and adjust the controls in order to achieve good posture.

b. Adjust the mirrors in order to minimize twisted posture.

c. Provide breaks in order to reduce long periods of sitting.

d. Avoid jumping from the cab.

e. Minimize repeated handling of loads and lifting of loads.

f. Minimize any shocks and impacts during sports and leisure activities.

Sources

The vibration information and the calculation procedure is based on “ISO/TR 25398 Mechanical Vibration - Guideline for the assessment of exposure to whole body vibration of ride on operated earthmoving machines”. Harmonized data is measured by international institutes, organizations and manufacturers.

This literature provides information about assessing the whole body vibration exposure of operators of earthmoving equipment. The method is based on measured vibration emission under real working conditions for all machines.

You should check the original directive. This document summarizes part of the content of the applicable law. This document is not meant to substitute the original sources. Other parts of these documents are based on information from the United Kingdom Health and Safety Executive.

Refer to Operation and Maintenance Manual Supplement , SEBU8257 for more information about vibration.

Consult your local Caterpillar dealer for more information about machine features that minimize vibration levels. Consult your local Caterpillar dealer about safe machine operation.

Use the following web site in order to find your local dealer:

Caterpillar, Inc.
www.cat.com

i07199012

Operator Station

SMCS Code: 7000

Any modifications to the inside of the operator station should not project into the operator space or into the space for the companion seat (if equipped). The addition of a radio, fire extinguisher, and other equipment must be installed so that the defined operator space and the space for the companion seat (if equipped) is maintained. Any item that is brought into the cab should not project into the defined operator space or the space for the companion seat (if equipped). A lunch box or other loose items must be secured. Objects must not pose an impact hazard in rough terrain or in the event of a rollover.

Product Information Section

General Information

i03652829

Specifications

SMCS Code: 7000

Intended Use

This machine is classified as a Wheel Dozer as described in “ISO 6165:2001”. This machine normally has a front attachment for dozing or another work tool for the principal intended functions of cutting, grading, and moving material such as earth, crushed rock or gravel.

Application/Configuration Restrictions

Refer to “Machine Data” below for information about maximum machine weight.

The maximum fore and aft slope for proper lubrication is 25 degrees continuous and 35 degrees intermittent.

This machine is approved for use in environments with no explosive gases.

Machine Data

This machine is equipped with a 3516B Engine.

Table 2

844H Wheel Dozer	
Approximate Weight	74079 kg (163316 lb)
Maximum Length	11941 mm (470 inch)
Width Across Tires	4152 mm (164 inch)
Height to Top of ROPS	5067 mm (200 inch)

Identification Information

i03652793

Plate Locations and Film Locations

SMCS Code: 1000; 7000

The Product Identification Number (PIN) is used to identify a powered machine that is designed for an operator to ride.

Caterpillar products such as engines, transmissions and major attachments that are not designed for an operator to ride are identified by Serial Numbers.

For quick reference, record the identification numbers in the spaces that are provided below the illustration.

Product Identification Number (PIN) and CE Plate

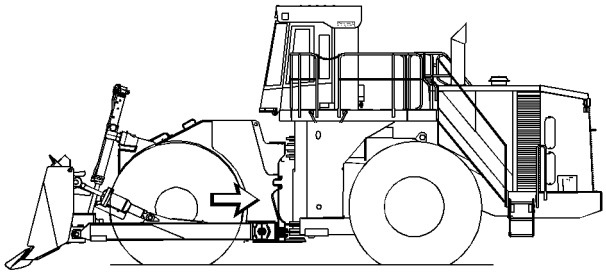


Illustration 27 g01055829

This plate is located on the left side of the front loader frame.

Machine PIN_____

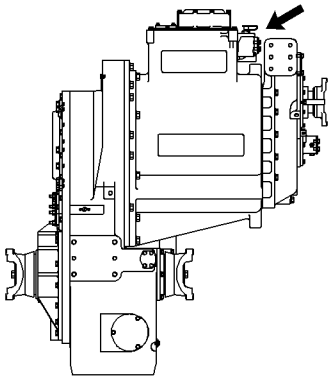


Illustration 28 g00940370

This plate is located on the transfer gear case.

Transmission Serial Number_____

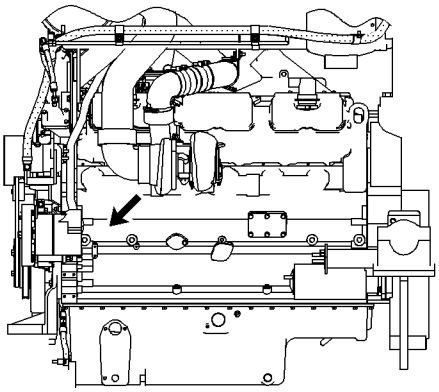


Illustration 29 g00941911

This plate is located on the top of the engine.

Engine Serial Number_____

European Union

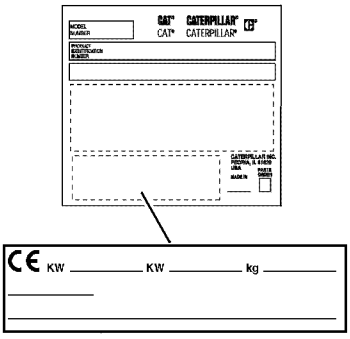


Illustration 30 g01880193

This plate is positioned on the bottom left side of the plate for the PIN.

Note: The CE plate is on machines that are certified to the European Union requirements that were effective at that time.

For machines compliant to 2006/42/EC, the following information is stamped onto the CE plate. For quick reference, record this information in the spaces that are provided below.

- Engine Power Primary Engine (kW)_____
- Engine Power for Additional Engine (If Equipped) _____
- Typical Machine Operating Weight for European Market (kg)_____
- Year of Construction_____
- Machine Type _____

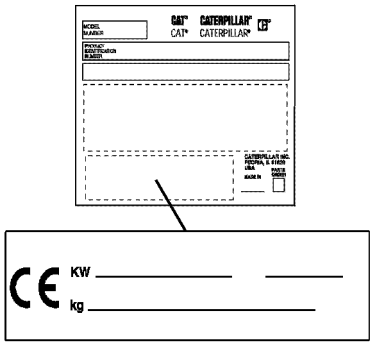


Illustration 31 g01120192

This plate is positioned on the bottom left side of the plate for the PIN.

Note: The CE plate is on machines that are certified to the European Union requirements that were effective at that time.

For machines compliant to 1998/37/EC and 1989/392/EEC, the following information is stamped onto the CE plate. For quick reference, record this information in the spaces that are provided below.

- Engine Power Primary Engine (kW)_____
- Typical Machine Operating Weight for European Market (kg)_____
- Year_____

For the name and address of the manufacturer, and the country of origin of the machine, refer to the PIN plate.

Certification

Sound

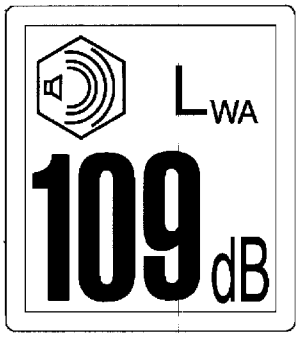


Illustration 32 g00933634

Typical example

If equipped, the film is used to verify the environmental sound certification of the machine. The value that is listed on the film indicates the guaranteed sound level. The guaranteed sound level is measured at the time of manufacture. Refer to Operation and Maintenance Manual, “Sound Information and Vibration Information” for the guaranteed sound level for your machine.

ROPS/FOPS Film

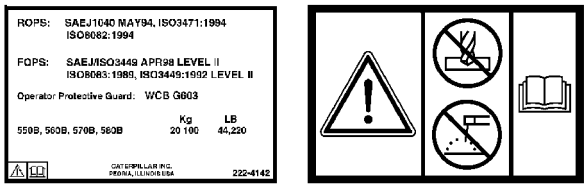


Illustration 33 g00944234

This film is located on the outside of the cab on the left side on the ROPS. This machine has been certified to the standards that are listed on the certification label. The maximum mass of the machine, which includes the operator and the attachments without a payload, should not exceed the mass on the certification label.

i04687649

Emissions Certification Film

SMCS Code: 1000; 7000; 7405

Certification Label for Emissions

Note: This information is pertinent in the United States, in Canada, and in Europe.

Consult your Cat dealer for an Emission Control Warranty Statement.

This label is located on the engine valve cover.

Declaration of Conformity

SMCS Code: 1000; 7000

Table 3

An EC Declaration of Conformity document was provided with the machine if it was manufactured to comply with specific requirements for the European Union. In order to determine the details of the applicable Directives, review the complete EC Declaration of Conformity provided with the machine. The extract shown below from an EC Declaration of Conformity for machines that are declared compliant to “2006/42/EC” applies only to those machines originally “CE” marked by the manufacturer listed and which have not since been modified.

EC DECLARATION OF CONFORMITY OF MACHINERY

Manufacturer: Caterpillar Inc., 100 N.E. Adams Street, Peoria, Illinois 61629, USA

Person authorized to compile the Technical File and to communicate relevant part (s) of the Technical File to the Authorities of European Union Member States on request:

Standards & Regulations Manager,Caterpillar France S.A.S 40,
Avenue Leon-Blum, B.P. 55, 38041 Grenoble Cedex 9, France

I, the undersigned, _____, hereby certify that the construction equipment specified hereunder

Description:	Generic Denomination:	Earth moving Equipment
	Function:	Wheeled Dozer
	Model/Type:	844H Wheel Dozer
	Serial Number:	
	Commercial Name:	Caterpillar

Fulfils all the relevant provisions of the following Directives

Directives	Notified Body	Document No.
2006/42/EC	N/A	
2000/14/EC amended by 2005/88/EC, Note (1)		
2004/108/EC	N/A	

Note (1) Annex -_____ Guaranteed Sound Power Level -____dB (A)
Representative Equipment Type Sound Power Level - ____dB (A)
Engine Power per ____-____ kW Rated engine speed - ____ rpm
Technical Documentation accessible through person listed above authorized to compile the Technical File

Done at: **Signature**

Date: **Name/Position**

Note: The above information was correct as of July 2009, but may be subject to change, please refer to the individual declaration of conformity issued with the machine for exact details.

Operation Section

Before Operation

i04021647

Mounting and Dismounting

SMCS Code: 7000

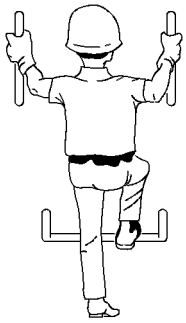


Illustration 34 g00037860
Typical example

Mount the machine and dismount the machine only at locations that have steps and/or handholds. Before you mount the machine, clean the steps and the handholds. Inspect the steps and handholds. Make all necessary repairs.

Face the machine whenever you get on the machine and whenever you get off the machine.

Maintain a three-point contact with the steps and with the handholds.

Note: Three-point contact can be two feet and one hand. Three-point contact can also be one foot and two hands.

Do not mount a moving machine. Do not dismount a moving machine. Never jump off the machine. Do not carry tools or supplies when you try to mount the machine or when you try to dismount the machine. Use a hand line to pull equipment onto the platform. Do not use any controls as handholds when you enter the operator compartment or when you exit the operator compartment.

Machine Access System Specifications

The machine access system has been designed to meet the intent of the technical requirements in “ISO 2867 Earth-moving Machinery – Access Systems”. The access system provides for operator access to the operator station and to conduct the maintenance procedures described in Maintenance section.

Alternate Exit

Machines that are equipped with cabs have alternate exits. For additional information, see Operation and Maintenance Manual, “Alternate Exit”.

i01830479

Daily Inspection

SMCS Code: 1000; 7000

For a maximum service life of the machine, complete a thorough walk-around inspection before you mount the machine and before you start the engine.

Inspect the area around the machine and under the machine. Look for loose bolts, trash buildup, oil, coolant leakage, broken parts, or worn parts.

Note: Watch closely for leaks. If you observe a leak, find the source of the leak and correct the leak. If you suspect a leak, check the fluid levels more frequently.

Inspect the condition of the equipment and of the hydraulic components.

Check the condition of the tires. Adjust the inflation pressure, if necessary.

Remove any trash buildup and debris. Make all necessary repairs before you operate the machine.

Make sure that all covers and guards are securely attached.

Adjust the mirrors for the correct rear view of the machine.

Make sure that the engine air filter service indicator is not in the red zone.

Grease all of the fittings that need to be serviced on a daily basis.

Perform the daily procedures that are applicable to your machine:

- Operation and Maintenance Manual, “Backup Alarm - Test”
- Operation and Maintenance Manual, “Bucket Control and Linkage - Lubricate”

- Operation and Maintenance Manual, “Bucket Cutting Edges - Inspect/Replace”
- Operation and Maintenance Manual, “Bucket Lower Pivot Bearings- Lubricate”
- Operation and Maintenance Manual, “Bucket Tips - Inspect/Replace”
- Operation and Maintenance Manual, “Cooling System Level - Check”
- Operation and Maintenance Manual, “Engine Air Filter Service Indicator - Check”
- Operation and Maintenance Manual, “Engine Oil Level - Check”
- Operation and Maintenance Manual, “Hydraulic System Oil Level (Implement and Braking) - Check”
- Operation and Maintenance Manual, “Hydraulic System Oil Level (Steering and Hydraulic Fan) - Check”
- Operation and Maintenance Manual, “Seat Belt - Inspect”
- Operation and Maintenance Manual, “Transmission Oil Level - Check”
- Operation and Maintenance Manual, “Windows - Clean”

i01851244

Steering Frame Lock

SMCS Code: 7506

WARNING

No clearance for person in this area when machine turns. Severe injury or death from crushing could occur.

Note: The machine must be in the straight ahead position in order to connect the steering frame lock.

The steering frame lock is located at the articulation joint on the right side of the machine.

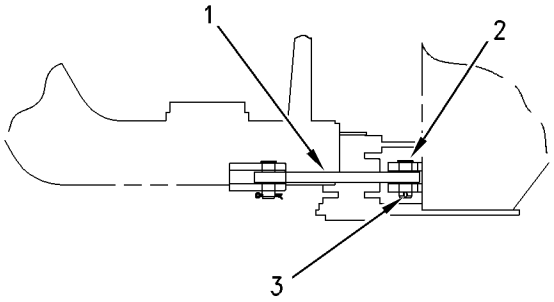


Illustration 35 g00943056

Connect steering frame lock (1) when the machine is being lifted and when the machine is being transported. Also connect the steering frame lock if you are performing service work near the articulation joint. Install pin (2) and secure the pin with locking pin (3).

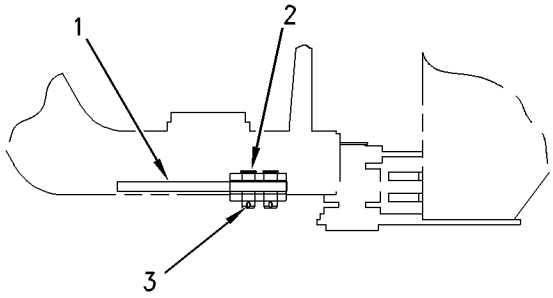


Illustration 36 g00943061

Separate steering frame lock (1) before the machine is operated.

Move the steering frame lock to the front frame and install pin (2). Secure the pin with locking pin (3).

Machine Operation

i02060850

Alternate Exit

SMCS Code: 7310

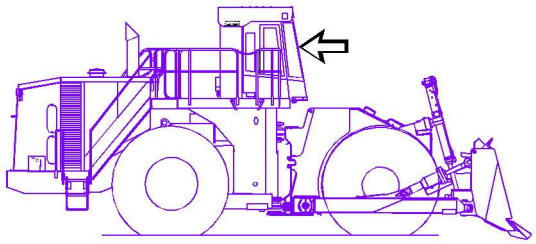


Illustration 37 g01056320

The right cab window can be used as an alternate exit. The window can be opened from the inside of the cab. Release the latch in order to open the window.

If you use the alternate exit, maintain three points of contact with the machine at all times. Three-point contact can be two feet and one hand. Three-point contact can also be one foot and two hands.

i01851303

Seat

SMCS Code: 7312

Note: The operator's seat that is provided with this machine is in compliance with the appropriate class of ISO 7096.

Adjust the seat in order to allow full travel of the pedals. Make the seat adjustments when the operator is sitting against the back of the seat.

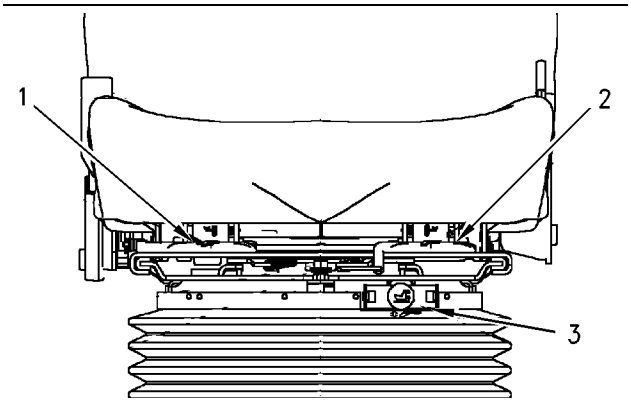


Illustration 38 g00943089

Backrest Cushion Angle (1) – Pull the lever upward. Hold the lever upward and adjust the backrest cushion to the desired angle. Release the lever in order to lock the backrest cushion into position.

Fore and Aft Position (2) – Pull the lever upward. Hold the lever upward and slide the seat forward or backward to the desired position. Release the lever in order to lock the seat into position.

Seat Height (3) – Pull the lever upward. Hold the lever upward and move the seat to the desired height. Release the lever in order to lock the seat into position.

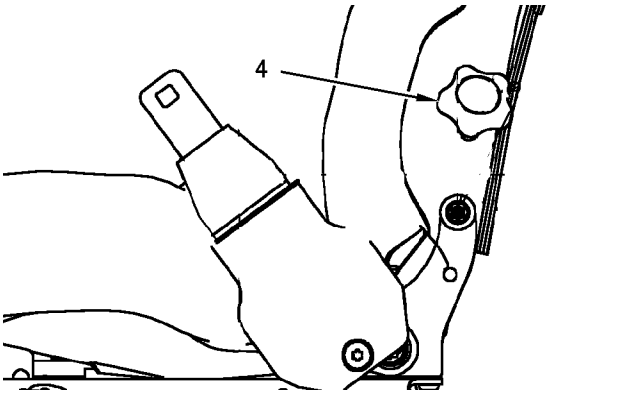


Illustration 39 g00943092

Lumbar Support (4) – Push the lever backward in order to increase support to the lower back. Pull the lever forward in order to decrease support to the lower back. Release the lever in order to lock the seat into position.

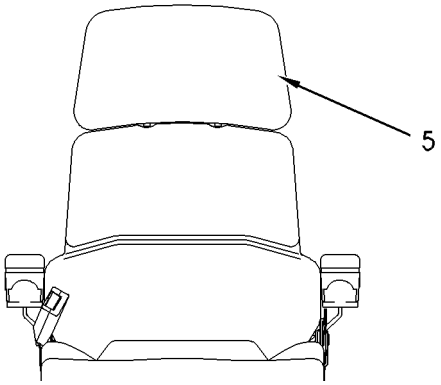


Illustration 40 g00847660

Pull up on the backrest in order to remove extension (5).

i04200349

Seat Belt

SMCS Code: 7327

Note: This machine was equipped with a seat belt when the machine was shipped from Caterpillar. At the time of installation, the seat belt and the instructions for installation of the seat belt meet the SAE J386 and ISO 6683 standards. Consult your Cat dealer for all replacement parts.

Always check the condition of the seat belt and the condition of the mounting hardware before you operate the machine.

Seat Belt Adjustment for Non-Retractable Seat Belts

Adjust both ends of the seat belt. The seat belt should be snug but comfortable.

Lengthening the Seat Belt

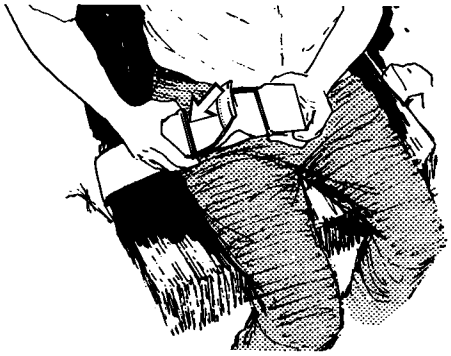


Illustration 41 g00100709

1. Unfasten the seat belt.

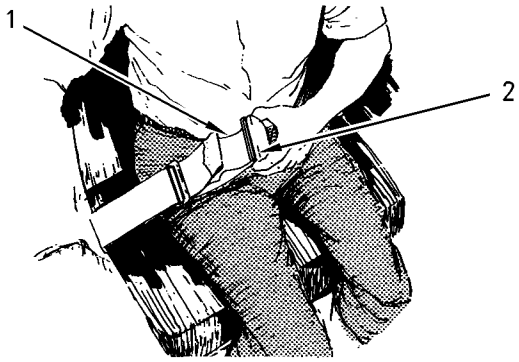


Illustration 42 g00932817

2. To remove the slack in outer loop (1), rotate buckle (2). This will free the lock bar. This permits the seat belt to move through the buckle.

3. Remove the slack from the outer belt loop by pulling on the buckle.

4. Loosen the other half of the seat belt in the same manner. If the seat belt does not fit snugly with the buckle in the center, readjust the seat belt.

Shortening the Seat Belt



Illustration 43 g00100713

1. Fasten the seat belt. Pull out on the outer belt loop in order to tighten the seat belt.

2. Adjust the other half of the seat belt in the same manner.

3. If the seat belt does not fit snugly with the buckle in the center, readjust the seat belt.

Fastening The Seat Belt

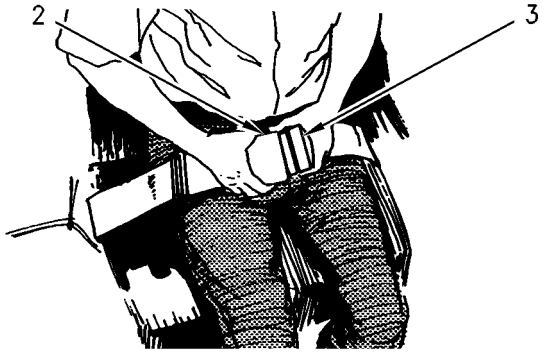


Illustration 44 g00932818

Fasten the seat belt catch (3) into the buckle (2). Make sure that the seat belt is placed low across the lap of the operator.

Releasing The Seat Belt

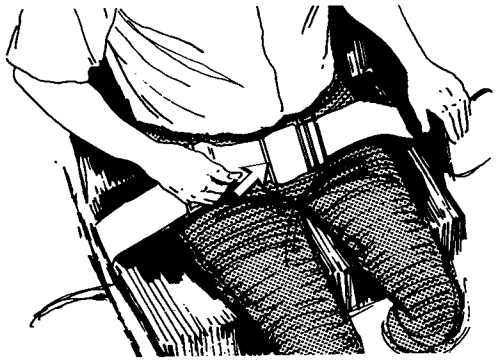


Illustration 45 g00100717

Pull up on the release lever. This will release the seat belt.

Seat Belt Adjustment for Retractable Seat Belts

Fastening The Seat Belt

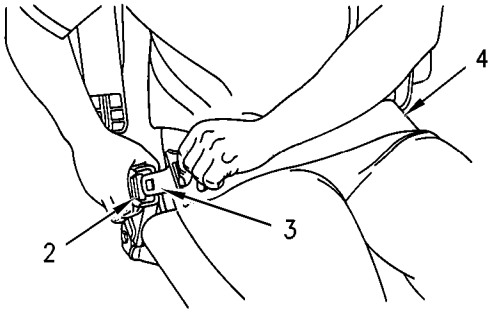


Illustration 46 g00867598

Pull seat belt (4) out of the retractor in a continuous motion.

Fasten seat belt catch (3) into buckle (2). Make sure that the seat belt is placed low across the lap of the operator.

The retractor will adjust the belt length and the retractor will lock in place. The comfort ride sleeve will allow the operator to have limited movement.

Releasing The Seat Belt

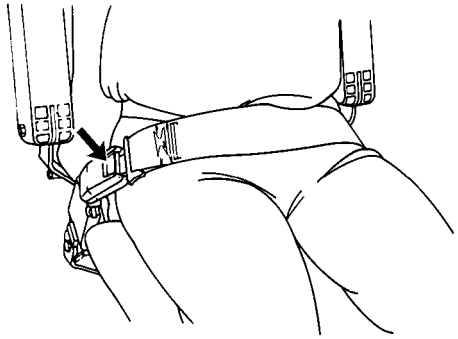


Illustration 47 g00039113

Push the release button on the buckle in order to release the seat belt. The seat belt will automatically retract into the retractor.

Extension of the Seat Belt

⚠ WARNING

When using retractable seat belts, do not use seat belt extensions, or personal injury or death can result.

The retractor system may or may not lock up depending on the length of the extension and the size of the person. If the retractor does not lock up, the seat belt will not retain the person.

Longer, non-retractable seat belts and extensions for the non-retractable seat belts are available.

Caterpillar requires only non-retractable seat belts to be used with a seat belt extension.

Consult your Cat dealer for longer seat belts and for information on extending the seat belts.

i04460905

Mirror

SMCS Code: 7319

⚠ WARNING

Adjust all mirrors as specified in the Operation and Maintenance Manual. Failure to heed this warning can lead to personal injury or death.

⚠ WARNING

Slips and falls can result in personal injury. Use the machine's access systems when adjusting the mirrors. If the mirrors cannot be reached using the machine access systems follow the instructions found within the Operation and Maintenance Manual, "Mirror" in order to access the mirrors.

Note: Your machine may not be equipped with all of the mirrors that are described in this topic.

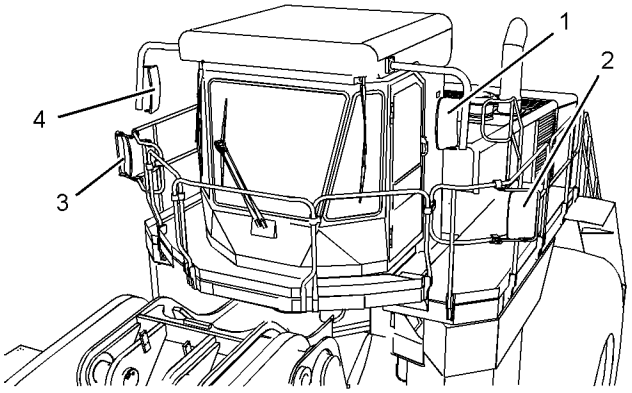


Illustration 48 g01586417

(1) Upper left side rear view mirror
(2) Lower left side rear view mirror
(3) Lower right side rear view mirror
(4) Upper right side rear view mirror

Mirrors provide additional visibility around your machine. Make sure that the mirrors are in proper working condition and that the mirrors are clean. Adjust all mirrors at the beginning of each work period and adjust the mirrors when you change operators.

Modified Machines or machines that have additional equipment or attachments may influence your visibility.

Mirror Adjustment

- Park the machine on a level surface.
- Stop the engine.

Hand tools will be needed in order to adjust the mirrors. Refer to Specifications, SENR3130, "Torque Specifications" for the recommended torque.

Left Side Rear View Mirrors

Upper Left Side Rear View Mirror

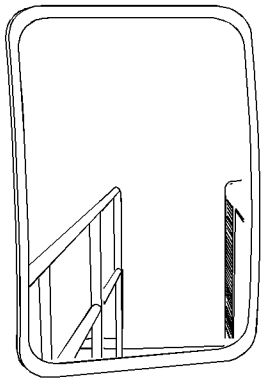


Illustration 49 g01603374

Adjust the mirror (1) so that the engine enclosure is visible from the operator seat. Additionally, adjust the mirror so that the stairs are visible in the center of the mirror. Additionally, provide as much visibility to the rear as possible.

Lower Left Side Rear View Mirror

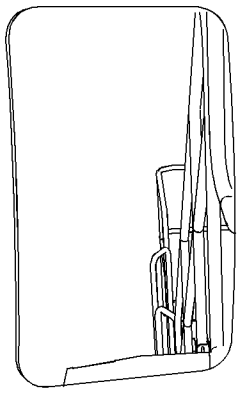


Illustration 50 g01592392

If equipped, adjust the mirror (2) so that the handrails of the platform are visible from the operator seat. Additionally, provide as much visibility to the rear as possible.

Note: Ensure that the mirror is mounted at the outermost end of the handrail.

Right Side Rear View Mirrors

Upper Right Side Rear View Mirror

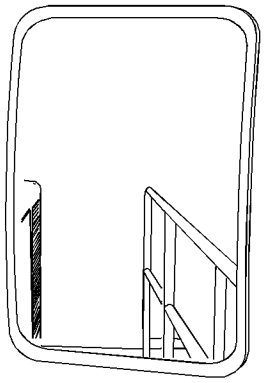


Illustration 51 g01603377

Adjust the mirror (4) so that the engine enclosure is visible from the operator seat. Additionally, adjust the mirror so that the stairs are visible in the center of the mirror. Additionally, provide as much visibility to the rear as possible.

Lower Right Side Rear View Mirror

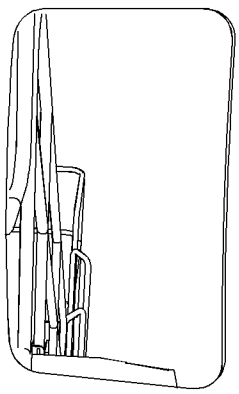


Illustration 52 g01603375

If equipped, adjust the mirror (3) so that the handrails of the platform are visible from the operator seat. Additionally, provide as much visibility to the rear as possible.

Note: Ensure that the mirror is mounted at the outermost end of the handrail.

i03711665

Operator Controls

SMCS Code: 7300; 7301; 7451

Note: Your machine may not be equipped with all of the controls that are discussed in this topic.

The operation section is a reference for the new operator and a refresher for the experienced operator. This section includes descriptions of gauges, switches, machine controls, attachment controls, transportation, and towing information.

Illustrations guide the operator through correct procedures of checking, starting, operating, and stopping the machine. Operating techniques that are outlined in this publication are basic. Skill and techniques develop as the operator gains knowledge of the machine and the capabilities of the machine.

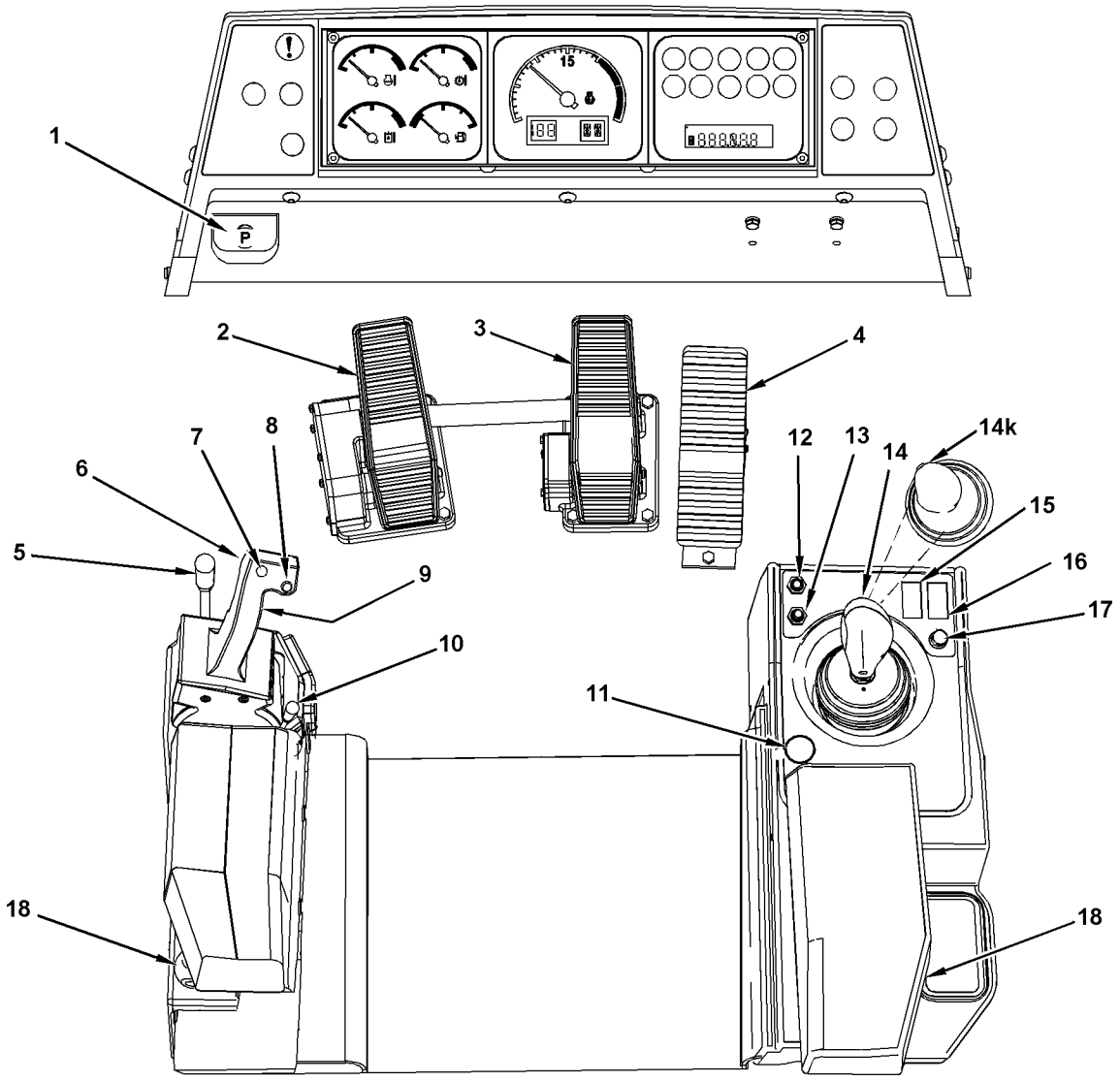


Illustration 53 g01675113

(1) Parking brake knob
(2) Left brake pedal and impeller clutch
(3) Right brake pedal
(4) Throttle control
(5) STIC control lock
(6) STIC steering control
(7) Upshift switch
(8) Downshift switch
(9) Direction control switch
(10) Steering console adjustment
(11) Adjustment for implement console
(12) Set/Decel switch
(13) Resume/Accel switch
(14) Blade control lever
(14k) Blade tip control (button)
(15) Implement lockout switch
(16) Dual tilt control
(17) Horn
(18) Armrest adjustment knobs

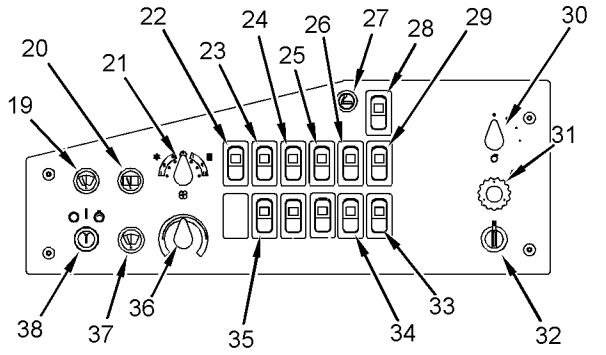


Illustration 54 g01215430

Right side instrument panel

(19) Front window wiper switch
(20) Rear window wiper switch
(21) Heating and air conditioning switch
(22) Mode switch for Engine Monitoring System (EMS)
(23) Torque converter lockup switch
(24) Quickshift switch
(25) HID light switch
(26) Front floodlight switch
(27) 12 Volt cigar lighter
(28) Rotating beacon
(29) Rear floodlight switch
(30) Reduced rimpull select switch
(31) Diagnostic connector
(32) 12 Volt power supply
(33) Stairway access light switch
(34) Running light switch
(35) Throttle lock switch
(36) Temperature control
(37) Window wiper switch for the quarter panel
(38) Engine start switch

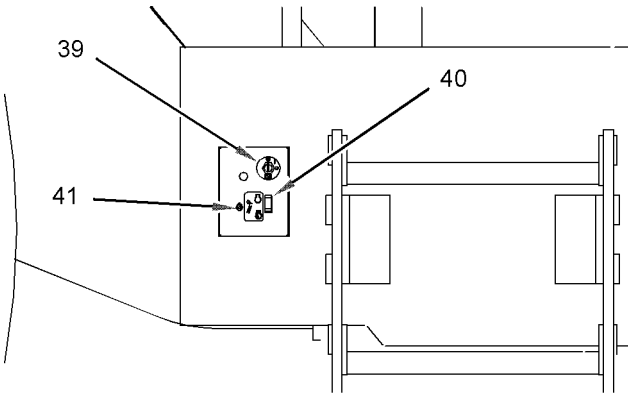


Illustration 55 g01057452

Left side bumper

(39) Battery disconnect switch
(40) Engine shutdown control
(41) Stairway access light switch

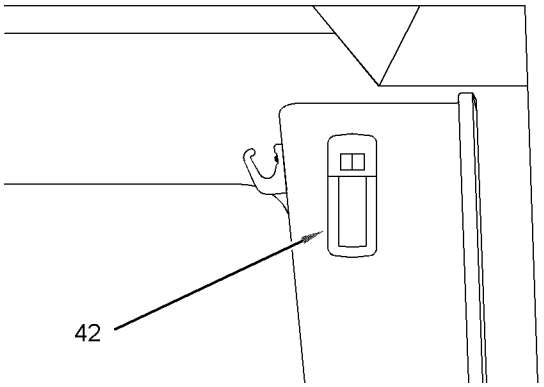


Illustration 56 g01057455

(42) Interior dome light

The following information briefly identifies the components of the cab.

Parking Brake (1)

Parking Brake – Engage the parking brake after the machine has been stopped. Use the parking brake if the service brakes fail to stop the machine.

Pull the knob outward in order to apply the parking brake. Push the knob inward in order to release the parking brake.

Left Brake Pedal and Impeller Clutch (2)

The left brake pedal controls both the brake pressure and the impeller clutch pressure. Partially depress the left brake pedal in order to reduce the impeller clutch pressure. The brake pressure is increased as the operator pushes down the pedal farther. This feature allows the operator to control the maximum drive train torque. Lowering the maximum drive train torque supplies more engine power to the implements and to the steering.

When the operator is digging, the left brake pedal can be used to stop any excessive tire slip.

Note: Calibration of the left brake pedal is necessary in order to compensate for normal mechanical wear. Refer to Systems Operation/Testing and Adjusting, SENR1372, “Transmission Electronic Control System” for information about calibrating the left brake pedal.

Right Brake Pedal (3)

The right brake pedal decelerates the machine. Depress the brake pedal for normal braking of the machine. Release the pedal in order to release the brake.

Throttle Control (4)

The throttle control is mounted on the floor of the operator's compartment. Depress the throttle control in order to increase the engine speed. Release the throttle control in order to decrease the engine speed.

STIC Control Lock (5)

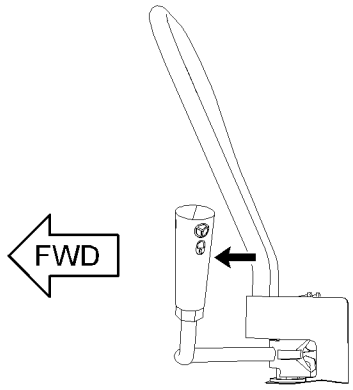


Illustration 57 g01318569

Steering

Lock

Move the lock lever to the left and to the rear in order to lock the STIC steering and transmission controls. Return the lock lever to the original position in order to unlock the STIC steering and transmission controls.

STIC Steering Control (6)

Note: The steering frame lock must be in the unlocked position in order to steer the machine.

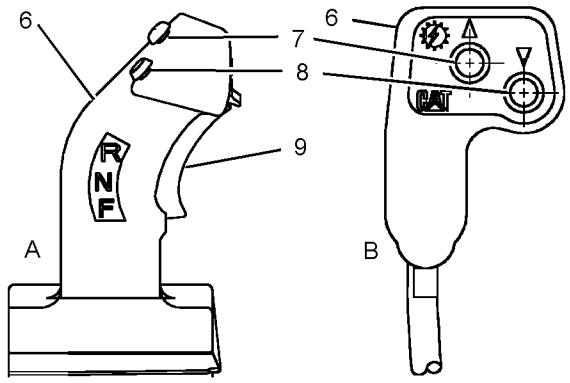


Illustration 58 g01318874

View from operator's seat

(A) Left view
(B) Front view

Left Turn – Move the STIC steering control to the left in order to steer the machine to the left. Moving the STIC steering control farther to the left will cause the machine to turn more quickly to the left.

Right Turn – Move the STIC steering control to the right in order to steer the machine to the right. Moving the STIC steering control farther to the right will cause the machine to turn more quickly to the right.

Note: When you release the STIC steering control, the control will return to the center position. However, the machine will maintain the current travel direction.

Upshift Switch (7)

Electronic Transmission Control

Push the upshift switch in order to shift the machine into the next highest speed. The active speed range will be shown on the speedometer.

- “1” indicates First Speed.
- “2” indicates Second Speed.
- “3” indicates Third Speed.

Downshift Switch (8)

Push the downshift switch in order to shift the machine into the next lowest speed. The active speed range will be shown on the speedometer.

Note: When the parking brake is engaged, the machine can only be shifted into second speed or into third speed.

Direction Control Switch (9)

The direction control switch for the STIC system is located on the steering control lever.

FORWARD – Move the bottom of trigger switch (9) to “F” . This will enable the machine to move in a forward direction. “F” will be displayed on the speedometer.

NEUTRAL – Move the trigger switch to the MIDDLE position that is indicated by “N” . This will disengage the transmission. “N” will be displayed on the speedometer.

REVERSE – Move the top of the trigger switch to “R” . This will enable the machine to move in a reverse direction. “R” will be displayed on the speedometer.

Steering Console Adjustment (10)

Push the lever downward in order to slide the console forward or backward. Release the lever in order to lock the console into position.

Adjustment for Implement Console (11)

Push the implement console adjustment lever downward in order to slide the console forward or backward. Release the lever in order to lock the console into position.

Set/Decel Switch (12)

Set/Decel – See this article, “Thottle Lock Switch (35)” for instructions on using the Set/Decel switch.

Resume/Accel Switch (13)

Resume/Accel – See this article, “Thottle Lock Switch (35)” for instructions on using the Resume/Accel switch.

Blade Control Lever (14)

Lift Control

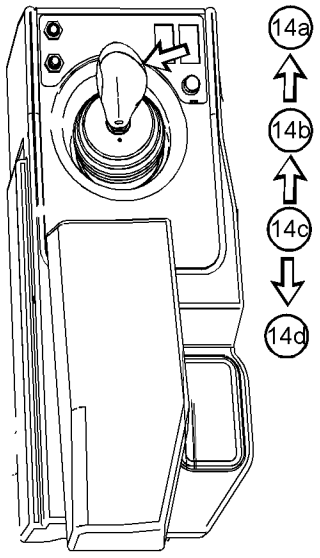


Illustration 59 g01448531

FLOAT (14a) – Push the control lever forward into the detent. The blade will lower to the ground. The blade will

follow along the contour of the ground. The control lever will remain in the detent until the control lever is manually moved out of the detent.

LOWER (14b) – Push the control lever forward in order to lower the blade. The control lever will return to the HOLD position when the control lever is released.

HOLD (14c) – The control lever will return to the HOLD position when the control lever is released from the RAISE position or from the LOWER position. The blade will remain in the selected position.

RAISE (14d) – Pull back on the control lever in order to raise the blade. The control lever will return to the HOLD position when the control lever is released.

Tilt Control

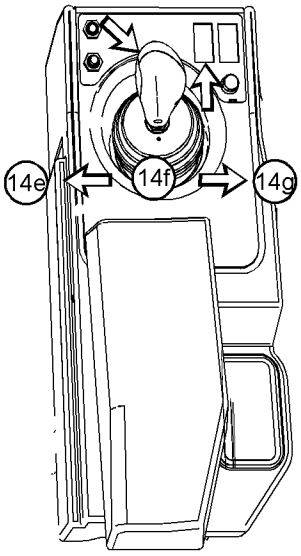


Illustration 60 g01448535

A switch is located on the right armrest. Pressing the top of the switch enables dual tilt operation of the blade.

Pressing the bottom of the switch enables single tilt operation for the blade. Blade movement is slower in single tilt operation and there is less movement and less downward force. Pressing the top of the switch enables the dual tilt function. Blade movement is faster in dual tilt operation and there is more movement and more downward force.

TILT LEFT (14e) – Move the control lever to the left in order to lower the blade to the left.

HOLD (14f) – The control lever will return to the HOLD position when the control lever is released. The blade will remain in the selected position.

TILT RIGHT (14g) – Move the control lever to the right in order to lower the blade to the right.

Blade Tip Control (14k)

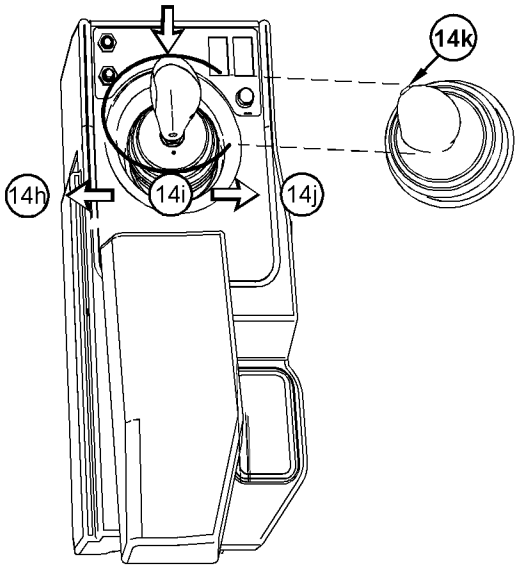


Illustration 61 g01686874

Momentary switch (14k) on the blade control lever allows the blade tip to tilt forward and backward. To tilt the blade tip, press the top of momentary switch (14k) when the control lever is moved to the left or to the right.

TIP BACK (14h) – Press the top of the rocker switch and move the control lever to the left in order to tip the blade rearward. Tipping the blade rearward improves the ability to carry a load.

HOLD(14i) – The control lever will return to the HOLD position when the control lever is released. The blade will remain in the selected position.



TIP FORWARD (14j) – Press the top of the momentary switch and move the control lever to the right in order to tip the blade forward. Tipping the blade forward improves the blade's ability to penetrate and the blade's ability to dump the load.

Implement Lockout Switch (15)



LOCKED – Push the front of the switch in order to electronically lock the hydraulic control lever.



UNLOCKED – Push the rear of the switch in order to electronically unlock the hydraulic control lever.

Dual Tilt Control (16)

Pressing the bottom of the switch enables single tilt operation for the blade. Blade movement is slower in single tilt operation and there is less movement and less downward force. Pressing the top of the switch enables the dual tilt function. Blade movement is faster in dual tilt operation and there is more movement and more downward force.

Horn (17)



Horn – Press the horn button in order to activate the horn.

Armrest Adjustment Knobs (18)

Turn the knobs counterclockwise in order to loosen the armrest. Pull up on the armrest in order to adjust to the desired height. Turn the knobs counterclockwise in order to tighten the armrest at the desired height.

Front Window Wiper Switch (19)



Front Window Wiper and Window Washer – Turn the knob clockwise in order to turn on the intermittent wiper. Two speeds are available. Push the knob in order to activate the window washer. Spring force will return the knob when the knob is released.

Rear Window Wiper Switch (20)



Rear Window Wiper and Window Washer – Turn the knob clockwise in order to turn on the window wiper. Push the knob in order to activate the window washer. Spring force will return the knob when the knob is released.

Heating and Air Conditioning Switch (21)

Fan Control



Heating and Air Conditioning Switch – This switch controls the three-speed heater/air conditioner fan.



OFF – Move the switch to this position in order to stop the blower fan.

Move the switch clockwise in order to operate the heating system. Move the switch counterclockwise in order to operate the air conditioning system.



Low Speed – Move the switch to this symbol for the lowest fan speed.



Medium Speed – Move the switch to this symbol for a medium fan speed.



High Speed – Move the switch to this symbol for the highest fan speed.

Mode Switch for Engine Monitoring System (EMS) (22)



EMS mode switch – The EMS mode switch is used to scroll between display modes.

Torque Converter Lockup Switch (23)



Torque Converter Lockup Clutch – This feature allows the operator to engage the lockup clutch, which prevents the torque converter from operating. This makes the power train direct drive. Push the top of the switch in order to enable the torque converter lockup clutch. When the lockup clutch is enabled, the transmission electronic control module (ECM) causes the engagement of the lockup clutch.

This feature provides more efficient operation for high speeds and for carrying loads. The feature is available in all speeds and directions.

Quickshift Switch (24)



Transmission Quickshift – This will enable the transmission to automatically shift from first speed into second speed when the operator moves the transmission control from the FORWARD position to the REVERSE position.

When the direction is shifted from the REVERSE position to the FORWARD position, the transmission will remain in SECOND SPEED.

Note: A quickshift can only occur when the transmission is in FIRST SPEED and the operator is moving the transmission control from the FORWARD position to the REVERSE position.

1. Press the top of the quickshift switch in order to activate the quickshift function.

2. An indicator on the front dash panel comes on when the transmission quickshift is activated. Move the transmission control from the FORWARD position to the REVERSE position.

3. Press the bottom of the quickshift switch in order to deactivate the quickshift function.

HID Light Switch (25)



Front HID Lights

Press the top of the switch (if equipped) in order to turn on the lights. Press the bottom of the switch (if equipped) in order to turn off the lights.

Front Floodlight Switch (26)



Floodlights – Push the top of the switch in order to turn on the front floodlights.

Cigar Lighter (27)



Lighter – Push the lighter inward and release the lighter. The lighter will move outward slightly when the lighter is ready for use.

NOTICE
The lighter outlet is part of a 24 volt circuit. Do not use this outlet to operate 12 volt electrical components. Use of the lighter outlet to operate 12 volt electrical components may result in damage to the component and/or to the machine electrical system.

Rotating Beacon (28)



Rotating Beacon Light (If Equipped) – Press the top of the switch in order to turn on the rotating beacon light. Press the bottom of the switch in order to turn off the rotating beacon light. The rotating beacon light is used to alert other vehicles when the machine is being roaded from one job to another job.

Rear Floodlight Switch (29)



Floodlights – Push the top of the switch in order to turn on the rear floodlights.

Reduced Rimpull Select Switch (30)

The reduced rimpull select switch reduces the potential for wheel slippage without reducing the hydraulic efficiency. The reduced rimpull select switch is a four-position switch. Each setting corresponds to a maximum allowable percentage of maximum rimpull.

Reduced Rimpull Selection Control Settings	Estimated % Rimpull
	100
	100
	100
	100

Illustration 62 g01998595

(C) Position of reduced rimpull select switch
(D) Estimated rimpull (percentage)

Operating With Reduced Rimpull



Reduced rimpull – In order to select a reduced rimpull setting, move the reduced rimpull switch to the desired setting.

If the machine is in FIRST SPEED FORWARD, the reduced rimpull select switch will limit the engine speed. The reduced engine speed will limit the rimpull to the desired level when the pedal is fully released.

Depressing the brake pedal will further reduce rimpull from the selected percentage. The rimpull that is commanded by the fully released pedal will equal the reduced rimpull that is selected on the reduced rimpull select switch.

When a lower rimpull is selected, pedal travel will result in a more gradual decrease in rimpull.

If the machine is not in FIRST SPEED FORWARD, the engine speed will not be limited until the transmission is placed into a forward speed.

Returning to Maximum Rimpull

The reduced rimpull select switch will continue to limit rimpull until the transmission is shifted out of FIRST SPEED or until the dial is placed in the MAXIMUM position.

Diagnostic Connector (31)

The diagnostic connector is for the connection of service tools.

12 Volt Power Supply (32)

Power Receptacle (12 Volt) – This machine has a 12 volt electrical outlet receptacle. This outlet supplies power for auxiliary uses. Remove the cap before you use the outlet.

Stairway Access Light Switch (33)



Stairway Access Lights – Press the top of the switch in order to turn on the stairway access lights. Press the bottom of the switch in order to turn off the stairway access lights.

Note: An external switch for the stairway access lights (41) is located in the bumper on the left side of the machine.

Running Light Switch (34)



Running Lights – Push the top of the switch in order to turn on the running lights. Move the switch to the center position in order to turn on the panel lights. The center position also turns on the rocker switches that are equipped with indicator lights. Push the bottom of the switch in order to turn off the running lights.

Throttle Lock Switch (35)



Throttle Lock Switch – The throttle lock switch is located on the right side of the cab. Engage the switch in order to keep the engine at the current rpm. When the throttle lock is active, an indicator light will illuminate on the front dash. Use the throttle lock control on long hauls in order to avoid driver fatigue. Fatigue may result from depressing the throttle control for an extended period of time.

On – Push the top of the switch in order to engage the throttle lock control.

Off – To release the throttle lock control, push the bottom of the switch or slightly depress the right brake pedal.

Setting the Throttle Lock

The throttle lock can be set for a desired rpm.

1. Push the top of the on/off switch in order to turn on the throttle lock.

2. The indicator light for the throttle lock will illuminate when the on/off switch is in the ON position. Refer to this Operation and Maintenance Manual, “Monitoring System” for the location of the indicator light.

3. Depress the throttle control in order to achieve the desired engine rpm.

4. Depress “Set/Decel” switch (12) in order to set the throttle.

Cancelling the Throttle Setting

The throttle setting may be cancelled by depressing the right brake pedal or by moving the on/off switch to the OFF position.

When the right brake pedal is used to cancel a throttle setting, press “Resume/Accel” switch (13) in order to resume the throttle setting.

Accelerate or Decelerate

In order to accelerate to a higher rpm, continue pressing the Resume/Accel switch. Once the switch is released the previous setting will resume.

In order to decelerate to a lower rpm, continue pressing the Set/Decel switch. Once the switch is released the previous setting will resume.

Temperature Control (36)



Setting the temperature – Turn the knob clockwise for warmer air. Turn the knob counterclockwise for cooler air.

The heating and air conditioning system can be used for four functions:



Heating – Turn fan control switch (21) clockwise to the desired speed. Adjust the temperature control for the desired temperature.



Cooling – Turn fan control switch (21) counterclockwise to the desired speed. Adjust the temperature control for the desired temperature.

Pressurizing – Pressure inside the cab will help keep out dust. Close the door and the windows in order to keep pressure in the cab.

Defogging – Turn fan control switch (21) counterclockwise in order to turn on the air conditioner. This will prevent moisture from forming on the windows. The volume of air that is needed to remove moisture from the cab varies according to the speed of the fan. Adjust the temperature control so that the windows remain free of moisture.

Quarter Panel Window Wiper and Window Washer Switch (37)



Quarter Panel Window Wiper and Washer – Turn the knob clockwise in order to turn on the window wiper. Push the knob in order to activate the window washer. Spring force will return the knob when the knob is released.

Engine Start Switch (38)



OFF – When you insert the key and when you remove the key, the engine start switch must be in the OFF position. Turn the engine start switch to the OFF position in order to stop the engine. Also, turn the engine start switch to the OFF position in order to disconnect the power to the electrical circuits in the cab.



ON – To activate the electrical circuits in the cab, turn the engine start switch clockwise to the ON position.



START – To start the engine, turn the engine start switch clockwise to the START position. When the key is released, the engine start switch will return to the ON position.

Note: If the engine fails to start, return the key to the OFF position. This must be done before you attempt to start the engine again.

Battery Disconnect Switch (39)

The battery disconnect switch and the engine start switch (38) perform different functions. The entire electrical system is disabled when the battery disconnect switch is turned to the OFF position. The battery remains connected to the electrical system when the engine start switch is turned to the OFF position.



Disconnect Switch ON – To activate the electrical system, insert the battery disconnect switch key and turn the key clockwise. The battery disconnect switch must be in the ON position before the engine can be started.



Disconnect Switch OFF – To deactivate the electrical system, turn the battery disconnect switch key counterclockwise to the OFF position.

Turn the battery disconnect switch to the OFF position and remove the key when you service the electrical system or any other machine components. Turn the battery disconnect switch to the OFF position and remove the key when the machine will not be used for an extended period of a month or more. This will help to prevent drainage of the battery.

NOTICE
Never move the battery disconnect switch to the OFF position while the engine is operating. Serious damage to the electrical system could result.

Engine Shutdown Control (40)

Note: The engine shutdown control does not shut off the electrical system of the machine.



Stop – Lift up the switch cover and move the switch upward in order to stop the engine.



Run – Push down the switch cover and the switch in order to allow the engine to be started.

Stairway Access Light Switch (41)



Stairway Access Lights – Press the top of the switch in order to turn on the stairway access lights. Press the bottom of the switch in order to turn off the stairway access lights.

Note: An internal switch for the stairway access lights (33) is located on the right side instrument panel in the cab of the machine.

Interior Dome Light (42)



Interior Light

Push the switch in order to turn the dome light on and off.

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Battery Disconnect Switch

SMCS Code: 1411

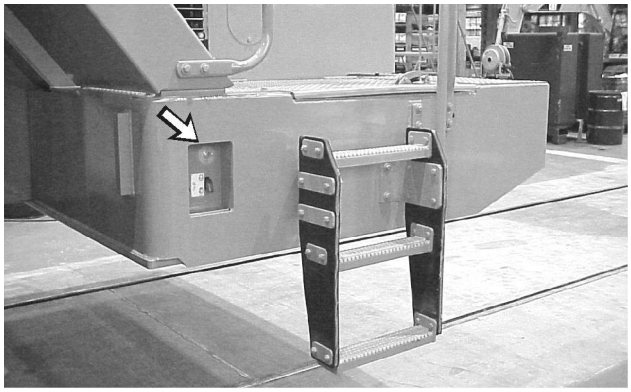


Illustration 63 g00750509

The battery disconnect switch is located in the bumper on the left side of the machine.

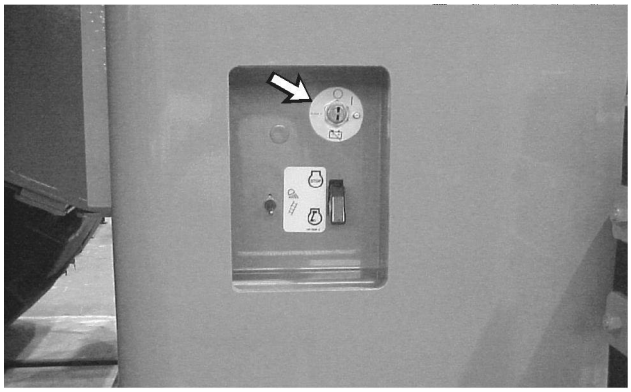


Illustration 64 g00750527

Disconnect Switch ON – To activate the electrical system, insert the battery disconnect switch key and turn the key clockwise. The battery disconnect switch must be in the ON position before the engine can be started.

Disconnect Switch OFF – To deactivate the electrical system, turn the battery disconnect switch key counterclockwise to the OFF position.

The battery disconnect switch and the engine start switch perform different functions. The entire electrical system is disabled when the battery disconnect switch is turned to the OFF position. The battery remains connected to the electrical system when the engine start switch is turned to the OFF position.

Turn the battery disconnect switch to the OFF position and remove the key when you service the electrical system or any other machine components.

NOTICE
Never move the battery disconnect switch to the OFF position while the engine is operating. Serious damage to the electrical system could result.

To ensure that no damage to the engine occurs, verify that the engine is fully operational before cranking the engine. Do not crank an engine that is not fully operational.

Perform the following procedure in order to check the battery disconnect switch for proper operation:

1. With the battery disconnect switch in the ON position, verify that electrical components in the operator compartment are functioning. Verify that the hour meter is displaying information. Verify that the engine will crank.
2. Turn the battery disconnect switch to the OFF position.
3. Verify that the following items are not functioning: electrical components in the operator compartment, hour meter and engine cranking. If any of the items continue to function with the battery disconnect switch in the OFF position, consult your Caterpillar dealer.

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Backup Alarm

SMCS Code: 7406

Backup Alarm – The backup alarm will sound when the transmission is placed in reverse. The backup alarm alerts people when the machine is backing up.

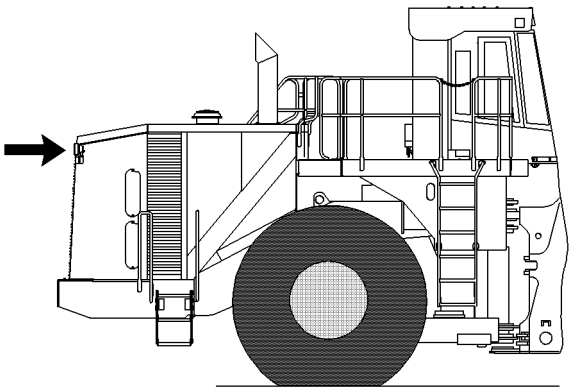


Illustration 65 g00847524

The backup alarm is behind the fan guard on the rear of the machine.

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Monitoring System

SMCS Code: 7451; 7490

Display Modules

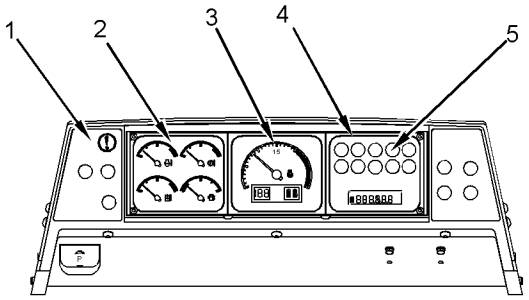


Illustration 66 g01051636

The Caterpillar Monitoring System is an electronic monitoring system that continuously monitors machine systems. The monitoring system has three display panels. The monitoring system includes the action lamp (1), gauge display (2), speedometer/tachometer display (3), and monitoring system display (4). The monitoring system display has alert indicators (5).

Functional Test

The Caterpillar Monitoring System performs an automatic internal test when the engine start switch is moved from the OFF position to the ON position. The test verifies proper operation of the outputs (displays, alert indicators, and the action alarm) and the internal circuits. The operator must observe the displays in order to determine whether the monitoring system is operating properly. The length of time for the test is approximately three seconds.

1. During this test, the action light is on continuously and the action alarm sounds once.

2. All of the alert indicators flash. Also, the “X10” indicator, the indicator for the hour meter, and all units of measurement come on in the display window. The digital readout shows “8.8.8.X.8.8.” .

3. On the speedometer/tachometer display, the gear/direction readout shows an asterisk and the digital speedometer shows 188 mph and km/h.

4. All of the gauge needles ramp straight up. Then, the gauge needles go to the right and to the left. The gauge needles then show the actual current readings.

5. The display then goes into the Normal Mode of operation or the display scrolls through the modes if the service input and the clear input are grounded or the operator switch input is grounded.

Warning Categories

The Caterpillar Monitoring System notifies the operator of an immediate problem with a machine system or an impending problem with a machine system. The Caterpillar Monitoring System provides four warning categories. The categories are based on the severity of the problem. The categories dictate the required response of the operator.

Table 4

WARNING OPERATION					
Warning Category	Warning Indications (1)			Required Action	Possible Result (2)
	Flashing Indicator	Flashing Action Lamp	Sounding of the Action Alarm		
1	X			No immediate action is required. The system needs attention soon.	No harm or damage
2	X	X		Change machine operation or perform maintenance to the system.	Severe damage to components
2-S	X	X	X (3)	Immediately change the machine operation.	Severe damage to components
3	X	X	X (4)	Immediately perform a safe engine shutdown.	Injury to the operator or severe damage to components

(1) The warning indicators that are active are marked with an “X” .
(2) This is the possible result if no action is taken.
(3) The alarm is on continuously.
(4) The alarm is on intermittently.

Alert Indicators

Note: Not all of the following indicators are present on every machine.



Coolant Temperature – This gauge indicates excessive coolant temperature. If the gauge needle is in the red area, stop the machine and investigate the cause of the fault.



Transmission Oil Temperature – This gauge indicates excessive transmission oil temperature. If the gauge needle is in the red area, reduce the load on the machine. If the gauge needle is in the red area and the action light continues to flash after approximately five minutes, stop the machine and investigate the cause of the fault.



Hydraulic Oil Temperature – This gauge indicates excessive hydraulic oil temperature. If the gauge needle is in the red area, reduce the load on the system. If the gauge needle remains in the red area, stop the machine and investigate the cause of the fault.



Fuel Level – The fuel tank is at 10 percent capacity. Refuel as soon as possible.



Parking Brake – This light indicates that the parking brake is engaged. If the machine is in neutral, only the indicator lights. However, if the machine is in a forward gear or a reverse gear, the action lamp and the action alarm also activates.



Charging System – This light indicates that the battery voltage is outside the battery charge range. While the engine is running, the light also turns on when the alternator frequency is low.

Engine Overspeed – This light indicates that the engine speed is too high.

Engine Oil Pressure – This light indicates that the engine oil pressure is low.

Transmission Oil Filter – This light indicates that the transmission oil filter is restricted.

NOTICE
If the transmission oil filter is plugged, the bypass valve will open. Unfiltered transmission oil will flow through the system and damage to other system components may occur.

Inlet Air Temperature – This light indicates that the air inlet temperature is high.

Fuel Pressure – This light indicates that the fuel filter is restricted.

Primary Steering – This light indicates that the primary steering pressure is low.

Steering Oil Temperature – This light indicates excessive steering oil temperature.

Brake Oil Pressure – This light indicates that the brake oil pressure is low.

Axle Oil Temperature – The light indicates that the axle oil temperature is high.

NOTICE
If the hydraulic oil filter is plugged, the bypass valve will open. Unfiltered hydraulic oil will flow through the system and damage to other system components may occur.

Reference: For the location of the electrical components, refer to the Electrical System Schematic in the Service Manual for your machine.

Indicators

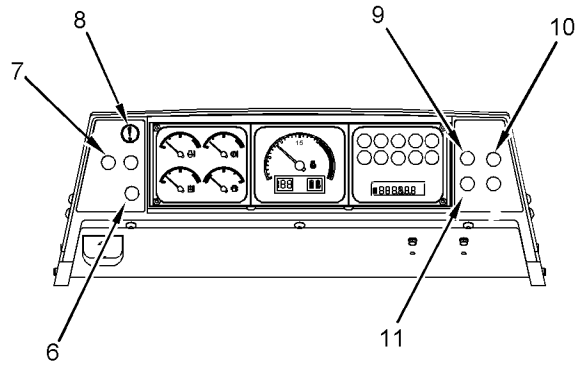


Illustration 67 g01059611

Quickshift function (6) – This light indicates when the quickshift switch is activated.

Secondary Steering Pressure (7) – This light indicates that the secondary steering system is activated.

Action Indicator (8) – This light indicates that the monitoring system has detected a fault.

Reduced Rimpull (9) – This light indicates that the rimpull selection switch has been moved to reduced rimpull.

Lockup Clutch (10) – This light indicates that the torque converter lockup control is activated.

Throttle Lock (11) – This light indicates that the throttle lock is activated.

i07233032

Product Link

SMCS Code: 7490; 7606

Note: Your machine may be equipped with the Cat ® Product Link ™ system.

The Cat Product Link communication device utilizes cellular and/or satellite technology to communicate equipment information. This information is communicated to Caterpillar, Cat dealers, and Caterpillar customers. The Cat Product Link communication device uses Global Positioning System (GPS) satellite receivers.

The capability of two-way communication between the equipment and a remote user is available with the Cat Product Link communication device. The remote user can be a dealer or a customer.

Data Broadcasts

Data concerning this machine, the condition of the machine, and the operation of the machine is being transmitted by Cat Product Link to Caterpillar and/or Cat dealers. The data is used to serve the customer better and to improve upon Cat products and services. The information transmitted may include: machine serial number, machine location, and operational data, including but not limited to: fault codes, emissions data, fuel usage, service meter hours, software, and hardware version numbers and installed attachments.

Caterpillar and/or Cat dealers may use this information for various purposes. Refer to the following list for possible uses:

- Providing services to the customer and/or the machine
- Checking or maintaining Cat Product Link equipment
- Monitoring the health of the machine or performance
- Helping maintain the machine and/or improve the efficiency of the machine
- Evaluating or improving Cat products and services
- Complying with legal requirements and valid court orders
- Performing market research
- Offering the customer new products and services

Caterpillar may share some or all the collected information with Caterpillar affiliated companies, dealers, and authorized representatives. Caterpillar will not sell or rent collected information to any other third party and will exercise reasonable efforts to keep the information secure. Caterpillar recognizes and respects customer privacy. For more information, please contact your local Cat dealer.

Operation in a Blast Site for Product Link Radios

⚠ WARNING

This equipment is equipped with a Cat® Product Link communication device. When electric detonators are being used for blasting operations, radio frequency devices can cause interference with electric detonators for blasting operations which can result in serious injury or death. The Product Link communication device should be deactivated within the distance mandated under all applicable national or local regulatory requirements. In the absence of any regulatory requirements Caterpillar recommends the end user perform their own risk assessment to determine safe operating distance.

Refer to your products Operation and Maintenance Manual Supplement, “Regulatory Compliance Information” for more information.

For information regarding the methods to disable the Cat Product Link communication device, please refer to your specific Cat Product Link manual listed below:

- Operation and Maintenance Manual, SEBU8142, “Product Link - 121SR/321SR/420/421/522/523”
- Operation and Maintenance Manual, SEBU8832, “Product Link PLE601, PL641, PL631, PL542, PL240, PL241, PL141, PL131, PL161, and G0100 Systems”

Note: If no radio disable switch is installed and the equipment will be operating near a blast zone, a Product Link radio disable switch may be installed on the equipment. The switch will allow the Cat Product Link communication device to be shut off by the operator from the equipment control panel. For more details and installation procedures, refer to the following:

- Special Instruction, “Installation Procedure forProduct Link PLE640 Systems”REHS7339
- Special Instruction, “Installation Procedure for the Elite Product Link PLE601, PLE641, and PLE631 Systems”REHS8850
- Special Instruction, “Installation Procedure for the Product Link PL131, PL141, and PL161 Systems”SEHS0377

- Special Instruction, “Installation Procedure for the Pro Product Link PL641 and PL631 Systems”REHS9111

i03638511

Camera
(If Equipped)

SMCS Code: 7347; 7348

The Work Area Vision System (WAVS) is a closed circuit television system that is designed to supplement the view for the operator during machine operation. The system may include one, two, or three cameras, depending on the type of machine and the application.

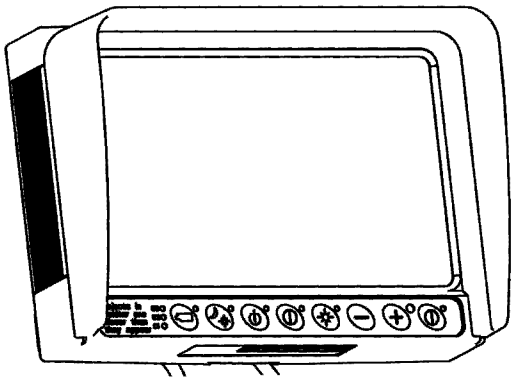


Illustration 68 g01223034
Display for WAVS

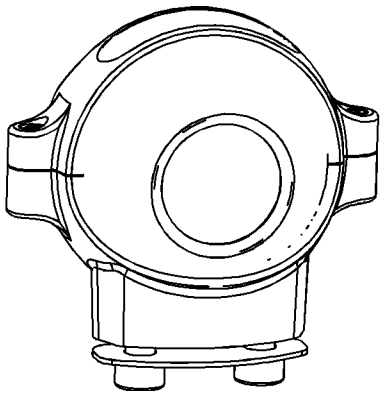


Illustration 69 g01223051
Camera for WAVS

Prior to operating the machine, ensure proper orientation of images by the camera(s). The camera (s) has been set up by the factory or by a Caterpillar dealer in order to provide views which comply with the guidelines that have been documented. Consult your Caterpillar dealer before any adjustments are made to the camera(s).

Prior to operating the machine, ensure that the features of the display are properly adjusted. Ensure that the brightness and the contrast are adjusted prior to operating the machine. Ensure that the brightness and the contrast are adjusted after changes in the conditions for ambient light.

Prior to operating the machine, ensure that the display is positioned in order to provide clear visibility of the display from the operator seat. Do not position the display in a way that will cause the following conditions:

- Cover any safety messages or other important information.
- Impede the entry to the cab or impede the exit from the cab.
- Obstruct the visibility of the operator.
- Obstruct the view of any indicators, gauges, or monitoring system.
- Impair access to any operator controls or impair movement of any operator controls.

Prior to operating the machine, ensure that the camera lens and the display are clean.

Refer to Operation and Maintenance Manual, SEBU8157, “Work Area Vision System” for additional information about WAVS.

i03917671

Operation Information

SMCS Code: 7000

Follow these basic instructions whenever you are operating the machine:

- To prevent injury, make sure that no one is working on the machine or near the machine. Always maintain control of the machine.
- Raise the bucket or the work tool enough to negotiate any obstacles.
- Before you release the parking brake, depress the service brake pedal in order to keep the machine from moving.
- Drive the machine forward for best visibility and for best control.
- Reduce the engine speed when you maneuver in tight quarters and when you are going over a hill.

Downhill Operation

Before you start down a hill or grade, select the proper gear to maintain a proper ground speed. Select a speed that is slow enough for the grade and conditions. In most situations, the proper gear will be the same gear that is required to drive up the grade. The proper gear should allow the machine to maintain the appropriate speed without continuous use of the brakes. Use the right service brake pedal or the engine brake (if equipped) in order to slow the machine until a lower gear can be selected. The engine speed should be in the mid range to maintain proper cooling and lubrication of the machine systems and not over speed the engine.

If the machine builds up excessive speed, the engine can over speed. Engine over speed can result in damage to the engine, the hydraulic pump and /or the power train.

Using the right service brake pedal continuously to control travel speed of the machine on a grade can cause the brake discs and axle oil to overheat. This use of the service brake can result in significant wear and /or damage to the service brakes and final drives.

Note: The left impeller clutch/brake pedal should not be used for downhill braking. Using the left impeller clutch/brake pedal will disengage the engine from the power train. This action will increase the load on the service brakes, increasing the risk of significant wear and/or damage to the service brakes and final drives.

i03084784

Parking Brake

SMCS Code: 7000

⚠ WARNING

Personal injury could result from the sudden stop of the machine. The parking brake is automatically engaged when brake oil pressure drops below an adequate operating pressure.

If the brake loses oil pressure, the alert indicator for the brakes will flash and the action alarm will sound. The alert indicator for the brakes is on the dash panel. Loss of oil pressure will cause the parking brake to automatically engage. This will stop the machine.

Anticipate a sudden stop. Correct the cause of the loss of oil pressure. Do not operate the machine without normal brake oil pressure.

The action light will also flash when the lights on the monitoring system flash. The action alarm will continuously sound.

Note: The action alarm intermittently sounds if the service brake loses oil pressure on early machines.

Driving Through the Parking Brake

NOTICE
Driving the machine through the parking brakes for an extended period can cause severe damage to the braking system.

Inspect the parking brake system and make any necessary repairs before returning the machine to operation.

You have the ability to drive through the parking brake in order to move the machine to a safe location. In order to drive the machine through the parking brake, follow these steps:

1. Move the transmission control to the NEUTRAL position.
2. Push the parking brake knob inward.
3. Continue to push the parking brake knob inward and shift the transmission control into the FORWARD position or the REVERSE position.

Note: “1F” and “1R” are the only gears that are available to drive through the parking brake. Although Other gears are selectable, the other gears will not provide the drive through capabilities.

4. Continue to push the parking brake knob inward. Increase the engine speed and move the machine to a safe location.

Note: Machine movement will be jerky since the power train is fighting the parking brake.

Note: A Warning Category 3 will activate during machine movement. The event will be logged, but the alarm should deactivate once the transmission is returned to the NEUTRAL position.

5. Shift the transmission control into the NEUTRAL position in order to stop the machine.
6. Before you return the machine to operation, inspect the brake system and make any necessary repairs.

i04147152

Secondary Steering
(If Equipped)

SMCS Code: 7000

Secondary steering enables steering in the event machine loses power while traveling. The system uses a ground driven pump to provide hydraulic pressure and flow to the steering system.

The activation of the secondary steering system indicates a failure of the primary steering. If the primary steering warning indicator comes on during operation, steer the machine to a safe location and immediately stop the machine. Stop the engine and investigate the cause of the problem.

Note: The secondary steering only works while the machine is in motion.

Complete any necessary repairs before you return the machine to operation.

Engine Starting

i05448891

Engine Starting

SMCS Code: 1000; 7000

⚠ WARNING

Do not allow a companion to ride on the machine unless the companion is seated within the Rollover Protective Structure (ROPS) or Falling Object Protection Structure (FOPS) with the seat belt fastened. The companion must have the seat belt fastened while the machine is in operation. The operator of the machine is responsible for the safety of the companion. Personal injury or death may occur if the companion is not restrained and protected.

⚠ WARNING

Diesel engine exhaust contains products of combustion which may be harmful to your health

Always start and operate the engine in a well-ventilated area and, if in an enclosed area, vent the exhaust to the outside.

1. Adjust the operator seat and fasten the seat belt.

2. Engage the parking brake.

3. Engage the steering and transmission integrated control (STIC) lock.

4. Deactivate the implement controls with the implement/hydraulic lockout switch.

5. Before the engine is started, check for the presence of bystanders or maintenance personnel. Ensure that all personnel are clear of the machine. Briefly sound the forward horn before you start the engine.

6. Turn the engine start switch key to the ON position. The monitoring system starts. Allow the monitoring system to complete the automatic self-diagnostic test

Note: For more information on the monitoring system, refer to Operation and Maintenance Manual, “Monitoring System”.

7. Turn the engine start switch key to START. Release the engine start switch key after the engine starts.

Note: Ether will be automatically injected if the ambient conditions call for the use of a starting aid.

NOTICE
Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again. Turbocharger damage can result if the engine rpm is not kept low until the oil gauge display verifies that the oil pressure is sufficient.

Note: This machines engine with standard specifications can start in areas that have temperatures as low as −18°C (0°F). For areas that are cooler, the use of cold weather starting aids is recommended.

Note: For temperatures below −23 °C (−10 °F), consult your Cat dealer for additional information or refer to Special Publication, SEBU5898, “Cold Weather Recommendations”.

i02044115

Engine and Machine Warm-Up

SMCS Code: 1000; 7000

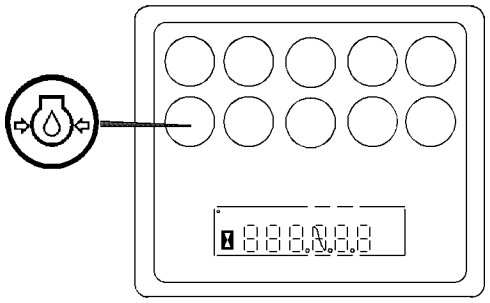


Illustration 70 g01049774

NOTICE
Keep the engine speed low for 10 seconds to allow the engine oil pressure to build.

If the message center displays low oil pressure, stop the engine and investigate the cause before starting again. Failure to do so can cause engine damage.

Turbocharger damage can result, if the engine speed is not kept low until the engine oil pressure is sufficient.

1. When the engine is cold, operate the engine at low idle for several minutes. Cycle all the hydraulic controls. This will aid the warm-up of the hydraulic components.

2. During operation, look at the indicators and the gauges frequently.

To speed the warming of the hydraulic oil, hold the blade in the RAISE position for short periods. Do not hold the blade in the RAISE position for more than ten seconds.

This will allow the hydraulic oil to reach relief pressure, which causes the hydraulic oil to warm more rapidly.

Cycle all controls in order to allow the warm oil to circulate through all hydraulic cylinders and through all hydraulic lines.

While you idle the engine for warm-up, observe the following recommendations:

- In temperatures above 0°C (32°F), the suggested warm-up period is 15 minutes.
- In temperatures below 0°C (32°F), the warm-up will require a period of 30 minutes or more.
- If the temperatures are below −18°C (0°F) or if the hydraulic functions are sluggish, the warm-up may require a longer period.

Parking

i06851283

Stopping the Machine

SMCS Code: 7000

NOTICE
Do not engage the secondary brake while the machine is moving unless the primary service brake fails.

The use of the secondary brake as a service brake in regular operation will cause severe damage to the brake system.

Park the machine on a level surface. If it is necessary to park on a grade, block the wheels.

1. Apply the service brakes to stop the machine.

2. Move the transmission control to the NEUTRAL position.

3. Engage the parking brake.

4. Lower the work tool to the ground and apply slight downward pressure.

i00982184

Stopping the Engine

SMCS Code: 1000; 7000

NOTICE
Stopping the engine immediately after it has been working under load, can result in overheating and accelerated wear of the engine components.

See the following stopping procedure, to allow the engine to cool, and to prevent excessive temperatures in the turbocharger center housing, which could cause oil coking problems.

1. While the machine is stopped, run the engine for five minutes at low idle. This allows hot areas of the engine to cool gradually.

2. Turn the engine start switch to the OFF position and remove the key.

i03314406

Stopping the Engine if an Electrical Malfunction Occurs

SMCS Code: 1000; 7000

If the engine start switch is in the OFF position but the engine does not stop, use the engine shutdown control (switch) to stop the engine.

Reference: Refer to Operation and Maintenance Manual, “Operator Controls” for more information.

Note: Do not operate the machine again until the problem has been corrected.

i02068544

Equipment Lowering with Engine Stopped

SMCS Code: 7000

1. Turn the engine start switch to the ON position.

2. Move the hydraulic lockout control to the UNLOCKED position.

3. Push the lift control to the LOWER position in order to lower the bucket or the work tool to the ground. The lift control will return to the HOLD position when the control lever is released.

4. Move the hydraulic lockout control to the LOCKED position.

5. Turn the engine start switch to the OFF position.

Note: If the work tools will not lower, the pilot supply on/off solenoid may be inoperable. In this case, proceed to Step 6.

⚠ WARNING

Personal injury or death may occur from failure to adhere to the following warnings.

Keep all personnel away from the boom drop area when lowering the boom with the engine stopped.

Keep all personnel away from the front linkage when lowering the boom.

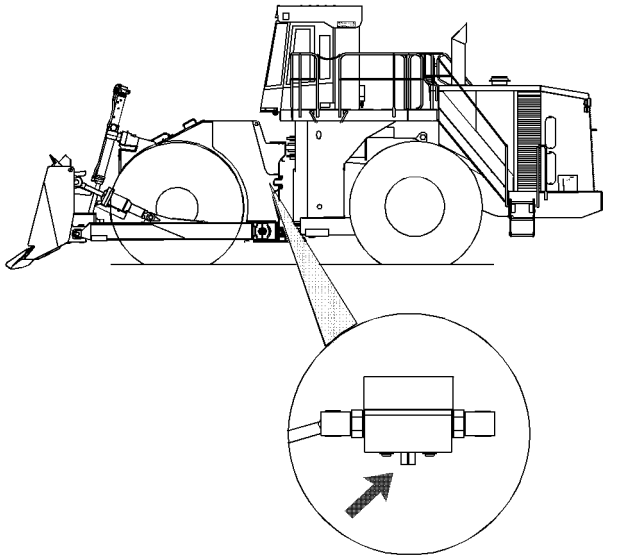


Illustration 71 g01059740

6. A ball valve is located near the left rear of the main control valve. This ball valve is used for manually lowering the work tool. **Slowly turn the square stem in the clockwise direction.** The square stem should be rotated 90 degrees. After the work tool is resting on the ground, rotate the square stem counterclockwise.

i03907860

Leaving the Machine

SMCS Code: 7000

1. Use the steps and the handholds when you get off the machine. Face the machine and use both hands. Make sure that the steps are clear of debris before you dismount.

2. Inspect the engine compartment for debris. Clean out any debris and paper in order to avoid a fire.

3. Remove all flammable debris in order to reduce a fire hazard. Dispose of all debris properly.

4. Always turn the battery disconnect switch to the OFF position before leaving the machine.

5. If the machine will not be operated for a month or more, remove the battery disconnect switch key.

6. Install all covers and all vandalism protection locks.

Transportation Information

i01671778

Shipping the Machine

SMCS Code: 7000; 7500

Investigate the travel route for overpass clearances. Make sure that there will be adequate clearance if the machine that is transported has a ROPS, a cab, or a canopy.

Remove ice, snow, or other slippery material from the loading dock and from the transport machine before you load the machine. This will help to prevent slippage of the machine. This will also help to prevent a shift while the machine is moving in transit.

Obey the appropriate laws that govern the parameters of the load (weight, width, and length).

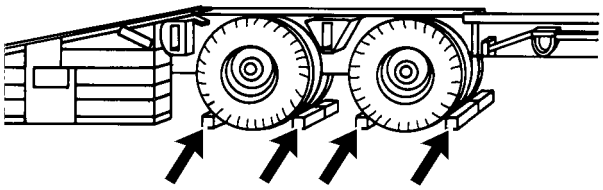


Illustration 72 g00863991

Properly chocked trailer wheels

1. Chock the trailer wheels or the rail car wheels before you load the machine.
2. After the machine is positioned, connect the steering frame lock in order to hold the front frame and the rear frame in place.
3. Lower the bucket or the work tool to the floor of the transport vehicle. Move the transmission control to the NEUTRAL position.
4. Engage the parking brake.
5. Turn the engine start switch to the OFF position. Remove the engine start switch key.
6. Move all of the control levers in order to relieve any trapped pressure.
7. Turn the battery disconnect switch to the OFF position. Remove the battery disconnect switch key.
8. Lock the door and the access covers. Attach any vandalism protection.
9. Secure the machine, any equipment, and any tools with adequate tie-downs in order to prevent movement during shipping.
10. Cover the exhaust opening. The turbocharger (if equipped) should not rotate when the engine is not operating. Damage to the turbocharger can result.

i01998604

Roading the Machine

SMCS Code: 7000

Check with the proper officials in order to obtain the required licenses and other similar items before roading the machine.

Complete a thorough daily inspection before you mount the machine and before you start the engine.

Reference: For more information, refer to Operation and Maintenance Manual, “Daily Inspection”.

Carry the work tool as low to the ground as possible. Disable the controls for the work tool when the machine is roaded.

Limitations for TON-kilometer per hour (TON-mile per hour) must be obeyed. Before roading, consult your tire dealer for recommended tire pressures and for speed limitations of the tires.

Inflate the tires to the correct pressure. Use a self-attaching inflation chuck in order to inflate the tire. Stand behind the tire tread while you inflate the tires.

Reference: For more information, refer to the Operation and Maintenance Manual, “Tire Inflation Information”.

When you road for long distances, schedule stops in order to allow the tires and the components to cool. Stop for 30 minutes after every 40 km (25 miles) or after every hour.

i03304404

Lifting and Tying Down the Machine

SMCS Code: 7000; 7500

⚠ WARNING

Improper lifting and improper tie-downs can allow the load to shift or fail and cause injury or damage. Use only properly rated cables and slings with lift and tie down points provided.

Follow the instructions in Operation and Maintenance Manual, "Lifting and Tying Down the Machine" for the proper technique for securing the machine. Refer to Operation and Maintenance Manual, "Specifications" for specific weight information.

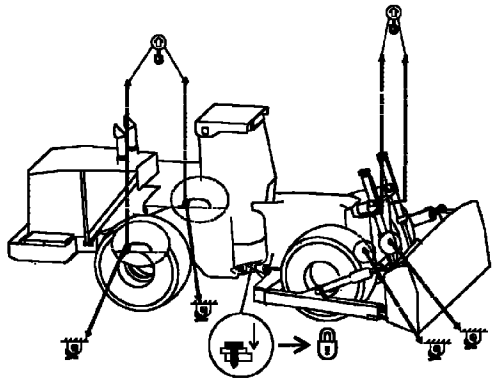


Illustration 73 g01687614

NOTICE
Improper lifting or tie-downs can allow the load to shift and cause injury or damage. Install the steering frame lock link before lifting.

Note: Do not use handles or steps in order to lift or tie down the machine.

Note: The machine shipping weight that is listed is the weight of the most common configuration of the machine. If attachments have been installed on your machine, the weight of your machine and the center of gravity of your machine may vary.

Reference: Refer to Operation and Maintenance Manual, "Specifications" for the dimensions and weight of the machine.

Lifting Point – In order to lift the machine, attach the lifting devices to the lifting points.

Tie Down Point – In order to tie down the machine, attach the tie-downs to the tie down points.

Use properly rated cables and properly rated slings to lift the machine.

Position the crane or the lifting device in order to lift the machine in a level position.

The width of the spreader bar must be sufficient to prevent the lifting cables or the lifting straps from contacting the machine.

1. Engage the parking brake before you sling the machine and before you secure the machine with tie-downs.
2. Install the frame lock pin prior to lifting the machine.
3. Attach two lifting cables to the rear of the machine. There is one lifting eye on each side of the rear of the machine. The lifting eyes are identified by a label that shows a hook.
4. Attach two lifting cables to the front of the machine. There is one eye on each side of the front of the machine. The lifting eyes are identified by a label that shows a hook.
5. Connect the four lifting cables to the spreader bars. The spreader bars must be centered over the machine.
6. If equipped, secure any attachments.
7. Lift the machine. Move the machine to the desired position.
8. When the machine is positioned, place the blocks behind the tires.
9. Secure the machine at the tie-down positions. The positions are identified on the machine by a label.

Check all of the laws that govern the load characteristics (height, weight, width, and length).

Reference: For shipping instructions, refer to Operation and Maintenance Manual, "Shipping the Machine".

Towing Information

i02959311

Machine Retrieval

SMCS Code: 7000

⚠ WARNING

Personal injury or death could result when towing a disabled machine incorrectly.

Block the machine to prevent movement before releasing the brakes. The machine can roll free if it is not blocked.

In order to properly perform the towing procedure, use the following recommendations.

Your machine is equipped with spring-applied parking brakes. The parking brakes are released by oil pressure. If the engine is inoperable or if the brake oil system is inoperable, the parking brakes are applied. The machine cannot be moved.

Use these towing instructions for moving a disabled machine over a short distance. Do not move the machine faster than 2 km/h (1.2 mph). Move the machine to a convenient location for repair. Use these instructions for emergency situations only. Always haul the machine if long distance moving is required.

Shielding must be provided on the towing machine in order to protect the operator in case the tow line breaks or the tow bar breaks.

Do not allow riders on the machine which is being towed.

Before you tow the machine, inspect the condition of the tow line or of the tow bar. Make sure that the tow line or the tow bar is sturdy enough to tow the disabled machine. The tow line or the tow bar must have a strength that is equal to 1.5 times the gross weight of the machine that is being towed. Use a tow bar with this strength or a tow line with this strength to tow a disabled machine that is stuck in the mud. Also, use a tow bar with this strength or a tow line with this strength to tow a disabled machine up a grade.

The towing force must not exceed 1100 kN (247291 lb).

Do not use a chain for pulling. A chain link may break. This can cause personal injury. Use a wire cable with cable loops or end rings. Position an observer at a safe location. The observer should stop the pulling procedure if the cable starts to break or the cable starts to unravel. If the towing machine moves without the pulled machine, stop the pulling procedure.

Keep the tow line angle to a minimum. Do not exceed a 30 degree angle from the straight ahead position.

Quick machine movement could overload the tow line or the tow bar. This could cause the tow line or the tow bar to break. Gradual, smooth machine movement is recommended.

Normally, the towing machine should be as large as the disabled machine. The towing machine must have enough brake capacity, enough weight, and enough power for the grade that is involved and for the distance that is involved.

It may be necessary to connect a larger machine or additional machines to the machine that is disabled. This will provide sufficient control for moving a disabled machine downhill and sufficient braking for moving a disabled machine downhill.

The requirements for different situations cannot be specified. Minimal towing machine capacity is required on smooth, level surfaces. Maximum towing machine capacity is required on inclines or on poor surface conditions.

Any towed machine with a load must be equipped with a brake system that can be operated from the operator's compartment.

Consult your Caterpillar dealer for more information about towing a disabled machine.

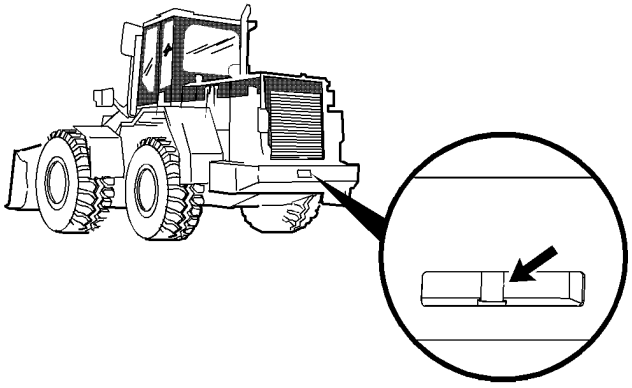


Illustration 74 g01478145

Location of the retrieval and towing pin

Towing with the Engine Idle

If the engine is running, the machine can be towed for a short distance under certain conditions. The power train and the steering system must be operable. **Tow the machine for a short distance only.** For example, pull the machine out of mud or pull the machine to the side of the road.

The operator on the towed machine must steer the machine in the direction of the tow line.

Carefully obey all of the instructions that are outlined in this topic.

Towing with the Engine Stopped

Perform the following steps before you tow the machine.

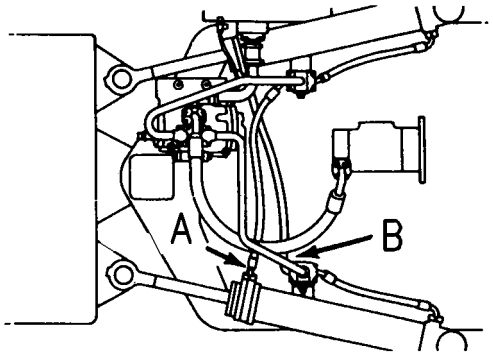


Illustration 75 g00286064

Typical example

(A) Rod end
(B) Head end

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Be sure the cylinder hoses are connected correctly before operating the machine. With the hoses reversed, the steering system will not function.

1. Reverse the hydraulic steering hose connections on one cylinder only. This will allow the steering cylinders to move freely.

⚠ WARNING

When the axle shafts are removed, the machine has no service or parking brakes. The machine can roll and cause personal injury or death.

Block the wheels securely so that the machine cannot move.

The towing connection must be rigid, or towing must be done by two machines of the same size or larger than the towed machine. Connect a machine on each end of towed machine.

2. If failure of the internal transmission or of the drive train is suspected, remove the axle shafts.

Reference: For more information on the axle shaft, refer to the Service Manual for your machine or consult your Caterpillar dealer.

NOTICE
Release the parking brake to prevent excessive wear and damage to the parking brake system when towing the machine.

3. Release the parking brake.

Reference: For information about the manual release of the parking brake, refer to Operation and Maintenance Manual, “Parking Brake Manual Release”.

4. Inspect the machine for power train damage. If damage is suspected, remove the axle shafts.

5. Fasten the tow bar.

⚠ WARNING

Personal injury or death can result from brake malfunction.

Make sure all necessary repairs and adjustments have been made before a machine that has been towed to a service area, is put back into operation.

6. Remove the wheel blocks. Tow the machine slowly. Do not exceed 2 km/h (1.2 mph).

i01851383

Parking Brake Manual Release

SMCS Code: 4267; 7000

⚠ WARNING

Personal injury or death can result from a brake malfunction. Do not operate the machine if the brake was applied due to a malfunction of the oil system or the brake.

Correct any problem before attempting to operate the machine.

1. Chock the wheels in order to prevent the machine from rolling when the parking brake is released.

2. Connect the steering frame lock.

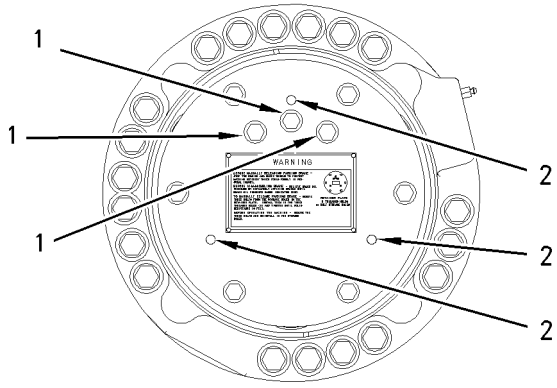


Illustration 76 g00943164

3. Remove three bolts (1) from the storage holes in the cover.

4. Install the bolts in forcing holes (2). Tighten these bolts until an opposing force is felt.

5. Before the machine is operated again, remove the bolts from the forcing holes and install bolts in the storage holes.

Engine Starting (Alternate Methods)

i02407539

Engine Starting with Jump Start Cables

SMCS Code: 1000; 7000

⚠ WARNING

Failure to properly service the batteries may cause personal injury.

Prevent sparks near the batteries. They could cause vapors to explode. Do not allow the jump start cable ends to contact each other or the machine.

Do not smoke when checking battery electrolyte levels.

Electrolyte is an acid and can cause personal injury if it contacts the skin or eyes.

Always wear eye protection when starting a machine with jump start cables.

Improper jump start procedures can cause an explosion resulting in personal injury.

When using jumper cables, always connect the positive (+) jumper cable to the positive (+) battery terminal first. Next, connect the negative (-) jumper cable to the frame away from the batteries. Follow the procedure in the Operation and Maintenance Manual.

Jump start only with an energy source of the same voltage as the stalled machine.

Turn off all lights and accessories on the stalled machine. Otherwise, they will operate when the energy source is connected.

⚠ WARNING

Do not attempt to charge a battery that has ice in any of the cells.

Charging a battery in this condition can cause an explosion that may result in personal injury or death.

Always let the ice melt before attempting to charge.

NOTICE
When starting from another machine, make sure that the machines do not touch. This could prevent damage to engine bearings and electrical circuits.

Turn on (close) the battery disconnect switch prior to the boost connection to prevent damage to electrical components on the stalled machine.

Severely discharged maintenance free batteries do not fully recharge from the alternator after jump starting. The batteries must be charged to proper voltage with a battery charger. Many batteries thought to be unusable are still rechargeable.

This machine has a 24 volt starting system. Use only the same voltage for jump starting. Use of a higher voltage damages the electrical system.

Use of Jump Start Cables

1. Place the transmission control on the stalled machine in the NEUTRAL position. Engage the parking brake. Lower all attachments to the ground. Move all controls to the HOLD position.
2. On the stalled machine, turn the engine start switch to the OFF position. Turn off the accessories.
3. On the stalled machine, turn the battery disconnect switch to the ON position.
4. Move the machine or the auxiliary power source close to the stalled machine so that the cables can reach. **DO NOT ALLOW THE MACHINE OR THE AUXILIARY POWER SOURCE TO CONTACT THE STALLED MACHINE.**
5. Stop the engine on the machine that is the electrical source. (If you are using an auxiliary power source, turn off the charging system.)
6. Check the battery caps for correct placement and for correct tightness. Make these checks on both machines. Make sure that the batteries in the stalled machine are not frozen. Check the batteries for low electrolyte.
7. Connect the positive jump start cable to the positive cable terminal of the discharged battery.

   Do not allow positive cable clamps to contact any metal except for battery terminals.

Note: Batteries in series may be in separate compartments. Use the terminal that is connected to the starter solenoid. This battery is normally on the same side of the machine as the starter.

8. Connect the positive jump start cable to the positive terminal of the electrical source. Use the procedure from Step 7 in order to determine the correct terminal.

9. Connect one end of the negative jump start cable to the negative terminal of the electrical source.

10. Make the final connection. Connect the negative cable to the frame of the stalled machine. Make this connection away from the battery, away from the fuel, away from the hydraulic lines, and away from all moving parts.

11. Start the engine of the machine that is the electrical source. (If you are using an auxiliary power source, energize the charging system on the auxiliary power source.)

12. Allow the electrical source to charge the batteries for two minutes.

13. Attempt to start the stalled engine.

Reference: For more information, refer to Operation and Maintenance Manual, “Engine Starting”.

14. Immediately after the stalled engine starts, disconnect the jump start cables in reverse order.

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Engine Starting with Auxiliary Start Receptacle
(If Equipped)

SMCS Code: 1463

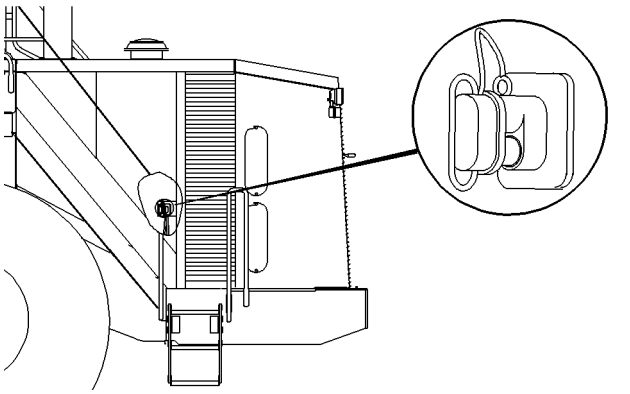


Illustration 77 g00943217

The Auxiliary Starting Receptacle is behind the access door on the left side of the machine.

Some Caterpillar machines may be equipped with auxiliary starting receptacles. All other machines can be equipped with a receptacle from parts service. A permanent receptacle is always available for jump starting.

There are two cable assemblies that can be used to jump start the stalled machine. You can jump start the stalled machine from another machine that is equipped with an auxiliary starting receptacle or with an auxiliary power pack. Your Caterpillar dealer can provide the correct cable lengths for your application.

1. Determine the reason that the engine will not start. See Special Instruction, SEHS7768 for information about the use of 6V-2150 Starting/Charging Analyzer. Use this procedure even if the machine does not have a diagnostic connector.

2. Move the transmission control lever on the stalled machine to the NEUTRAL position. Engage the parking brake. Lower all attachments to the ground. Move all controls to the HOLD position.

3. Turn the start switch key on the stalled machine to the OFF position. Turn off all accessories.

4. Turn on the battery disconnect switch that is located on the stalled machine .

5. Move the machine that is being used as a power source close to the stalled machine so that the jump start cables reach the batteries on both machines. **DO NOT ALLOW THE MACHINES TO CONTACT EACH OTHER.**

6. Stop the engine on the machine that is being used as a power source. If you use an auxiliary power source, turn off the charging system.

7. Connect the appropriate jump start cable to the auxiliary starting receptacle on the stalled machine.

8. Connect the other end of the jump start cable to the auxiliary starting receptacle of the machine that is being used as a power source.

9. Start the engine on the machine that is being used as a power source or energize the charging system on the auxiliary power source.

10. Allow the machine that is being used as a power source to charge the batteries for two minutes.

11. Attempt to start the stalled engine.

12. Immediately after the stalled engine starts, disconnect the jump start cable from the machine that is being used as a power source.

13. Disconnect the other end of the jump start cable from the stalled machine.

14. Conclude the failure analysis on the starting charging system of the stalled machine, as required. Check the machine while the engine is running and the charging system is in operation.

Maintenance Section

Tire Inflation Information

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Tire Inflation with Nitrogen

SMCS Code: 4203

Caterpillar recommends the use of dry nitrogen gas for tire inflation and for tire pressure adjustments. This includes all machines with rubber tires. Nitrogen is an inert gas that will not aid combustion inside the tire.

⚠ WARNING

Proper nitrogen inflation equipment, and training in using the equipment, are necessary to avoid over inflation. A tire blowout or rim failure can result from improper or misused equipment and personal injury or death can occur.

A tire blowout and/or rim failure can occur if the inflation equipment is not used correctly, due to the fact that a fully charged nitrogen cylinder's pressure is approximately 15000 kPa (2200 psi).

There are other benefits to using nitrogen in addition to reducing the risk of an explosion. The use of nitrogen for tire inflation lessens the slow oxidation of the rubber. Use of nitrogen also slows gradual tire deterioration. This is especially important for tires that are expected to have a long service life of at least four years. Nitrogen reduces the corrosion of rim components. Nitrogen also reduces problems that result from disassembly.

⚠ WARNING

A tire blowout or a rim failure can cause personal injury.

Use a self-attaching inflation chuck and stand behind the tread when inflating a tire, to prevent personal injury.

Note: Do not set the tire inflation equipment regulator higher than 140 kPa (20 psi) over the recommended tire pressure.

Use 6V-4040 Inflation Group or an equivalent inflation group to inflate tires with a nitrogen gas cylinder.

Reference: For tire inflation instructions, refer to Special Instruction, SMHS7867, “Nitrogen Tire Inflation Group”.

For nitrogen inflation, use the same tire pressures that are used for air inflation. Consult your tire dealer for operating pressures.

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Tire Inflation Pressure

SMCS Code: 4203; 7500

The tire inflation pressure for machines that are shipped from the factory is suitable for shipping only. Always obtain the proper tire inflation pressures for your machine from the tire supplier before placing the machine into operation. The recommended tire inflation pressures for the front tires and for the rear tires will vary for each application.

Proper tire inflation pressure and maintenance of the tire inflation pressure is critical for optimum tire life. The tire inflation pressure should always be obtained from the tire supplier due to changes in the technology of tires, equipment, and job applications.

Reference: Refer to the latest edition of Special Publication, “Caterpillar Performance Handbook” for general information on tire inflation pressure.

i02610518

Tire Inflation Pressure Adjustment

SMCS Code: 4203

Always obtain the proper tire inflation pressures and maintenance recommendations for the tires on your machine from your tire supplier. The tire pressure in a warm shop area 18° to 21°C (65° to 70°F) will significantly change when you move the machine into freezing temperatures. If you inflate the tire to the correct pressure in a warm shop, the tire will be underinflated in freezing temperatures. Low pressure shortens the life of a tire.

Reference: When you operate the machine in freezing temperatures, refer to Special Publication, SEBU5898, “Cold Weather Recommendations for All Caterpillar Machines” in order to adjust tire inflation pressures.

Lubricant Viscosities and Refill Capacities

i05562829

Lubricant Viscosities

SMCS Code: 7581

General Information for Lubricants

When you are operating the machine in temperatures below −20°C (−4°F), refer to Special Publication, SEBU5898, “Cold Weather Recommendations”. This publication is available from your Cat dealer.

For cold-weather applications where transmission oil SAE 0W-20 is recommended, Cat TDTO Cold Weather is recommended.

Refer to the “Lubricant Information” section in the latest revision of the Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for a list of Cat engine oils and for detailed information. This manual may be found on the Web at Safety.Cat.com.

The footnotes are a key part of the tables. Read ALL footnotes that pertain to the machine compartment in question.

Selecting the Viscosity

In order to select the proper oil for each machine compartment, refer to the "Lubricant Viscosity for Ambient Temperature" table. Use the oil type AND oil viscosity for the specific compartment at the proper ambient temperature.

The proper lubricant viscosity grade is determined by the minimum outside temperature when the machine is started. The proper lubricant viscosity grade is also determined by the maximum outside temperature while the machine is operated. Use the column on the table that is designated “Min” in order to determine the lubricant viscosity grade that is required when you start a cold machine and when you operate a cold machine. Use the column on the table that is designated “Max” to select the lubricant viscosity grade when you operate the machine at the highest temperature that is anticipated. When you start the machine, use the oil with the highest lubricant viscosity that is allowed for the temperature.

Machines that are continuously operated should use the oils with a higher viscosity in the final drives and differentials in order to maintain the highest possible oil film thickness. Refer to “General Information for Lubricants” article, “Lubricant Viscosities” tables, and any associated footnotes. Consult your Cat dealer if additional information is needed.

NOTICE
Not following the recommendations found in this manual can lead to reduced performance and compartment failure.

Engine Oil

Cat oils have been developed and tested in order to provide the full performance and life that has been designed and built into Cat engines.

Cat DEO-ULS multigrade and Cat DEO multigrade oils are formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Cat diesel engines where recommended for use.

Table 5

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Performance Requirements	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Engine Crankcase for all Machines	Cat DEO-ULS Cold Weather	SAE 0W-40	−40	40	−40	104
	Cat DEO-ULS SYN	SAE 5W-40	−30	50	−22	122
	Cat DEO-ULS Cat DEO	SAE 10W-30	−18	40	0	104
	Cat DEO-ULS Cat DEO	SAE 15W-40	−9.5	50	15	122

When fuels of sulfur level of 0.1 percent (1000 ppm) or higher are used, Cat DEO-ULS may be used if S·O·S oil analysis program is followed. Base the oil change interval on the oil analysis.

Note: Failure to follow oil analysis recommended oil change interval may result in reduced engine component life.

Hydraulic Systems

Refer to the “Lubricant Information” section in the latest revision of the Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for detailed information. This manual may be found on the Web at Safety.Cat.com.

The following are the preferred oils for use in most Cat machine hydraulic systems:

- Cat HYDO Advanced 10 SAE 10W
- Cat HYDO Advanced 30 SAE 30W
- Cat BIO HYDO Advanced

Cat HYDO Advanced fluids have a 50% increase in the standard oil drain interval for machine hydraulic systems over second and third choice oils when you follow the maintenance interval schedule for oil filter changes and for oil sampling that is stated in the Operation and Maintenance Manual for your particular machine. 6000 hour oil drain intervals are possible when using S·O·S Services oil analysis. Consult your Cat dealer for details. When switching to Cat HYDO Advanced fluids, cross contamination with the previous oil should be kept to less than 10%.

Second choice oils are listed below.

- Cat MTO
- Cat DEO
- Cat DEO-ULS
- Cat TDTO
- Cat TDTO Cold Weather
- Cat TDTO-TMS
- Cat DEO-ULS SYN
- Cat DEO-ULS Cold Weather

Table 6

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
Hydraulic System	**Cat HYDO Advanced 10**(1) Cat TDTO	SAE 10W	−20	40	−4	104
	Cat HYDO Advanced 30 Cat TDTO	SAE 30	0	50	32	122
	Cat BIO HYDO Advanced	“ISO 46” Multi-Grade	−30	45	−22	113
	Cat MTO Cat DEO-ULS Cat DEO	SAE10W-30	−20	40	−4	104
	Cat DEO-ULS Cat DEO	SAE15W-40	−15	50	5	122
	Cat TDTO-TMS	Multi-Grade	−15	50	5	122
	Cat DEO-ULS SYN	SAE 5W-40	−25	40	−13	104
	Cat DEO-ULS Cold Weather	SAE0W-40	−40	40	−40	104
	Cat TDTO Cold Weather	SAE 0W-20	−40	40	−40	104

(1) −20° C (−4° F) to 50° C (122° F) if equipped with the High Ambient Cooling Attachment

Other Oil Applications

Refer to the “Lubricant Information” section in the latest revision of the Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for detailed information. This manual may be found on the Web at Safety.Cat.com.

Cat HYDO Advanced fluids are the preferred oils for use in Cat machines hydraulic systems.

When you are operating the machine in temperatures below −20°C (−4°F), refer to Special Publication, SEBU5898, “Cold Weather Recommendations”. This publication is available from your Cat dealer.

Table 7

Wheel Loaders, Integrated Toolcarriers, Wheeled Dozers, and Compactors Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
Power Shift Transmission	**Cat TDTO Cat TDTO-TMS Cat Cold Weather TDTO Cat TO-4, Cat TO-4M**	SAE 0W-20	−40	10	−40	50
		SAE 10W	−20	10	−4	50
		SAE 30	0	35	32	95
		SAE 50	10	50	50	122
		TDTO-TMS	−20	43	4	110

(continued)

(Table 7, contd)

Wheel Loaders, Integrated Toolcarriers, Wheeled Dozers, and Compactors Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
Drive Axles for Large Wheel Loaders (988-993), Large Wheel Dozers (834-854), and Large Compactors (836)	**Cat TDTO Cat TDTO-TMS Cat Cold Weather TDTO Cat TO-4, Cat TO-4M**	SAE 0W-20	−40	−10	−40	14
		SAE 10W	−25	0	−13	32
		SAE 30	−20	20	−4	68
		SAE 50	−10	50	14	122
		Cat TDTO-TMS	−25	22	−13	72
Drive Axles for 994 Wheel Loader	**Cat TDTO Cat TDTO-TMS Cat TO-4, Cat TO-4M**	SAE 10W	−25	0	−13	32
		SAE 30	−20	20	−4	68
		SAE 50	−10	43	14	110
		SAE 60	−5	50	23	122
		Cat TDTO-TMS	−25	22	−13	72
Powered Stairway (If equipped)	**Cat TDTO** Cat TO-4	SAE 10W	0	50	32	122
	Cat Cold Weather TDTO	SAE 0W-20	0	50	32	122
	MIL-H-5606A	MIL-H-5606A	-40	40	-40	104

Grease Applications

In order to use a non-Cat grease, the supplier must certify that the lubricant is compatible with Cat grease.

Each pin joint should be flushed with the new grease. Ensure that all old grease is removed. Failure to meet this requirement may lead to failure of a pin joint.

Table 8

Type of Cat Grease								
Application Point	**Typical Load and Speed**	**Load Factor**	**Ambient Temperature Range**				**NLGI Grade**	**Grease Type**
			° C		**° F**			
			Min	**Max**	**Min**	**Max**		
Articulation Bearings, Articulation Pins, Blade Lift Cylinder Socket, Centershift Cylinder Socket, Fan Drive Bearings, Fan Drive Belt Tightener, Pump Drive Shaft Slip Spline	High	Ditching, fill spreading, spreading base material, ripping, heavy road maintenance, snow plowing.	−35	40	−31	104	1	Cat Ultra 5Moly Grease
			−30	50	−22	122	2	
	Medium	Average road maintenance, road mix work, scarifying, snow plowing.	−20	40	−4	104	2	Cat Advanced 3Moly Grease
	Low	Finish grading, light maintenance, road travel.	−30	40	−22	104	2	Cat Multipurpose Grease
Drive Shaft Spline (Center)			−30	50	−22	122	2	Cat Ultra 5Moly Grease
Drive Shaft Support Bearing, Drive Shaft Universal Joints			-30	40	-22	104	2	Cat Multipurpose Grease

Table 9

Recommended Grease for the Autolube System				
Compartment or System	GreaseType	NLGI Grade	°C	°F
			Min	Min
Cat Autolube System	Cat 3Moly Grease	NLGI Grade 2	−18	0
	Cat Ultra 5Moly	NLGI Grade 2	−7	20
		NLGI Grade 1	−18	0
		NLGI Grade 0	−29	−20
	Cat Arctic Platinum	NLGI Grade 0	−43	−45
	Cat Desert Gold	NLGI Grade 2	2	35

The grease used with the automatic lubrication system must not contain any graphite or PTFE.

Note: Pumpability is based on “US Steel Mobility and Lincoln Ventmeter Tests”. Performance may vary depending on lubrication equipment and the length of the lines.

Reference: Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for additional information about grease. This manual may be found on the Web at Safety.Cat.com.

Diesel Fuel Recommendations

Diesel fuel must meet Caterpillar Specification for Distillate Fuel and the latest revisions of “ASTM D975-09a” and “EN 590” in order to ensure optimum engine performance. Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for the latest fuel information and for Caterpillar fuel specification. This manual may be found on the Web at Safety.Cat.com.

The preferred fuels are distillate fuels. These fuels are commonly called diesel fuels, furnace oil, gas oil, or kerosene. These fuels must meet the Caterpillar Specification for Distillate Fuel For Off-Highway Diesel Engines. Diesel fuels that meet the Caterpillar specification will help provide maximum engine service life and performance. This manual may be found on the Web at Safety.Cat.com.

Misfueling with fuels of high sulfur level can have the following negative effects:

- Reduce engine efficiency and durability.
- Increase the wear.
- Increase the corrosion.
- Increase the deposits.
- Lower fuel economy
- Shorten the time period between oil drain intervals (more frequent oil drain intervals).
- Increase overall operating costs.
- Negatively impact engine emissions

Failures that result from the use of improper fuels are not Cat factory defects. Therefore the cost of repairs would not be covered by a Cat warranty.

Caterpillar does not require the use of ULSD in non-road and machine applications that are not Tier 4/ Stage IIIB/ Stage IV certified engines and are not equipped with aftertreatment devices. Follow operating instructions and fuel tank inlet labels, if available in order to ensure that the correct fuels are used.

Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for more details about fuels, lubricants. This manual may be found on the Web at Safety.Cat.com.

Fuel Additives

Cat Diesel Fuel Conditioner and Cat Fuel System Cleaner are available for use when needed. These products are applicable to diesel and biodiesel fuels. Consult your Cat dealer for availability.

Biodiesel

Biodiesel is a fuel that can be made from various renewable resources that include vegetable oils, animal fat, and waste cooking oil. Soybean oil and rapeseed oil are the primary vegetable oil sources. In order to use any of these oils or fats as fuel, the oils or fats are chemically processed (esterified). The water and contaminants are removed.

U.S. distillate diesel fuel specification “ASTM D975-09a” includes up to B5 (5 percent) biodiesel. Currently, any diesel fuel in the U.S. may contain up to B5 biodiesel fuel.

European distillate diesel fuel specification “EN 590” includes up to B5 (5 percent) and in some regions up to B7 (7 percent) biodiesel. Any diesel fuel in Europe may contain up to B5 or in some regions up to B7 biodiesel fuel.

Note: Up to B20 biodiesel blend level is acceptable for use in this machine.

When biodiesel fuel is used, certain guidelines must be followed. Biodiesel fuel can influence the engine oil, aftertreatment devices, non-metallic, fuel system components, and others. Biodiesel fuel has limited storage life and has limited oxidation stability. Follow the guidelines and requirements for engines that are seasonally operated and for standby power generation engines.

In order to reduce the risks associated with the use of biodiesel, the final biodiesel blend and the biodiesel fuel used must meet specific blending requirements.

All the guidelines and requirements are provided in the latest revision of Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations”. This manual may be found on the Web at Safety.Cat.com.

Coolant Information

The information provided in this “Coolant Recommendation” section should be used with the “Lubricants Information” provided in the latest revision of Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations”. This manual may be found on the Web at Safety.Cat.com.

The following two types of coolants may be used in Cat diesel engines:

Preferred – Cat ELC (Extended Life Coolant)

Acceptable – Cat DEAC (Diesel Engine Antifreeze/ Coolant)

NOTICE
Never use water alone as a coolant. Water alone is corrosive at engine operating temperatures. In addition, water alone does not provide adequate protection against boiling or freezing.

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Capacities (Refill)

SMCS Code: 7560

Table 10

Approximate Refill Capacities			
Component or System	**Liters**	**US gal**	**Recommended Type**
Engine Crankcase	95	25	Diesel Engine Oil (DEO) API CG-4 or CF-4
Transmission	110	30	Caterpillar TDTO

(continued)

(Table 10, contd)

Approximate Refill Capacities			
Component or System	**Liters**	**US gal**	**Recommended Type**
Hydraulic Tank (Implement and Brakes)	197	52	Caterpillar HYDO or Caterpillar HEES
Hydraulic Tank (Steering and Fan Drive Motor)	132	35	Caterpillar HYDO or Caterpillar HEES
Cooling System	150	40	Caterpillar ELC
Fuel Tank	1016	260	No. 1 Diesel Fuel or No. 2 Diesel Fuel
Front Differential and Final Drive(1)	271	72	Caterpillar TDTO
Rear Differential and Final Drive(1)	261	69	Caterpillar TDTO

(1) Allow 4 L (1 US gal) for the addition of 1U-9891 Hydraulic Oil Additive.

Table 11

Caterpillar Extender for ELC	
Cooling System Capacity	**Recommended Amount of Extender**
22 to 30 L (6 to 8 US gal)	0.57 L (20 fl oz)
31 to 38 L (8 to 10 US gal)	0.71 L (24 fl oz)
39 to 49 L (10 to 13 US gal)	0.95 L (32 fl oz)
50 to 64 L (13 to 17 US gal)	1.18 L (40 fl oz)
65 to 83 L (17 to 22 US gal)	1.60 L (54 fl oz)
84 to 114 L (22 to 30 US gal)	2.15 L (72 fl oz)
115 to 163 L (30 to 43 US gal)	3.00 L (100 fl oz)
164 to 242 L (43 to 64 US gal)	4.40 L (148 fl oz)

For the refill capacities for the air conditioning system, refer to Service Manual, SENR5664, “Air Conditioning and Heating R-134a For All Caterpillar Machines”.

i07445339

S·O·S Information

SMCS Code: 1348; 1395; 3080; 4070; 4250; 4300; 5050; 7542

S·O·S Services is a highly recommended process for Cat customers to use in order to minimize owning and operating cost. Customers provide oil samples, coolant samples, and other machine information. The dealer uses the data in order to provide the customer with recommendations for management of the equipment. In addition, S·O·S Services can help determine the cause of an existing product problem.

Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluid Recommendations” for detailed information concerning S·O·S Services.

The effectiveness of S·O·S Services is dependent on timely submission of the sample to the laboratory at recommended intervals.

Refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” for a specific sampling location and a service hour maintenance interval.

Consult your Cat dealer for complete information and assistance in establishing an S·O·S program for your equipment.

Maintenance Support

i03291524

System Pressure Release

SMCS Code: 1250-553-PX; 1300-553-PX; 1350-553-PX; 3000-553-PX; 4250-553-PX; 4300-553-PX; 5050-553-PX; 6700-553-PX; 7540-553-PX

General Precautions

⚠ WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

Perform this procedure in order to release compressed air pressure or hydraulic oil pressure.

Put blocks in front of the wheels and behind the wheels.

Perform this procedure before performing any of the following service procedures:

- Disconnecting any hydraulic connections for the implement system
- Removing any sensors or switches from the implement system
- Working on the bucket or linkage

Brake Pressure

To release any brake oil pressure, depress the brake pedal repeatedly.

Cooling System Pressure

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

Wait until the radiator is cool.

Slowly loosen cooling system pressure cap in order to relieve any system pressure.

Hydraulic Pressure

⚠ WARNING

Hydraulic oil pressure can remain in the hydraulic system on this machine after the engine and pump have been stopped. Serious injury can result if this pressure is not released before any service is done on the hydraulic systems. In order to prevent possible injury, release the hydraulic system pressure before working on any fitting, hose, or hydraulic component.

Lower all attachments to the ground before service is started. If the hydraulic system must be serviced, tested, or adjusted with the attachment in the raised position, the attachments and lift cylinders must be supported properly.

Always move the machine to a location away from the travel of other machines. Be sure that other personnel are not near the machine when the engine is running and tests or adjustments are being made.

Note: The pressure in the hydraulic system must be released before hose assemblies or components can be removed or disconnected.

Note: Hydraulic lockout control must be in the UNLOCKED position.

1. Ensure that the machine is on a smooth, horizontal surface. Ensure that the machine is away from working machines and personnel. Lower all implements to the ground. Install the articulation lock pin.

Note: Permit only one operator on the machine. Keep all other personnel away from the machine or in the view of the operator.

2. Activate the parking brake. Place all implements on the ground.
3. If equipped, move all joysticks into all positions repeatedly.
4. Place the lift cylinders in the FLOAT position. The oil will return to the hydraulic tank. This will relieve pressure in the circuit.
5. Stop the engine.

NOTICE
Never remove the fill/vent plug from the hydraulic tank if the oil is hot.

Air can enter the system and cause pump damage.

6. In order to release all remaining pressure in the hydraulic oil tank, hold down the plunger on the breaker relief valve. The breaker relief valve is located on the hydraulic oil tank.

Note: The pressure in the hydraulic oil tank may also be released by slowly loosening the filler cap. Make sure that the filler cap is cool enough to touch with your bare hand.

7. Ensure that all pressure is relieved in the secondary hydraulic system. Ensure that all pressure is relieved in the auxiliary hydraulic system.

8. Make sure that all of the hydraulic pressure is relieved before any work is performed on the hydraulic system or any hydraulic component.

9. Tighten the cap on the hydraulic tank.

Lock Valve Pressure

The procedures in this section may be used in the following operations:

- Maintenance on lock valves
- Maintenance on hydraulic cylinders

1. Fully slacken the locknut.

2. Use an appropriate allen wrench in order to adjust the screw as far as possible in a counterclockwise direction. Record the number of turns in order to reset the lock valve later. The pressure in the lock valve will now be relieved.

3. Reset the lock valve after all the pressure has been relieved.

Steering Pressure

To release any steering oil pressure, move the steering control through all travel positions several times in both directions. Move the steering wheel several times in both directions in order to relieve the pilot pressure in the steering system. If you are servicing the steering cylinders, the steering valve, or the steering hoses, slowly crack the lines in order to purge any trapped oil that may be in the steering system.

i07382254

Welding on Machines and Engines with Electronic Controls

SMCS Code: 1000; 7000

Do not weld on any protective structure. If it is necessary to repair a protective structure, contact your Cat dealer.

Proper welding procedures are necessary in order to avoid damage to the electronic controls and to the bearings. When possible, remove the component that must be welded from the machine or the engine and then weld the component. If you must weld near an electronic control on the machine or the engine, temporarily remove the electronic control in order to prevent heat related damage. The following steps should be followed in order to weld on a machine or an engine with electronic controls.

1. Turn off the engine. Place the engine start switch in the OFF position.

2. If equipped, turn the battery disconnect switch to the OFF position. If there is no battery disconnect switch, remove the negative battery cable at the battery.

NOTICE
Do NOT use electrical components (ECM or sensors) or electronic component grounding points for grounding the welder.

3. Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. Make sure that the electrical path from the ground cable to the component does not go through any bearing. Use this procedure in order to reduce the possibility of damage to the following components:

- Bearings of the drive train

- Hydraulic components
- Electrical components
- Other components of the machine

4. Protect any wiring harnesses and components from the debris and the spatter which is created from welding.

5. Use standard welding procedures in order to weld the materials together.

i07483722

Maintenance Interval Schedule

SMCS Code: 7000

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance. All adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging are included. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance. Refer to the maintenance procedure for any other exceptions that may change the maintenance intervals.

Note: The aftertreatment system can be expected to function properly for the useful life of the engine (emissions durability period), as defined by regulation. All prescribed maintenance requirements must be followed.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

Note: If Cat HYDO Advanced hydraulic oils are used, the hydraulic oil change interval may be extended substantially. S·O·S services may extend the oil change even longer. Consult your Cat dealer for details.

When Required

“ Alternator - Inspect” 84
“ Articulation Bearings - Lubricate” 84
“ Automatic Lubrication Grease Tank - Fill” 84
“ Automatic Lubrication System Components - Check” 85
“ Battery - Recycle” 89
“ Battery or Battery Cable - Inspect/Replace”. 89
“ Camera - Clean” 93
“ Circuit Breakers - Reset” 94
“ Cutting Edges and End Bits - Inspect/Replace” 100
“ Engine Air Filter Primary Element - Clean/Replace” 104
“ Engine Air Filter Secondary Element - Replace” 107
“ Engine Air Precleaner - Clean” 108
“ Ether Starting Aid Cylinder - Replace” 116
“ Fuel System - Prime” 118
“ Fuses - Replace” 122
“ High Intensity Discharge Lamp (HID) - Replace” 123
“ Oil Filter - Inspect” 132
“ Radiator Core - Clean” 132
“ Seat Side Rails - Adjust” 135
“ Secondary Steering - Test” 135
“ Transmission Magnetic Screen - Clean” 138
“ Window Washer Reservoir - Fill” 141
“ Window Wiper - Inspect/Replace” 141

Every 10 Service Hours or Daily

“ Backup Alarm - Test” 89
“ Cooling System Coolant Level - Check”. 97
“ Engine Air Filter Service Indicator - Inspect” . . . 107
“ Engine Oil Level - Check” 112
“ Hydraulic System Oil Level (Implement) (Braking) - Check” 130
“ Hydraulic System Oil Level (Steering) (Hydraulic Fan) - Check” 130
“ Seat Belt - Inspect” 133
“ Transmission Oil Level - Check” 140
“ Windows - Clean”. 141

Every 50 Service Hours or Weekly

“ Cab Air Filter - Clean/Replace” 92
“ Fuel System Primary Filter (Water Separator) - Drain” 119
“ Fuel Tank Water and Sediment - Drain” 121

“ Tire Inflation - Check” 137

Every 100 Service Hours or 2 Weeks

“ Axle Oscillation Bearings - Lubricate”. 88
“ Steering Cylinder Bearings - Lubricate” 136
“ Tilt Cylinder Bearings - Lubricate”. 137

Every 250 Service Hours

“ Engine Oil Sample - Obtain” 112

Every 250 Service Hours or Monthly

“ Battery - Clean” 89
“ Belts - Inspect/Adjust/Replace”. 90
“ Brake Accumulator - Check” 91
“ Braking System - Test” 91
“ Differential and Final Drive Oil Level - Check” . . 101
“ Drive Shaft Spline (Center) - Lubricate” 103
“ Engine Air Filter Service Indicator - Inspect/ Replace” 108
“ Engine Oil (High Speed) and Oil Filter - Change” 110
“ Engine Oil and Filter - Change”. 113

Initial 500 Service Hours

“Cooling System Coolant Sample (Level 2) - Obtain” 98
“ Electronic Unit Injector - Inspect/Adjust” 104
“ Engine Valve Lash - Check” 115
“ Engine Valve Rotators - Inspect” 115
“ Seat Side Rails - Adjust” 135

Every 500 Service Hours

“ Differential and Final Drive Oil Sample - Obtain” 102
“ Hydraulic System Oil Sample (Implement) (Braking) - Obtain” 131
“ Hydraulic System Oil Sample (Steering) (Hydraulic Fan) - Obtain” 131
“ Transmission Oil Sample - Obtain”. 140

Every 500 Service Hours or 3 Months

“Cooling System Coolant Sample (Level 1) - Obtain” 97
“ Engine Oil (High Speed) and Oil Filter - Change” 110
“ Engine Oil and Filter - Change”. 113
“ Fuel System Primary Filter (Water Separator) Element - Replace” 119
“ Fuel System Secondary Filter - Replace”. 120
“ Fuel Tank Cap and Strainer - Clean” 121
“ Hoses and Clamps - Inspect/Replace”. 124
“ Hydraulic System Oil Filter (Implement) (Braking) - Replace” 129
“ Hydraulic System Oil Filter (Steering) (Hydraulic Fan) - Replace” 129
“ Transmission Oil Filter - Replace”. 139

Every 1000 Service Hours or 6 Months

“ Articulation Bearings - Lubricate” 84
“ Battery Hold-Down - Tighten” 89
“ Case Drain Oil Filters - Replace” 93
“ Drive Shaft Support Bearing - Lubricate” 104
“ Drive Shaft Universal Joints - Lubricate” 104
“ Lift Cylinder Yoke Bearings - Lubricate” 131
“ Rollover Protective Structure (ROPS) - Inspect” 133
“ Transmission Oil - Change”. 138

Every 2000 Service Hours or 1 Year

“ Crankshaft Vibration Damper - Inspect” 99
“ Differential and Final Drive Oil - Change”. 100
“ Engine Crankcase Breather - Clean” 108
“ Hydraulic System Oil (Implement) (Braking) - Change” 127
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“ Hydraulic Tank Breaker Relief Valve - Clean” . . 131

“ Receiver Dryer (Refrigerant) - Replace”. 133

“ Service Brake Wear Indicator - Check” 135

Every Year

“Cooling System Coolant Sample (Level 2) - Obtain” 98

Every 3000 Service Hours

“ Electronic Unit Injector - Inspect/Adjust” 104

“ Engine Valve Lash - Check” 115

“ Engine Valve Rotators - Inspect” 115

Every 3000 Service Hours or 2 Years

“ Cooling System Coolant Extender (ELC) - Add” 96

“ Engine Mounts - Inspect” 109

Every 3 Years

“ Seat Belt - Replace”. 134

Every 5000 Service Hours or 3 Years

“ Alternator - Inspect” 84

“ Starting Motor - Inspect” 136

“ Turbocharger - Inspect”. 141

Every 6000 Service Hours or 4 Years

“ Cooling System Coolant (ELC) - Change” 95

“ Cooling System Water Temperature Regulator - Replace” 98

“ Engine Water Pump - Inspect” 115

Every 12 000 Service Hours or 6 Years

“ Fuel Lines - Replace”. 116

i01853769

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator.

1. Open the engine access door on the right side of the machine.

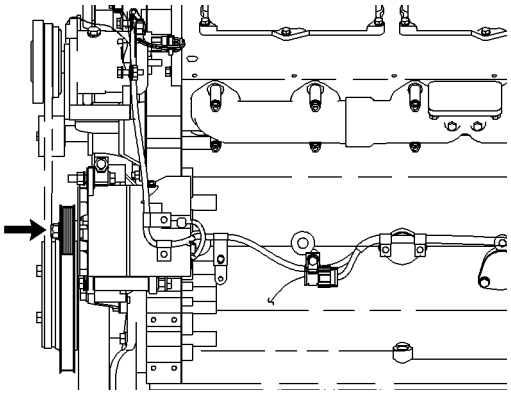


Illustration 78 g00946039

2. Inspect the alternator for loose connections.

3. Check the ammeter during engine operation in order to ensure that the electrical system is functioning properly. Make the necessary repairs.

4. Check the alternator and the battery charger for proper operation. Keep the batteries fully charged.

Note: Air temperature affects the cranking power of the batteries. Keep the batteries warm. The engine will not crank if the batteries are too cold. Even when the engine is warm, cold batteries will not crank the engine.

Note: When the engine is operated for short periods of time, the batteries may not fully recharge. Make sure that the alternator is functioning properly. The alternator will charge the battery.

i01855622

Articulation Bearings - Lubricate

SMCS Code: 7057-086-BD; 7065-086-BD; 7066-086-BD

Wipe the fittings before you apply any lubricant.

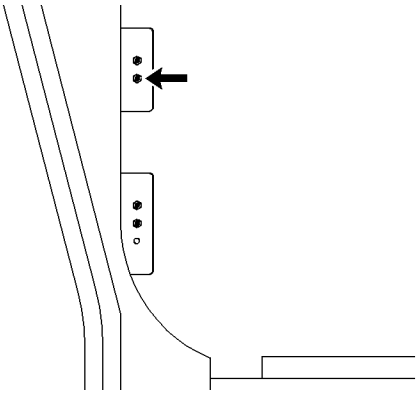


Illustration 79 g00949655

Apply lubricant through the remote fitting for the upper hitch.

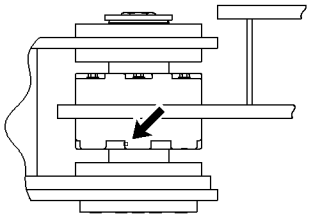


Illustration 80 g00946295

Apply lubricant through one fitting on the lower hitch.

i02216552

Automatic Lubrication Grease Tank - Fill
(If Equipped)

SMCS Code: 7540-544-TNK

⚠ WARNING

A pressure hazard is present. Severe personal injury or death can result from removing hoses or fittings that are under pressure. Relieve the pressure in the system before you remove hoses or fittings.

The Centro-Matic Lubrication System

Reference: Before any service work is performed on the lubrication system, refer to Special Instructions, REHS1394 or consult your Caterpillar dealer.

Bulk Fill

1. In order to fill the reservoir, remove the lower and upper plugs from the side of the reservoir.
2. Attach the appropriate pump to the lower inlet.
3. Fill the reservoir until visual indicator on the lid of the tank indicates FULL or until the grease appears at the top vent port.

Reference: For the correct type of grease, refer to Operation and Maintenance Manual, “Lubricant Viscosities”.

4. Remove the pump and replace both plugs.

The Quicklub Lubrication System

Reference: Before any service work is performed on the lubrication system, refer to Special Instructions, REHS1396 or consult your Caterpillar dealer.

Filling the Reservoir

1. Fill the reservoir through the grease fitting. The grease fitting is located at the base of the reservoir.

Reference: For the correct type of grease, refer to Operation and Maintenance Manual, “Lubricant Viscosities”.

2. Refill the reservoir when the grease reaches the “MIN” mark on the reservoir.
3. Fill the reservoir to the “MAX” mark on the reservoir.

Priming the System

After the reservoir has been filled with the recommended lubricant, loosen the fitting to the supply line. Operate the pump until lubricant flows from the outlet. Then, tighten fitting.

i04164902

Automatic Lubrication System Components - Check
(If Equipped)

SMCS Code: 7540-535

⚠ WARNING

A pressure hazard is present. Severe personal injury or death can result from removing hoses or fittings that are under pressure. Relieve the pressure in the system before you remove hoses or fittings.

Reference: Before any service work is performed on the lubrication system, refer to Special Instructions, REHS1394 or consult your Cat dealer.
Autolube systems need to be adjusted before being put into use to ensure each joint gets the appropriate amount of grease. Different applications require frequency, volume, and proportioning adjustments from the recommended or factory settings.

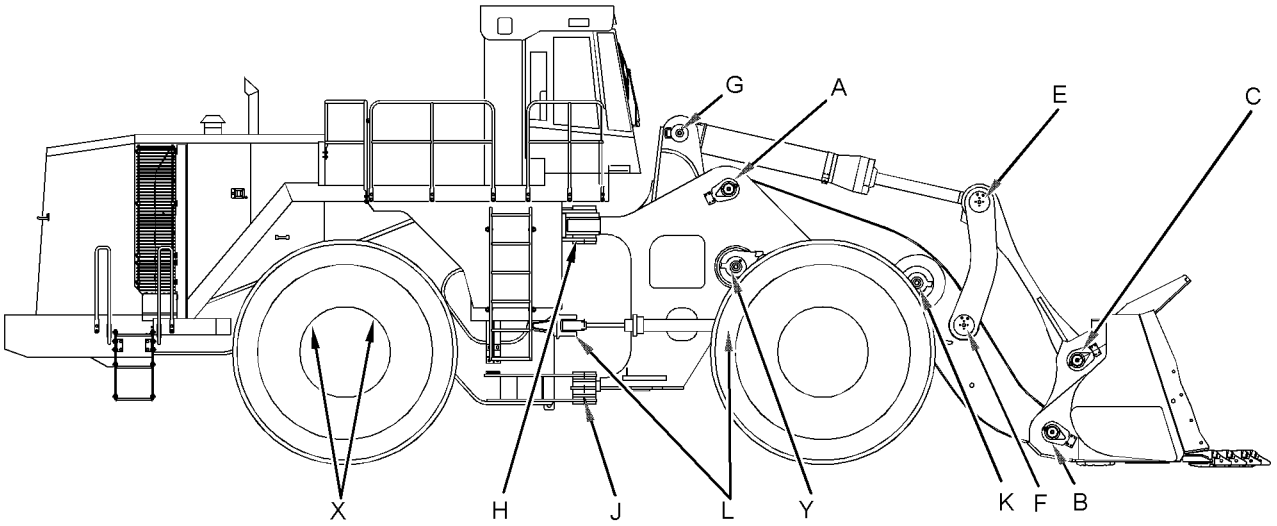


Illustration 81 g01032039

(A) A-Pin
(B) B-Pin
(C) C-Pin
(E) E-Pin
(F) F-Pin
(G) G-Pin
(H) Pin for Upper Articulation Joint
(J) Pin for Lower Articulation Joint
(K) K-Pin
(L) Steering Cylinder Pins
(X) Trunnions
(Y) Y-Pin

1. Remove any buildup of grease. Check that each pin joint is receiving a fresh supply of grease.

Reference: If a fresh supply of grease is not present, refer to Special Instructions, REHS1394 for system troubleshooting procedures.

2. Check the grease level at the top vent port of the reservoir.

Reference: For filling procedures, refer to Operation and Maintenance Manual, “Automatic Lubrication Grease Tank - Fill”.

Settings of the Injectors for the Autolube System

The controller of the autolube system is preset from the factory. The lubrication is dispensed at 15 minute intervals, and all of the injectors are preset at the full flow setting. There may be an excessive buildup of grease around some of the joints. As a result, the grease reservoir may need filling more frequently. The injectors for selected joints can be adjusted in order to reduce the flow of grease without adversely affecting the life of the pin. The injectors are set by the factory at the full flow setting. This setting is equivalent to 8 turns open. When the injectors are adjusted, the injectors should first be closed. Then, the injectors should be opened by the number of specified turns. The recommended settings for the injectors at each pin location are listed in Table 12 .

Table 12

Pins	Qty (Injectors)	Settings (Turns)
A	0	8
B	2	
C	2	
E	3	5
F	2	2
G	1	8
H	1	2
J	1	
K	0	8
L	4	2
X	2	8
Y	0	8

Note: By using the above settings, the buildup of grease will be reduced. The interval between refills of the reservoir will be extended to approximately 250 hours. Grease levels in the reservoir must be checked in order to ensure an uninterrupted flow.

Timer Operation

Autolube systems must be adjusted before being put into use to ensure each joint gets the appropriate amount of grease. Different applications require frequency, volume, and proportioning adjustments from the recommended or factory settings.

Autolube settings must be monitored and adjusted as needed to account for changes in application, temperature, grease type, and NLGI grade.

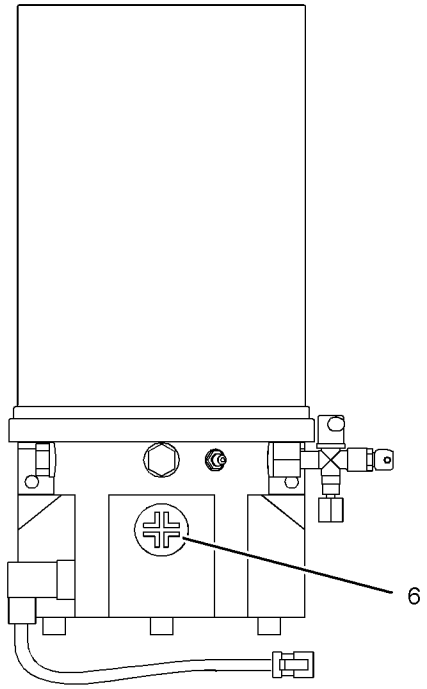


Illustration 82 g01239276

(6) Access plug

Remove access plug (6) on the front of the pump in order to access the timer control. The timer control group consists of the following:

- Manual lubrication switch
- OFF timer rotary switch
- ON timer rotary switch
- Power ON LED
- Pump ON LED

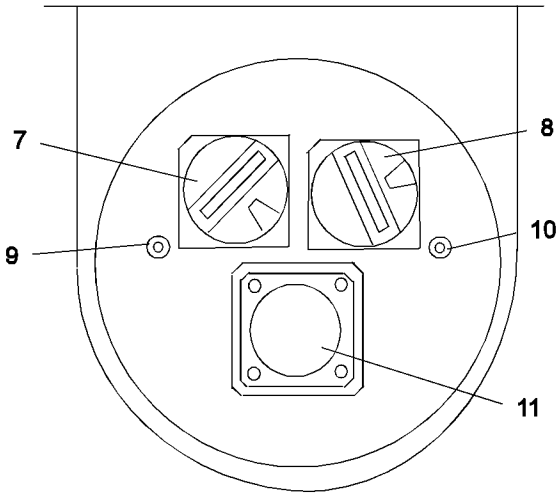


Illustration 83 g01238978

Timer control

(7) OFF timer switch
(8) ON timer switch
(9) Power ON LED.
(10) Pump motor ON LED
(11) Push button for manual lubrication

OFF timer switch (7) can be adjusted to 15 values. See Table 1 for the time interval for each value.

ON timer switch (8) can be adjusted to 15 values. See Table 1 for the time interval for each value.

LED (9) is marked “battery” . This LED will illuminate when power is sent to the pump control.

LED (10) is marked “motor” . This LED will illuminate when the pump is pumping lubricant.

Press push button (11) for 2 seconds. This process will initiate a manual lubrication cycle.

The OFF position of the timer begins accumulating time when the ignition switch closes. When the OFF position of the timer reaches the preset value, the pump will turn ON. The pump remains activated for the time period that is preset on the ON timer.

When the ignition is turned OFF, the used time is saved for an unlimited duration.

Turn the ignition to the ON position. The automatic lubrication operation will finish the cycle time.

Note: Do not use the zero setting that is located on the timer switches.

Note: The factory setting for the OFF position is “4” (16 minutes). The factory setting for the ON position is “2” (4 minutes).

Table 13

OFF TIME Rotary Switch Setting	Interval Between Cycles	ON TIME Rotary Switch Setting	Cycle Time of the Pump
0	0 minutes	0	0 minutes
1	4 minutes	1	2 minutes
2	8 minutes	2	4 minutes
3	12 minutes	3	6 minutes
4	16 minutes	4	8 minutes
5	20 minutes	5	10 minutes
6	24 minutes	6	12 minutes
7	28 minutes	7	14 minutes
8	32 minutes	8	16 minutes
9	36 minutes	9	18 minutes
A	40 minutes	A	20 minutes
B	44 minutes	B	22 minutes
C	48 minutes	C	24 minutes
D	52 minutes	D	26 minutes
E	56 minutes	E	28 minutes
F	60 minutes	F	30 minutes

Note: If the Lincoln 94824 Pump or the printed circuit board are replaced in the field, contact Lincoln Technical Service Department at 314-679-4200 ext. 4782 for instructions on special jumper pin setting for timer operation prior to installation and start up.

i02044747

Axle Oscillation Bearings - Lubricate

SMCS Code: 3268-086-BD; 3278-086-BD

Wipe the fittings before you apply any lubricant.

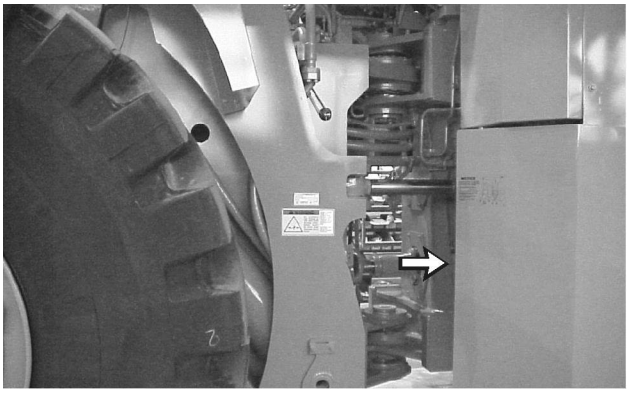


Illustration 84 g00761327

The two remote fittings are located near the articulation joint on the left side of the machine.

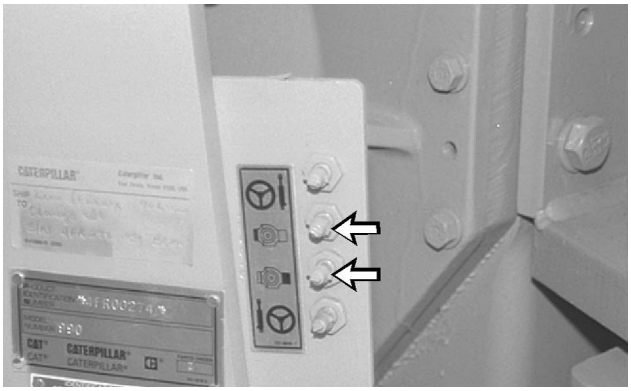


Illustration 85 g01050142

Apply lubricant through the two remote fittings.

i02044811

Backup Alarm - Test

SMCS Code: 7406-081

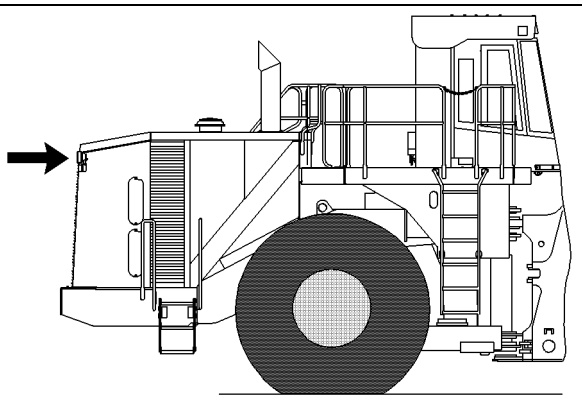


Illustration 86 g00847524

The backup alarm is behind the fan guard on the rear of the machine.

1. Turn the engine start switch to the ON position in order to perform the test.
2. Apply the service brake.
3. Move the transmission direction control switch to the REVERSE position. The backup alarm should immediately sound. The backup alarm will continue to sound until the transmission direction control switch is moved to the NEUTRAL position or to the FORWARD position.

i01861358

Battery - Clean

SMCS Code: 1401-070

Open the battery compartments on the left and right sides of the rear bumper.

Clean the battery terminals and the surfaces of the batteries with a clean cloth. Coat the battery terminals with petroleum jelly. Make sure that the battery cables are installed securely.

i06543763

Battery - Recycle

SMCS Code: 1401-561

Always recycle a battery. Never discard a battery.

Always return used batteries to one of the following locations:

- A battery supplier
- An authorized battery collection facility
- Recycling facility

i01861362

Battery Hold-Down - Tighten

SMCS Code: 7257-527

Open the battery compartments on the left and right sides of the rear bumper.

Over time, the vibration of an operating machine can cause the battery hold-downs to loosen. To help to prevent loose batteries and the possibility of loose cable connections, tighten the four locknuts (two per battery) to a torque of 14 ± 2 N·m (10 ± 1.5 lb ft).

i01835250

Battery or Battery Cable - Inspect/Replace

SMCS Code: 1401-510; 1401-040; 1402-510; 1402-040

1. Turn the engine start switch key to the OFF position. Turn all of the switches to the OFF position.
2. Turn the battery disconnect switch to the OFF position. Remove the key.
3. Disconnect the positive battery cable at the battery disconnect switch. The battery disconnect switch is connected to the machine frame.

Note: Do not allow the disconnected battery cable to contact the disconnect switch.

4. Disconnect the negative battery cable at the battery that is connected to the battery disconnect switch. If the machine has four 12 volt batteries, disconnect the negative battery cables of two of the batteries.
5. Make any necessary repairs or replace the battery.
6. Reconnect the negative battery cable at the battery that is connected to the battery disconnect switch.
7. Reconnect the positive battery cable at the battery disconnect switch.
8. Install the key and turn the battery disconnect switch to the ON position.

i01861375

Belts - Inspect/Adjust/Replace

SMCS Code: 1357-040; 1357-025; 1357-510

Alternator Belt

1. Stop the engine. Open the right side engine access door.

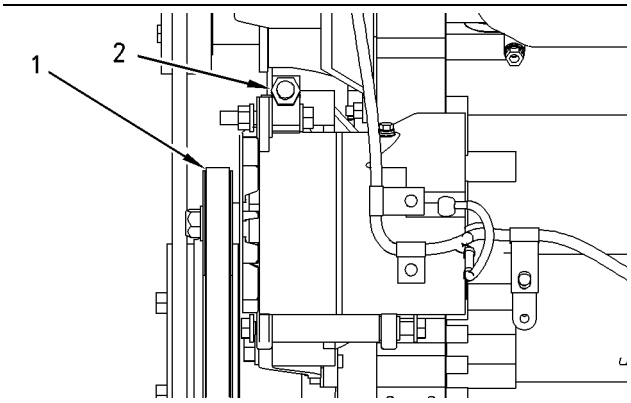


Illustration 87 g00949309

2. Inspect the condition of alternator belt (1). If the belt is cracked or frayed, replace the belt.

3. Use a Kent Moore Company BT-33-97 gauge to check the tension of the alternator belt.

The tension of a used alternator belt with more than 30 minutes of operation at rated speed should be 400 ± 44 N (90 ± 10 lb). The tension of a new alternator belt with 30 minutes of operation or less at rated speed should be 534 ± 22 N (120 ± 5 lb).

Adjusting the Tension of the Alternator Belt

1. Loosen mounting bolt (2) and the adjusting locknut.

2. Move the alternator until the correct tension is reached.

3. Tighten the adjusting locknut and mounting bolt (2).

4. Recheck the belt tension. If the belt tension is incorrect, repeat the adjustment procedure.

Air Conditioner Belt

1. Stop the engine. Open the right side engine access door.

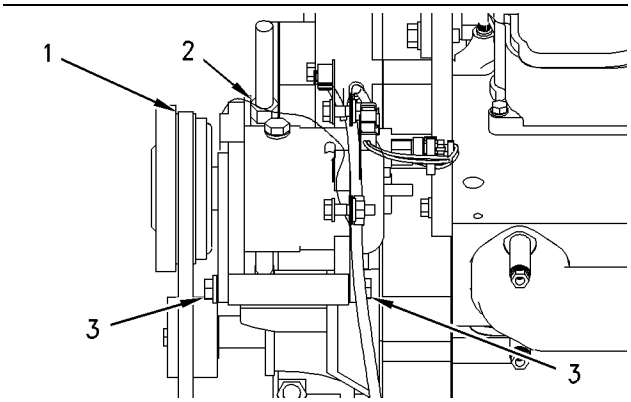


Illustration 88 g00949214

2. Inspect the condition of air conditioner belt (1). If the belt is cracked or frayed, replace the belt.

3. Use a Kent Moore Company BT-33-97 gauge to check the tension of the air conditioner belt.

The tension of a used air conditioner belt with more than 30 minutes of operation at rated speed should be 400 ± 44 N (90 ± 10 lb). The tension of a new air conditioner belt with 30 minutes of operation or less at rated speed should be 534 ± 22 N (120 ± 5 lb).

Adjusting the Tension of the Air Conditioner Belt

1. Loosen two pivot bolts (3).

2. Loosen two adjusting nuts (2).

3. Move the adjusting nuts until the correct belt tension is reached.

4. Tighten the two adjusting nuts. The torque for the nuts is 150 ± 20 N·m (110 ± 15 lb ft).

5. Tighten two pivot bolts (3).

6. Recheck the belt tension. If the belt tension is incorrect, repeat the adjustment procedure.

i01445933

Brake Accumulator - Check

SMCS Code: 4263-535

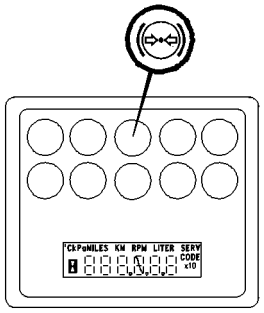


Illustration 89 g00757073

1. Turn the engine start switch to the ON position. The alert indicator for the brake oil pressure should come on if the braking system is not at the normal operating pressure.

2. Start the engine and run the engine for one minute in order to increase the accumulator pressure. The alert indicator for the brake oil pressure should go off. Stop the engine.

3. Apply the service brake pedal for a minimum of five applications until the alert indicator for the brake oil pressure comes on.

4. If the alert indicator for the brake oil pressure comes on with less than five applications of the service brake pedal, measure the nitrogen precharge pressure of the accumulator.

Your Caterpillar dealer has the appropriate tools for measuring the precharge pressure of the brake accumulator. Only use dry nitrogen gas to recharge the brake accumulator.

i01249292

Braking System - Test

SMCS Code: 4251-081; 4267-081

- Park the machine on a hard, dry, level surface.
- Check the area around the machine. Make sure that the machine is clear of personnel and clear of obstacles.
- Make sure that the steering frame lock is in the unlocked position.
- Fasten the seat belt before you test the brakes.

The following tests are used to determine whether the braking system is functional. These tests are not intended to measure the maximum brake holding effort. The required brake holding effort for sustaining a machine at a specific engine rpm varies from one machine to another machine. The variations include differences in the engine setting, the power train efficiency, the brake holding ability, etc.

Service Brake Holding Ability Test

⚠ WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

This test is performed when the service brakes are engaged. If the machine begins to move, compare the engine rpm to the engine rpm of a prior test. This will indicate the amount of system deterioration.

1. Start the engine. Raise the implement slightly. Apply the service brake. Release the parking brake.

2. Place the transmission in THIRD SPEED FORWARD while the service brakes are applied.

3. Gradually increase the engine speed to high idle. The machine should not move.

4. Reduce the engine speed to low idle. Place the transmission in neutral. Engage the parking brake. Lower the implement to the ground. Stop the engine.

If the machine moved during the test, consult your Caterpillar dealer for a brake inspection. Make any necessary repairs before the machine is returned to operation.

Parking Brake Holding Ability Test

⚠ WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move, reduce the engine speed immediately and apply the service brake pedal.

This test is performed when the parking brake is engaged. If the machine begins to move, compare the engine rpm to the engine rpm of a prior test. This will indicate the amount of system deterioration.

1. Start the engine. Raise the implement slightly. Engage the parking brake.

2. Place the transmission in THIRD SPEED FORWARD.

The parking brake indicator light should come on.

3. Gradually increase the engine speed to high idle. The machine should not move.

4. Reduce the engine speed. Place the transmission in neutral. Lower the implement to the ground. Stop the engine.

If the machine moved during the test, consult your Caterpillar dealer for a brake inspection. Make any necessary repairs before the machine is returned to operation.

i02053319

Cab Air Filter - Clean/Replace

SMCS Code: 7342-510; 7342-070

Note: The filters must be cleaned more often if the machine is being operated in dusty conditions.

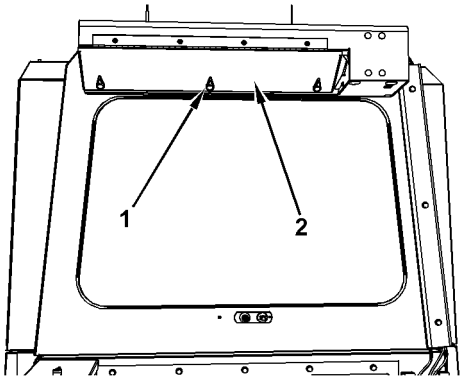


Illustration 90 g01052909

1. Open latches (1) on cover (2) and lift the cover.

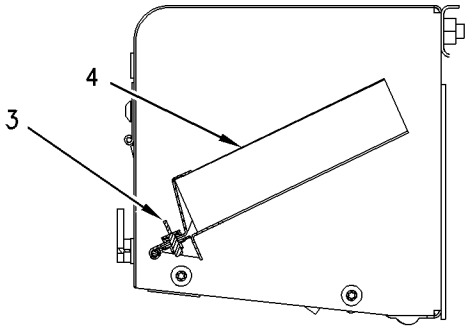


Illustration 91 g00949852

2. Remove retainers (3) from the cover. Remove fresh air filter (4).

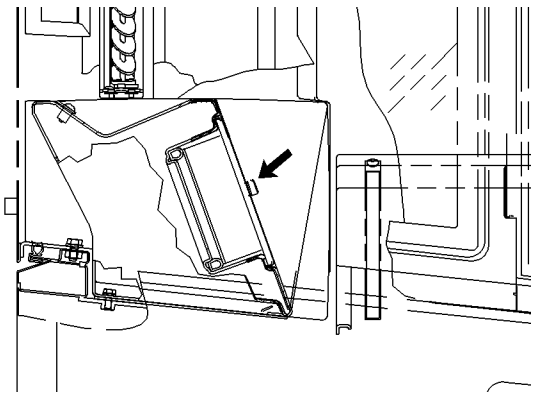


Illustration 92 g00949812

3. Remove the filter cover behind the seat. Remove the recirculation filter.

4. Clean the filter elements with pressure air or wash the filter elements in warm water with a nonsudsing household detergent.

5. If water was used to wash the filter elements, rinse the filter element in clean water and allow the filter element to air dry thoroughly.

6. Install the recirculation filter and the filter cover behind the seat.

7. Install fresh air filter (4) and retainers (3). Close the cover on the outside rear of the cab and close the latches.

i02816405

Camera - Clean
(If Equipped)

SMCS Code: 7348-070

In order to maintain sufficient vision, keep the Work Area Vision System (WAVS) camera lens and the display clean.

Display

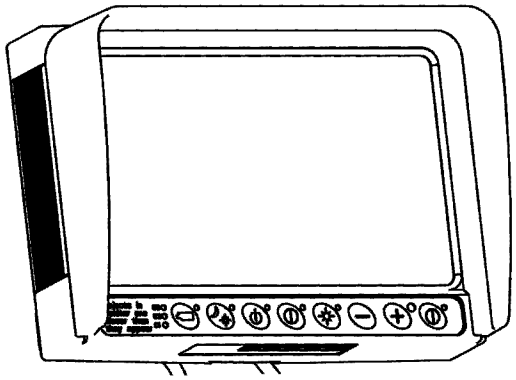


Illustration 93 g01223034
WAVS display

Use a soft, damp cloth in order to clean the display. The display has a soft plastic surface that can be easily damaged by an abrasive material. **The display is not sealed. Do not immerse the display with liquid.**

Camera

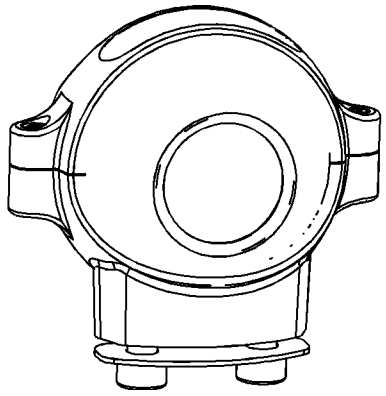


Illustration 94 g01223051
The WAVS camera is located on the rear of the machine in the center of the fan guard.

Use a damp cloth or water spray in order to clean the camera lens. The camera is a sealed unit. The camera is not affected by high pressure spray.

The camera is equipped with an internal heater to help counteract the effects of condensation, snow, or ice.

Note: For more information on WAVS, refer to Operation and Maintenance Manual, SEBU8157, “Work Area Vision System”.

i05984657

Case Drain Oil Filters - Replace
(If Equipped)

SMCS Code: 5091-510

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Hydraulic Pump Filters

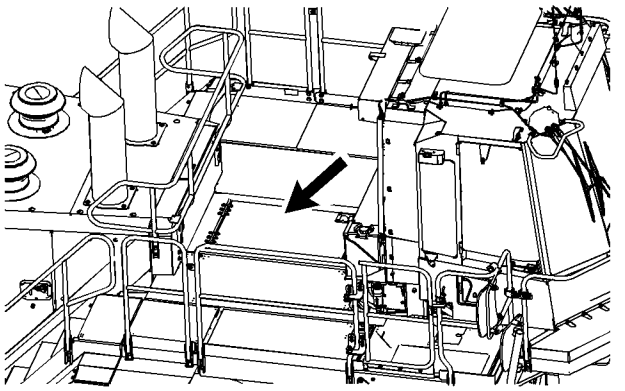


Illustration 95 g02146855

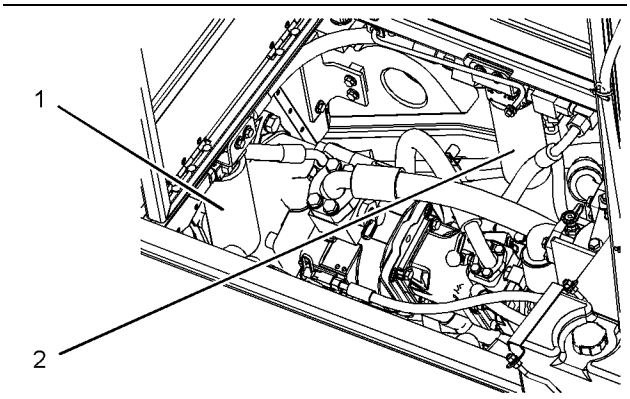


Illustration 96 g02146901

1. Stop the engine

2. Remove the steering pump filter (1) and remove the fan pump filter (2).

3. Clean the filter mounting base.

4. Lubricate the gasket of the new filter with clean hydraulic oil.

5. Discard the filter elements.

6. Install the new filter elements.

7. Check the hydraulic oil level. Refer to Operation and Maintenance Manual, “Hydraulic System Oil Level - Check” for more details about the hydraulic oil level.

8. Start the engine and run the engine at low idle. Operate the steering, the brakes, and the implements

9. Stop the engine. Inspect the filters for leaks. Make any necessary reparis. Close all access doors.

Hydraulic Fan Motor Filter

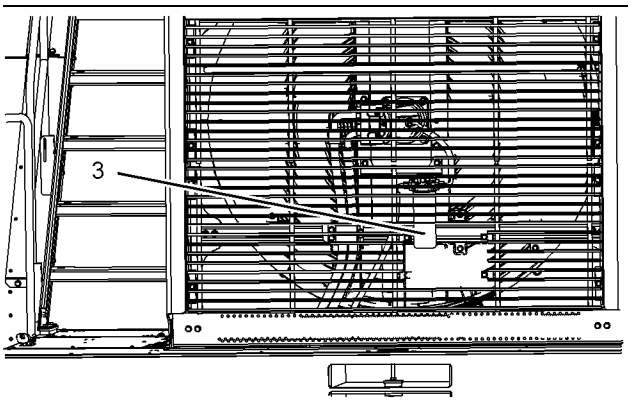


Illustration 97 g02146859

1. Remove the fan motor filter (3).

2. Clean the filter mounting base.

3. Lubricate the gasket of the new filter with clean hydraulic oil.

4. Discard the filter element.

5. Install the new filter element.

6. Check the hydraulic oil level. Refer to Operation and Maintenance Manual, “Hydraulic System Oil Level - Check” for more details about the hydraulic oil level.

7. Start the engine and run the engine at low idle. Operate the steering, the brakes, and the implements

8. Stop the engine. Inspect the filters for leaks. Make any necessary reparis. Close all access doors.

i02068764

Circuit Breakers - Reset

SMCS Code: 1420-529

Circuit Breaker/Reset – Push in the button in order to reset the circuit breaker. If the system is functioning properly, the button will remain depressed. If the button does not remain depressed, check the appropriate electrical circuit.

The circuit breakers are located under the rear access door on the right side of the cab platform.

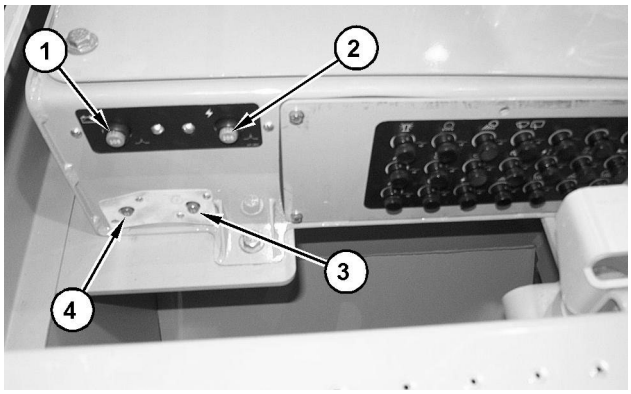


Illustration 98 g01050339

Main Circuit (1) – 105 amp

Alternator (2) – 105 amp

Engine ECM (3) – 15 amp

Engine Start Switch (4) – 10 amp

i01862955

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-044-NL

WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

NOTICE
Topping off or mixing Cat ELC with other products that do not meet Caterpillar EC-1 specifications reduces the effectiveness of the coolant and shortens coolant service life.

Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for pre-mixed or concentrate coolants. Use only Extender with Cat ELC.

Failure to follow these recommendations can result in shortened cooling system component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Reference: For information about adding Extender to your cooling system, refer to Operation and Maintenance Manual, “Cooling System Coolant Extender (ELC) - Add” or consult your Caterpillar dealer.
If an Extended Life Coolant was previously used, flush the cooling system with clean water. No other cleaning agents are required. Use the following procedure to change the Extended Life Coolant.

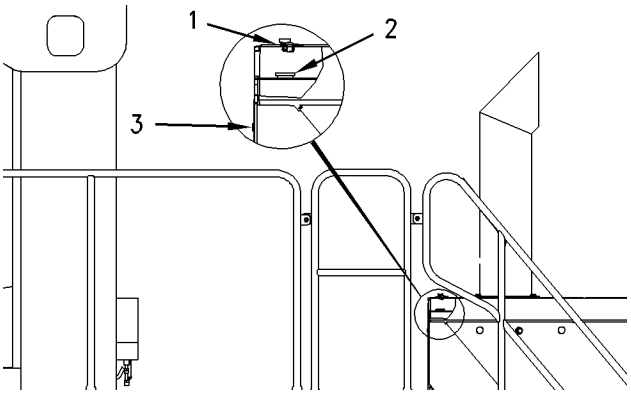


Illustration 99 g00964090
Left side view

1. Open access door (1) on the top of the engine compartment. Slowly remove cooling system pressure cap (2) in order to relieve system pressure.

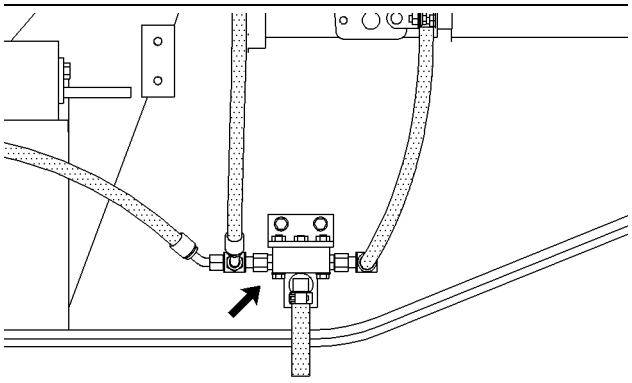


Illustration 100 g00949689

2. The coolant drain valve is located under the right rear of the machine. Open the drain valve. Allow the coolant to drain into a suitable container.

3. Flush the cooling system with clean water until the draining water is clean. Close the drain valve.

4. Replace the water temperature regulator.

Reference: Refer to Operation and Maintenance Manual, “Cooling System Water Temperature Regulator - Replace” for the correct procedure.

5. Add the Extended Life Coolant (ELC).

Reference: Refer to Operation and Maintenance Manual, “Capacities (Refill) ” for the correct amount.

6. Start the engine. Run the engine without the cooling system pressure cap until the thermostat opens and the coolant level stabilizes.

7. Maintain the coolant level in sight gauge (3).

8. Install the cooling system pressure cap. Close the access door.

i01863590

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-544-NL

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

NOTICE
Topping off or mixing Cat ELC with other products that do not meet Caterpillar EC-1 specifications reduces the effectiveness of the coolant and shortens coolant service life.

Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for pre-mixed or concentrate coolants. Use only Extender with Cat ELC.

Failure to follow these recommendations can result in shortened cooling system component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

When a Caterpillar Extended Life Coolant (ELC) is used, an Extender must be added to the cooling system.

Use a 8T-5296 Coolant Test Kit to check the concentration of the coolant.

Reference: For additional information about the addition of Extender, refer to Operation and Maintenance Manual, SEBU6250, “Caterpillar Machine Fluids Recommendations” or consult your Caterpillar dealer.

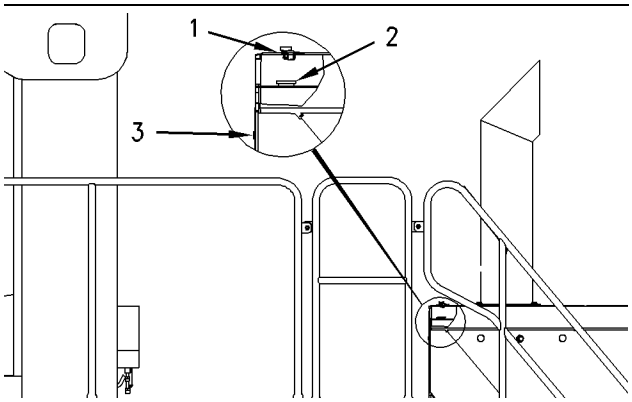


Illustration 101 g00964090

1. Open the small access door (1) on the top of the engine compartment. Slowly remove cooling system pressure cap (2) in order to relieve system pressure.

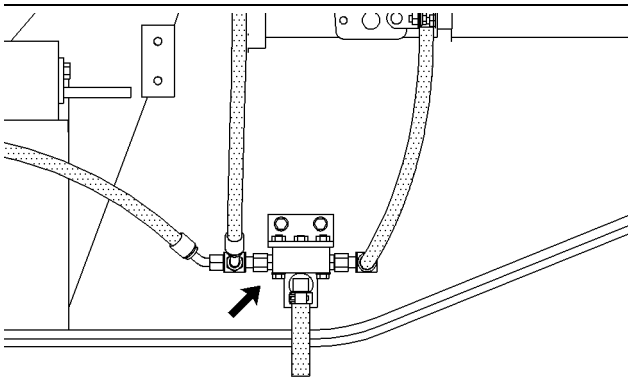


Illustration 102 g00949689

2. If necessary, drain enough coolant from the radiator in order to allow the addition of the Extender to the cooling system. The coolant drain valve is located under the rear of the machine.

3. Add the Extender to the cooling system.

Reference: Refer to Operation and Maintenance Manual, “Capacities (Refill) ” for the correct amount.

4. Maintain the coolant level in sight gauge (3).

5. Install the cooling system pressure cap. Close the access door.

i01889708

Cooling System Coolant Level - Check

SMCS Code: 1350-535-FLV

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

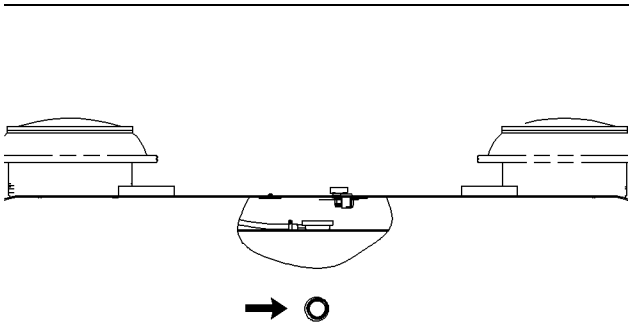


Illustration 103 g00949993

Maintain the coolant level in the sight gauge. If it is necessary to add coolant daily, check for leaks.

i02279524

Cooling System Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-008; 7542

Note: It is not necessary to obtain a Coolant Sample (Level 1) if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems that are filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval that is stated in the Maintenance Interval Schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC. This includes the following types of coolants.

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification -1 (Caterpillar EC-1)
- Cat Diesel Engine Antifreeze/Coolant (DEAC)
- Commercial heavy-duty coolant/antifreeze

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

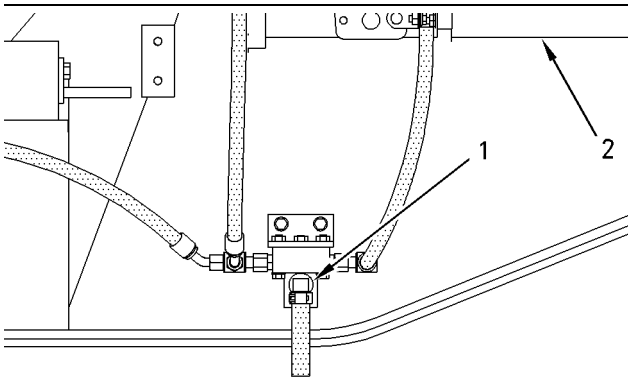


Illustration 104 g00936889

(1) Coolant drain valve
(2) Engine oil pan

The cooling system is not equipped with a sampling valve. To obtain a sample of the coolant, use the drain valve under the engine compartment on the right rear side of the machine.

Submit the sample for level 1 analysis.

i02053404

Cooling System Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-008; 7542

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

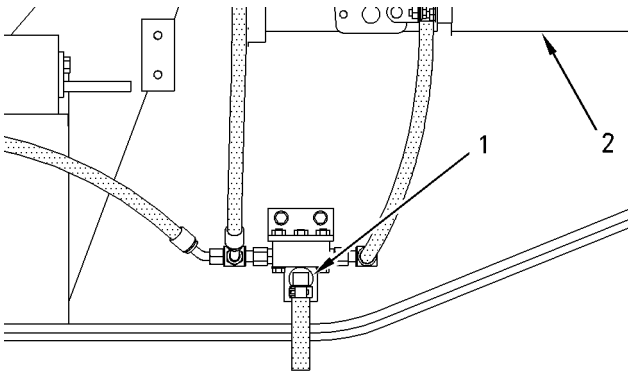


Illustration 105 g00936889

(1) Coolant drain valve
(2) Engine oil pan

The cooling system is not equipped with a sampling valve. To obtain a sample of the coolant, use the drain valve under the engine compartment on the right rear side of the machine.

Submit the sample for level 2 analysis.

i02046056

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510; 1393-010

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

NOTICE
Failure to replace the engine's thermostat on a regularly scheduled basis could cause severe engine damage.

NOTICE
Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a thermostat installed.

If the thermostat is installed wrong, it will cause the engine to overheat. Inspect gaskets before assembly and replace if worn or damaged.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Replace the water temperature regulator (thermostat) on a regular basis in order to reduce the chance of unscheduled downtime and the chance of problems with the cooling system.

The thermostat should be replaced after the cooling system has been cleaned. Replace the thermostat and the seals while the cooling system is completely drained or while the cooling system coolant is drained to a level that is below the thermostat housing.

Note: If you are only replacing the thermostat, drain the cooling system coolant to a level that is below the thermostat housing. There are two water temperature regulators on this engine. One water temperature regulator is located on each side of the engine.

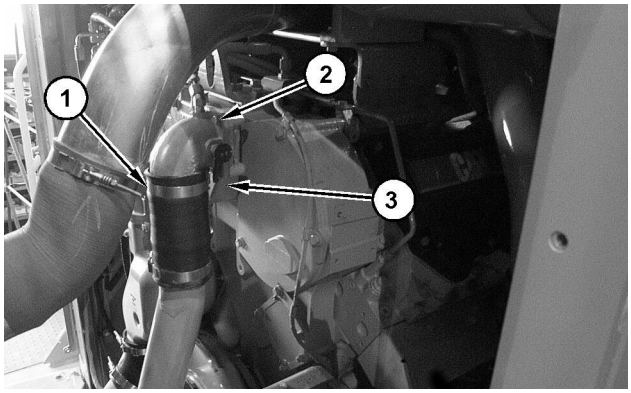


Illustration 106 g01050345

1. Loosen hose clamps (1). Remove hose from housing (3).

2. Remove bolts (2), housing (3), and the gasket.

3. Remove the water temperature regulator. Install a new water temperature regulator.

4. Inspect the gaskets. Replace the gaskets if wear or damage is evident.

5. Install housing (3) and bolts (2).

6. Install hose on housing (3). Tighten hose clamps (1).

7. Repeat Steps 1 through 6 for the remaining water temperature regulator.

i01863697

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

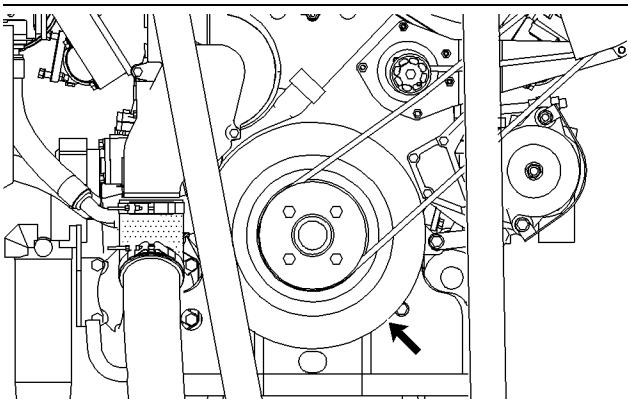


Illustration 107 g00950089

The crankshaft vibration damper is located at the rear end of the engine compartment.

Damage to the vibration damper or failure of the vibration damper will increase torsional vibrations. These vibrations will result in damage to the crankshaft and to the other engine components. A deteriorating vibration damper will cause excessive gear train noise at variable points in the speed range.

Caterpillar recommends replacing the vibration damper for any of the following reasons:

- The engine has had a failure because of a broken crankshaft.
- The S·O·S oil analysis detected a worn crankshaft front bearing.
- The S·O·S oil analysis detected a large amount of gear train wear that is not caused by a lack of oil.
- The alignment marks on the hub and on the outer ring are not in alignment because the rubber seal has separated.

The vibration damper can be used again if none of the above conditions are found and the damper is not damaged.

Note: Some wobble on the outer ring of the vibration damper is normal.

Reference: Refer to Disassembly and Assembly, SENR1013, “3408E & 3412E Engines For Caterpillar Built Machines” for more information.

i03314441

Cutting Edges and End Bits - Inspect/Replace

SMCS Code: 6801-510; 6801-040; 6804-510; 6804-040

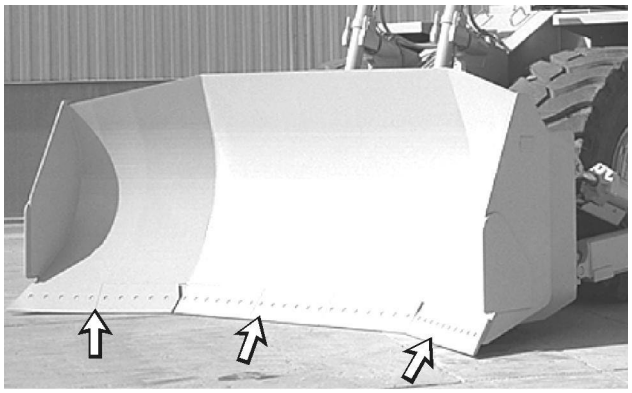


Illustration 108 g00312104

1. Raise the bulldozer blade and block up the bulldozer blade. When you remove the cutting edges and the end bits, maintain the bulldozer blade at a minimum height.

2. Remove the bolts. Then, remove the cutting edge and the end bits.

3. Thoroughly clean all contact surfaces.

4. Inspect the opposite side of the cutting edge. If the opposite side of the cutting edge is not worn, turn the opposite side of the cutting edge outward and install the cutting edge.

If both sides of the cutting edge are worn, install a new cutting edge section.

5. Repeat Step 4 for the end bits.

6. Install all bolts and tighten the bolts to the specified torque. Refer to Specifications, Torque Specifications, “Ground Engaging Tool (G.E.T.) Fasteners”.

7. Strike the bolt heads with a 1.4 kg (3 lb) hammer. Tighten the bolts to the specified torque again.

8. Raise the bulldozer blade and remove the blocking. Lower the bulldozer blade to the ground.

i06761495

Differential and Final Drive Oil - Change

SMCS Code: 3278-044; 4050-044

⚠ WARNING

Pressurized system: Hot oil can cause serious burns. To open plug, stop engine, wait until axle is cool. The loosen plug slowly to relieve the pressure.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

Note: Perform this procedure on one axle at a time.

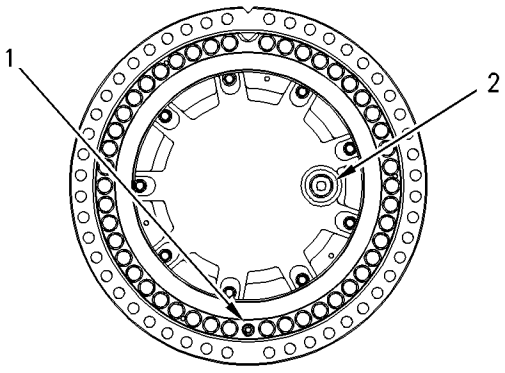


Illustration 109 g00950121

1. Position the wheels so that final drive drain plugs (1) are facing downward. Remove the drain plugs and allow the oil to drain into a suitable container. Clean the drain plugs and install the drain plugs.

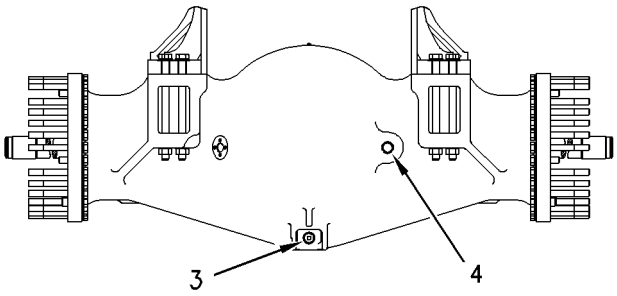


Illustration 110 g00950123
Front axle

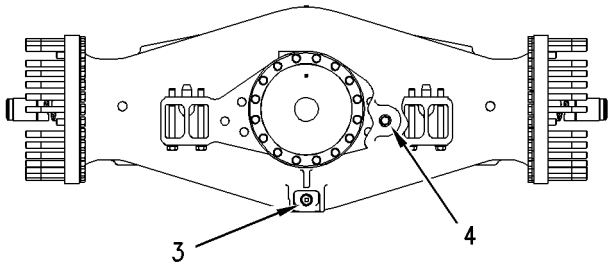


Illustration 111 g00950125
Rear axle

2. Remove differential drain plug (3) and allow the oil to drain into a suitable container. Clean the drain plug and install the drain plug.

3. Remove differential filler plug (4). Fill the differential to the bottom of the filler plug opening.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the correct type of oil and for the correct amount of oil.

4. Clean the filler plug and install the filler plug.

5. Position both wheels so that filler plugs (2) for the final drives are flush with the centerline of each wheel. Remove the filler plugs.

6. Fill the final drives to the bottom of the filler plug openings.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the correct type of oil and for the correct amount of oil.

7. Clean the filler plugs and install the filler plugs.

8. If the specified amount of oil will not fit in the final drives, install the final drive filler plugs. Operate the machine on level ground for a few minutes in order to equalize the oil level in the axles. Remove the final drive filler plugs and add the remaining oil.

9. Operate the machine for a few minutes and recheck the oil level. The oil level should reach the bottom of the filler plug opening.

If the oil level is higher than the filler plug opening, do not allow the oil to drain to the proper level. Install the filler plug.

10. Repeat this procedure for the other differential and final drives.

i06761497

Differential and Final Drive Oil Level - Check

SMCS Code: 3278-535-FLV; 4050-535-FLV

⚠ WARNING

Pressurized system: Hot oil can cause serious burns. To open plug, stop engine, wait until axle is cool. The loosen plug slowly to relieve the pressure.

Note: Perform this procedure on one axle at a time.

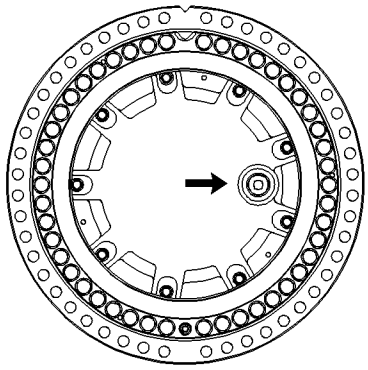


Illustration 112 g00950152

1. Position the wheels so that the filler plugs for the final drives are flush with the centerline of the wheels.

2. Remove the filler plugs. The oil level should be at the bottom of the filler plug openings. Add oil, if necessary.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities” for the correct type of oil.

If the oil level is higher than the filler plug openings, do not allow the oil to drain to the proper level. Install the filler plugs.

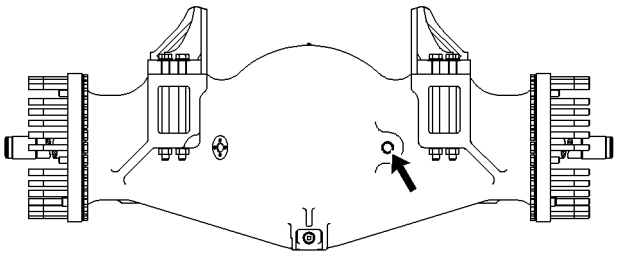


Illustration 113 g00935893
Front axle

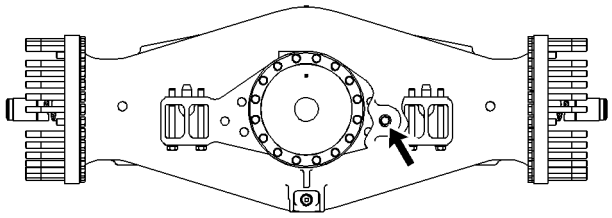


Illustration 114 g00935898
Rear axle

3. Remove the differential filler plug. The oil level should be at the bottom of the filler plug opening. Add oil, if necessary.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities” for the correct type of oil.

If the oil level is higher than the filler plug opening, do not allow the oil to drain to the proper level. Install the filler plug.

4. Repeat the procedure for the other differential and final drives.

i06761499

Differential and Final Drive Oil Sample - Obtain

SMCS Code: 3278-008; 4050-008; 4070-008; 7542

⚠ WARNING

Pressurized system: Hot oil can cause serious burns. To open plug, stop engine, wait until axle is cool. The loosen plug slowly to relieve the pressure.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Operate the machine for a few minutes before obtaining the oil sample. This will thoroughly mix the oil for a more accurate sample.

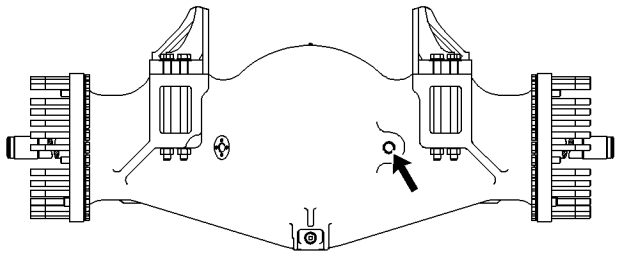


Illustration 115 g00935893
Front Differential Filler Plug

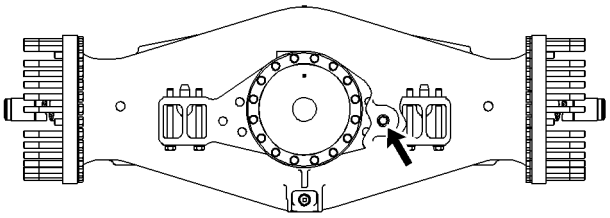


Illustration 116 g00935898
Rear Differential Filler Plug

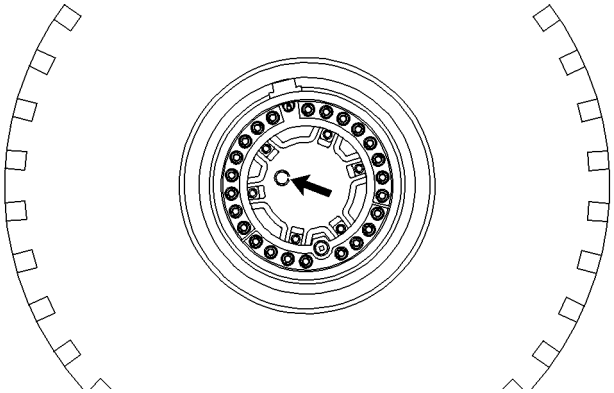


Illustration 117 g00760182
Final Drive Filler Plug

2. The differential and final drives are not equipped with sampling valves. Obtaining an oil sample will require the use of a vacuum pump or equivalent in order to extract the oil from the component. Extract the oil through the filler openings on the differential and final drives.

Note: This procedure requires a sample for each final drive and each differential. There will be a total of three samples per axle and six samples for this procedure in total. Make sure that you properly record the location of each oil sample.

Reference: For more information, refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” and Special Publication, PEHP6001, “How To Take A Good Oil Sample”.

i01863955

Drive Shaft Spline (Center) - Lubricate

SMCS Code: 3253-086-SN

NOTICE
To prevent damage to the seal, articulate the machine full right or left, before lubricating the splines.

1. Start the engine. Raise the bucket. Release the parking brake. Articulate the machine to the right or to the left.

2. Lower the bucket to the ground. Engage the parking brake. Stop the engine.

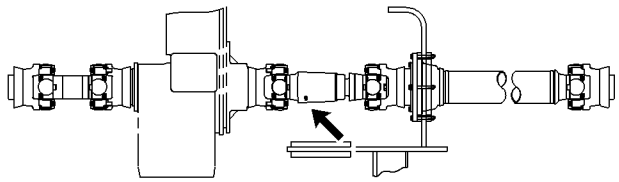


Illustration 118 g00950288

3. Wipe the fitting before you apply any lubricant. Apply lubricant through the fitting on the center drive shaft spline.

4. Start the engine. Raise the bucket. Release the parking brake. Reposition the machine in a straight direction.

5. Lower the bucket to the ground. Apply a slight down pressure. Engage the parking brake. Stop the engine.

i01863808

Drive Shaft Support Bearing - Lubricate

SMCS Code: 3267-086-BD

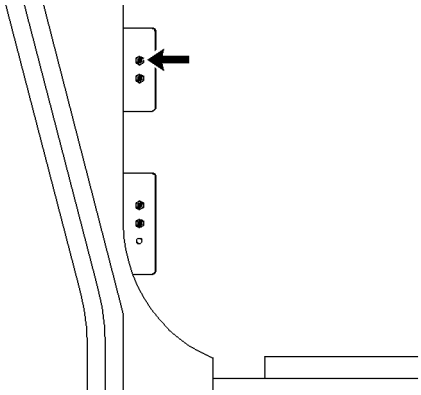


Illustration 119 g00950169

Apply lubricant through the remote fitting that is located on the left side of the machine. Wipe the fitting before you apply any lubricant.

i01863805

Drive Shaft Universal Joints - Lubricate

SMCS Code: 3251-086

Wipe the fittings before you apply any lubricant.

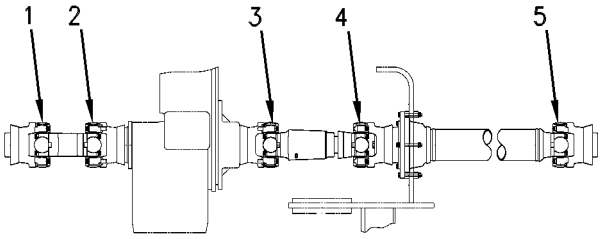


Illustration 120 g00310828

1. Apply lubricant through fittings (1) and (2) on the rear drive shaft universal joints. There is a total of two fittings.
2. Apply lubricant through fitting (3) on the rear end of the center drive shaft universal joint.
3. Apply lubricant through fitting (4) on the front end of the center drive shaft universal joint.
4. Apply lubricant through fitting (5) on the front drive shaft universal joint.

i02549084

Electronic Unit Injector - Inspect/Adjust

SMCS Code: 1251-025; 1251-040; 1290-040; 1290-025

⚠ WARNING

Be sure the engine cannot be started while this maintenance is being performed. To prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting the unit injectors.

The electronic unit injectors use high voltage. Disconnect the unit injector enable circuit connector in order to prevent personal injury. Do not come in contact with the injector terminals while the engine is running.

This procedure is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life. Only qualified personnel should perform this procedure.

For information on adjusting the electronic unit injector, refer to Systems Operation, Testing And Adjusting, SENR9937, “C27 and C32 Engines for Caterpillar Built Machines” or consult your Caterpillar dealer.

i01879349

Engine Air Filter Primary Element - Clean/Replace

SMCS Code: 1054-510-PY; 1054-070-PY

⚠ WARNING

To avoid personal injury, always wear eye and face protection when using pressurized air.

NOTICE
Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

NOTICE
Service the air filter only with the engine stopped. Engine damage could result.

Clean the engine air filter primary element when the clogged air filter indicator is displayed on the Caterpillar controller. Clean the engine air filter primary element as soon as convenient.

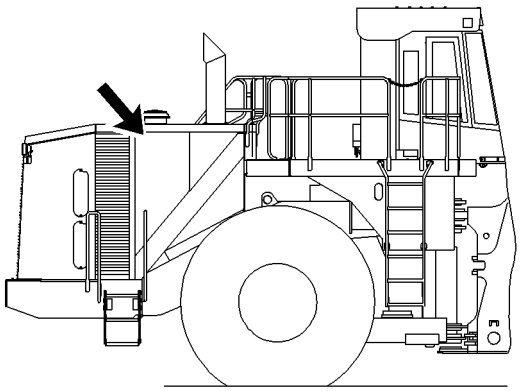


Illustration 121 g00964171

1. Open the access door on the right side of the machine.

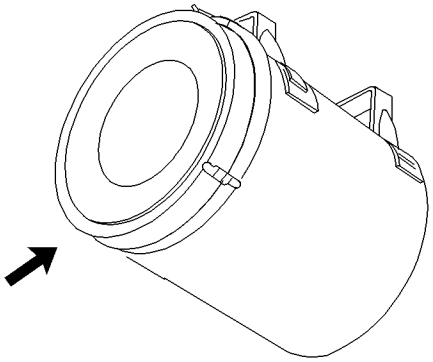


Illustration 122 g00845360

2. Loosen the four cover latches and remove the air cleaner cover.

Note: The latches for the air cleaner housing may snap open when you release the latches.

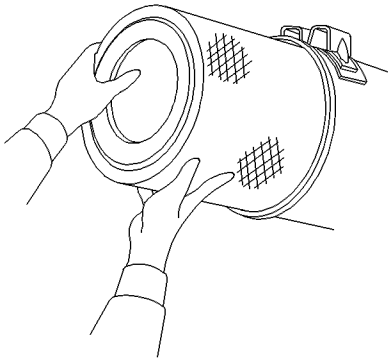


Illustration 123 g00101415

3. Remove the primary filter element from the air cleaner housing. In order to remove the engine air filter primary element, pull the element outward. While you pull the element outward, rock the element.

Use Steps 4 through 6 in order to clean the primary element:

4. Inspect the primary element. If the pleats, the gaskets, or the seals are damaged, discard the element. Replace a damaged primary element with a clean primary element.

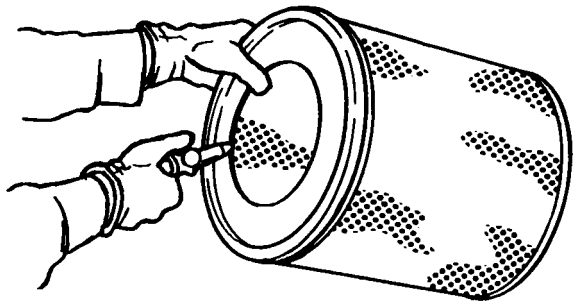


Illustration 124 g00328468

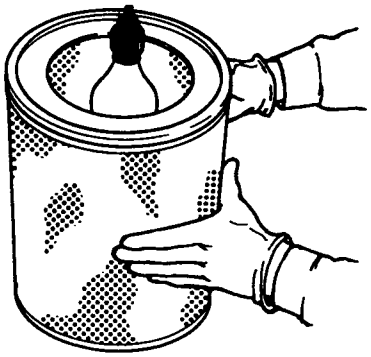


Illustration 125 g00328470

5. If the primary element is not damaged, clean the primary element.

Pressurized air can be used to clean a primary element that has not been cleaned more than two times. Use filtered, dry air at a maximum pressure of 207 kPa (30 psi).

Note: Pressurized air will not remove deposits of carbon and oil.

6. When you clean the primary element, always begin in the inside of the element (clean side). This will force dirt particles toward the outside of the element (dirty side).

Direct the air along the length (inside) of the filter. This will help prevent damage to the paper pleats.

Note: Do not aim the stream of air directly at the primary element. Dirt could be forced further into the pleats.

Use Steps 7 through 10 in order to inspect the primary element:

7. Place a light bulb inside the filter element. Use a 60 watt blue light in a dark room or in a similar facility. Inspect the primary element for light that may show through the filter material.

8. Inspect the primary element while you rotate the element. Inspect the primary element for tears and/or holes. Do not use a primary element that has any tears and/or holes in the filter material. Do not use a primary element with damaged pleats, gaskets, or seals.

9. If it is necessary, compare the primary element to a new primary element. Use a new primary element that has the same part number. This may be necessary in order to confirm the results of the inspection.

10. Discard a damaged primary element.

Use Steps 11 through 13 to install a clean primary element:

NOTICE
Do not use a filter if the pleats, the gaskets or the seals are damaged.

11. Install a clean primary filter element over the engine air filter secondary element. Apply firm pressure to the end of the primary element as you gently rock the filter element. This seats the primary element.

12. Clean the cover for the air cleaner housing. Align the slot on the cover with the pin on the air cleaner housing. Install the cover.

13. Close the access door.

Repeat the procedure for the air cleaner on the left side of the machine.

i01632178

Engine Air Filter Secondary Element - Replace

SMCS Code: 1054-510-SE

NOTICE
Service the air filter only with the engine stopped. Engine damage could result.

NOTICE
Always replace the secondary element. Do not attempt to reuse it by cleaning. Engine damage could result.

Note: Replace the secondary element when you service the primary element for the third time. If a clean primary element has been installed and a warning for the air filter still occurs, replace the secondary element. Also if the exhaust smoke remains black and a clean primary element has been installed, replace the secondary element.

1. Remove the primary element.

Reference: Refer to Operation and Maintenance Manual, “Engine Air Filter Primary Element - Clean/ Replace” for the correct procedure.

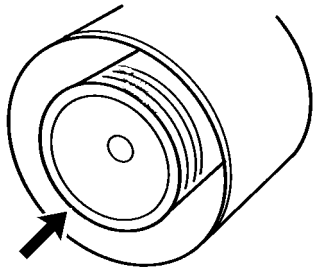


Illustration 126 g00845406

2. Remove the secondary element.

3. Cover the air inlet opening. Clean the inside of the air cleaner housing.

4. Inspect the gasket between the air inlet pipe and the air cleaner housing. Replace the gasket if the gasket is damaged.

5. Uncover the air inlet opening. Install a new secondary element.

6. Install a clean primary element and the cover for the air cleaner housing.

7. Close the access door.

8. Repeat the procedure for the air cleaner on the other side of the machine.

i01549255

Engine Air Filter Service Indicator - Inspect

SMCS Code: 7452-040

NOTICE
Service the air cleaner only with the engine stopped. Engine damage could result.

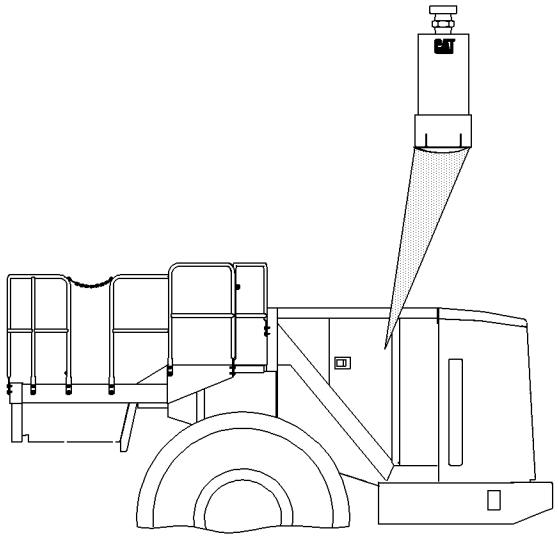


Illustration 127 g00804672

Open the engine access door on the left side of the machine.

The air filter service indicator is located on the air inlet line.

If the yellow piston in the filter service indicator is in the red zone, service the air cleaner.

i01548088

Engine Air Filter Service Indicator - Inspect/Replace

SMCS Code: 7452-040; 7452-510

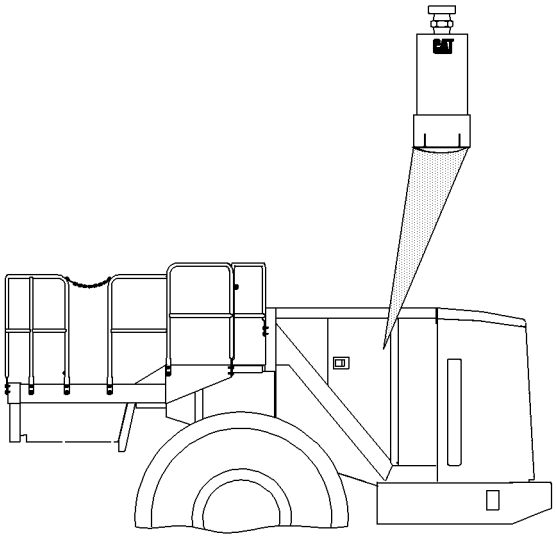


Illustration 128 g00804672

Open the access door on the left side of the machine.

To check the condition of the service indicator, try resetting the service indicator. This should require less than three pushes of the reset button.

Next, check the movement of the yellow piston in the service indicator. Start the engine and accelerate the engine to high idle for a few seconds. After the governor control pedal is released, the yellow piston should remain at the highest position that was achieved during acceleration.

If either of these conditions are not met, replace the service indicator.

i01863898

Engine Air Precleaner - Clean

SMCS Code: 1055-070

NOTICE
Service the air cleaner only with the engine stopped. Engine damage could result.

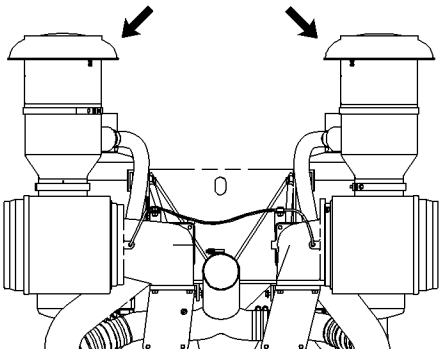


Illustration 129 g00950249

1. Remove the precleaners.
2. Inspect the air inlet screens for dirt and debris. Remove the screens and clean the screens, if necessary.
3. Inspect the precleaner tube openings. Remove any dirt and debris.
4. Clean the precleaners with compressed air or wash the precleaners in warm water. Dry all of the parts.
5. Install the precleaners.

i03304734

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

There are a total of two engine crankcase breathers on the right side of the engine. Perform this procedure for each breather.

1. Park the machine on level ground. Lower the dozer blade to the ground. Move the transmission control switch to the NEUTRAL position and engage the parking brake. Shut off the engine.
2. Open the engine access door on the platform behind the cab on the left side of the machine.

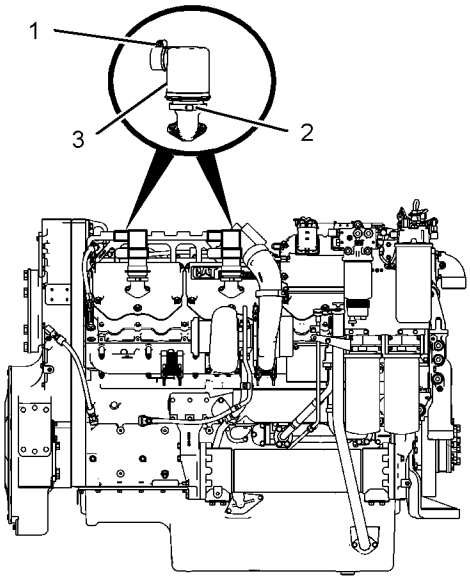


Illustration 130 g01687705

3. Loosen outlet hose clamp (1). Remove the hose from the breather cover.

4. Loosen clamp (2) on the inlet hose and remove the breather element cover assembly (3).

5. Check the condition of the cover seal. If the used seal is damaged, replace the seal with a new seal.

6. Wash the element and the cover assembly in clean, nonflammable solvent.

7. To dry the element, shake the element or use pressure air.

8. Inspect the hose for damage. If necessary, replace the hose.

9. Install the breather element in the cover.

10. Install breather element cover assembly (3). Tighten clamp (2) over the inlet hose.

11. Install the outlet hose and tighten outlet hose clamp (1).

12. Repeat steps 3 through 11 for the other breather.

13. Close the engine access door.

i00689133

Engine Mounts - Inspect

SMCS Code: 1152-040

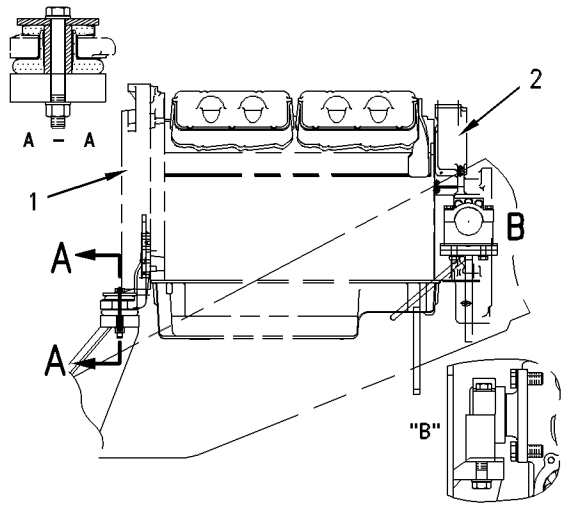


Illustration 131 g00297415

The front housing (1). The flywheel housing (2).

Caterpillar recommends checking the engine mounts for deterioration. Checking the engine mounts will ensure that the bolts have the proper torque. This will prevent excessive engine vibration that is caused from improper mounting.

Refer to Service Manual Module, SENR1017, “Engine Specifications” for the proper bolt torques on the engine mounts.

i02433175

Engine Oil (High Speed) and Oil Filter - Change

SMCS Code: 1318-510-HZ

Selection of the Oil Change Interval

NOTICE
This machine is equipped with an engine that meets EPA Tier 2, Euro Stage II, or MOC Step 2 emission regulations. A 500 hour engine oil change interval is available, provided that operating conditions and recommended multigrade oil types are met. When these requirements are not met, shorten the oil change interval to 250 hours, or use an S·O·S oil sampling and analysis program to determine an acceptable oil change interval.

If you select an interval for oil and filter change that is too long, you may damage the engine.

Caterpillar oil filters are recommended.

Recommended multigrade oil types are listed in Table 14 . Do not use single grade oils.

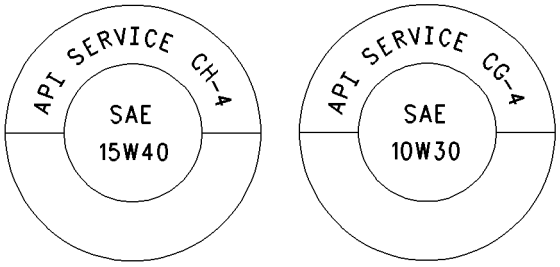


Illustration 132 g00753767

API Trademark

Commercial oils that are licensed by the American Petroleum Institute (API) bear this trademark. Commercial oils that do not bear this trademark are not licensed and these oils are not recommended. Oils that are not listed in Table 14 are not recommended.

Abnormally harsh operating cycles or harsh environments can shorten the service life of the engine oil. Arctic temperatures, corrosive environments, or extremely dusty conditions may require a reduction in engine oil change intervals from the recommendations in Table 14 . Also refer to Manual, SEBU5898, “Cold Weather Recommendations”. Poor maintenance of air filters or of fuel filters requires reduced oil change intervals. See your Caterpillar dealer for more information if this product will experience abnormally harsh operating cycles or harsh environments.

Table 14

990H Wheel Loader 844H Wheel Tractor Engine Oil Change Interval[1]				
Multigrade Oil Type	Operating Conditions			
	Normal[2]	High Load Factor[3] above 91 L (24 US gal) per hr of fuel	Severe	
			Fuel Sulfur from 0.3% to 0.5% [4]	Altitude above 1830 m (6000 ft)
Cat DEO Preferred	500 hr	500 hr	500 hr	250 hr[6]
API CH-4 11.0 minimum TBN[4] Preferred	500 hr	500 hr	500 hr	250 hr[6]
API CH-4 TBN[4] below 11.0	500 hr	500 hr	250 hr[5]	250 hr[6]
API CG-4	500 hr	250 hr[5]	250 hr[5]	250 hr[6]
API CF-4	250 hr[5]	250 hr[6]	250 hr[6]	250 hr[6]

(1) The traditional oil change interval for engines is 250 hours. The standard oil change interval in this machine is 500 hours, if the operating conditions and recommended oil types that are listed in this table are met. Improvements in the engine allow this engine oil change interval. This new standard interval is not permitted for other machines. Refer to the applicable Operation and Maintenance Manuals for the other machines.
(2) Normal conditions include these factors: Fuel sulfur below 0.3%, altitude below 1830 m (6000 ft) and good air filter and fuel filter maintenance. Normal conditions do not include high load factor, harsh operating cycles, or harsh environments.
(3) High load factors can shorten the service life of your engine oil. Continuous heavy load cycles and very little idle time result in increased fuel consumption and oil contamination. These factors deplete the oil additives more rapidly. If the average fuel consumption of your 990 Series II Wheel Loader or 844 Wheel Tractor exceeds 91 L (24 US gal) per hour, follow the “High Load Factor” recommendations in Table 14 . To determine average fuel consumption, measure average fuel consumption for a period of 50 to 100 hours. If the application of the machine is changed, the average fuel consumption may change.
(4) For sulfur content above 0.5%, refer to Operation and Maintenance Manual, SEBU6250, “Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines”.
(5) In order to verify an oil change interval of 500 hours, refer to “Program A” below.
(6) Use “Program B” below to determine an appropriate interval.

Adjustment of the Oil Change Interval

Note: Your Caterpillar dealer has additional information on these programs.

Program A

Verification for an Oil Change Interval of 500 Hours

This program consists of three oil change intervals of 500 hours. Oil sampling and analysis is done at 250 hours and 500 hours for each of the three intervals for a total of six oil samples. The analysis includes oil viscosity and infrared (IR) analysis of the oil. If all of the results are satisfactory, the 500 hour oil change interval is acceptable for the machine in that application. Repeat Program A if you change the application of the machine.

If a sample does not pass the oil analysis, take one of these actions:

- Shorten the oil change interval to 250 hours.
- Proceed to Program B.
- Change to a preferred oil type in Table 14 .

Program B

Optimizing Oil Change Intervals

Begin with a 250 hour oil change interval. The oil change intervals are adjusted by increments. Each increment is an additional 50 hours. Periodic oil sampling and analysis is done during each interval. The analysis includes oil viscosity and infrared (IR) analysis of the oil. Repeat Program B if you change the application of the machine.

If an oil sample does not pass the analysis, shorten the oil change interval, or change to a preferred multigrade oil type in the listing above.

References

Reference: Form, PEDP7035, “Optimizing Oil Change Intervals”

Reference: Form, PEDP7036, “S·O·S Fluid Analysis”

Reference: Form, PEDP7076, “Understanding the S·O·S Oil Analysis Tests”

Procedure for Changing the Engine Oil and Filter

Your machine may be equipped with a high speed arrangement for changing the engine oil. The high speed arrangement allows the engine oil to be changed faster than the conventional method.

1. Open the access door on the right side of the machine.

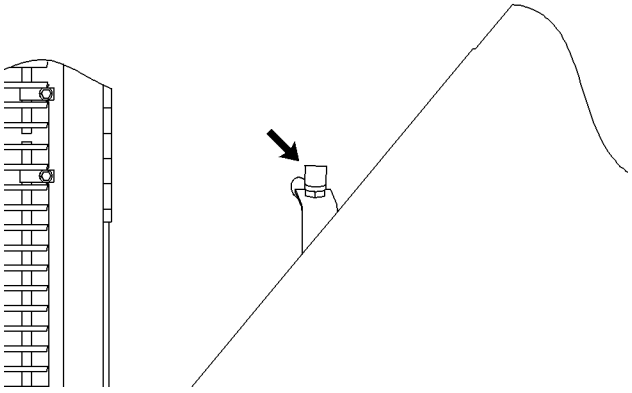


Illustration 133 g00950306

2. Remove the cap that protects the male coupler. Connect an oil pump to the fitting.

3. Turn on the oil pump and withdraw the engine oil from the engine crankcase.

4. Close the access door. Open the engine access door on the left side of the machine in order to access the engine oil filters.

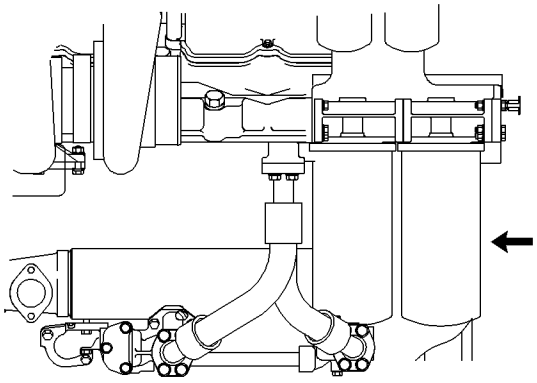


Illustration 134 g00950381

5. Use a strap type wrench to remove the used oil filter elements.

6. Clean the filter mounting base with a clean cloth.

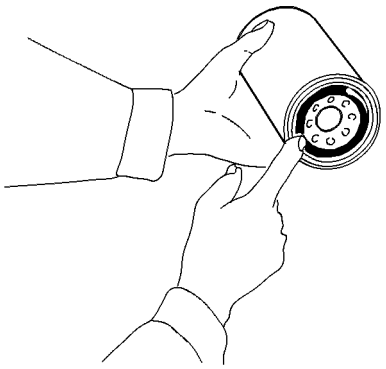


Illustration 135 g00101318

7. Apply a thin film of clean engine oil to the sealing surface of both new filter elements.

8. Install the new filter elements hand tight. When the gasket contacts the filter base, tighten the filter by an additional 3/4 turn.

9. Clean the end of the male coupler for the high speed arrangement. Connect an oil pump to the male coupler. Fill the crankcase with new oil.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the type of lubricant and for the refill capacity.

10. Clean the end of the male coupler and the cap that covers the male coupler. Install the cap.

11. Start the engine and allow the oil to warm. Check the machine for oil leaks.

12. Close the access door.

13. Check the engine oil level.

Reference: Refer to Operation and Maintenance Manual, “Engine Oil Level - Check” for the correct procedure.

i01864246

Engine Oil Level - Check

SMCS Code: 1000-535-FLV

NOTICE
Do not under fill or overfill engine crankcase with oil. Either condition can cause engine damage.

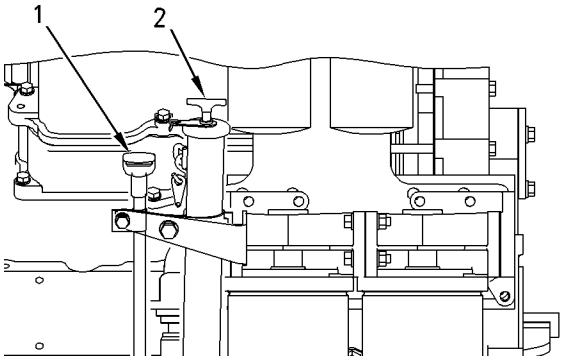


Illustration 136 g00950425

1. Open the access door that is located on the left side of the machine. The oil level dipstick (1) and filler cap (2) are located on the left side of the machine.

2. When the engine is not running, maintain the engine oil within the “Safe Starting Range” on the dipstick.

3. Remove the filler cap (2). If necessary, add oil.

4. Clean the filler cap and install the filler cap.

5. Close the access door.

i01832371

Engine Oil Sample - Obtain

SMCS Code: 1348-008; 7542

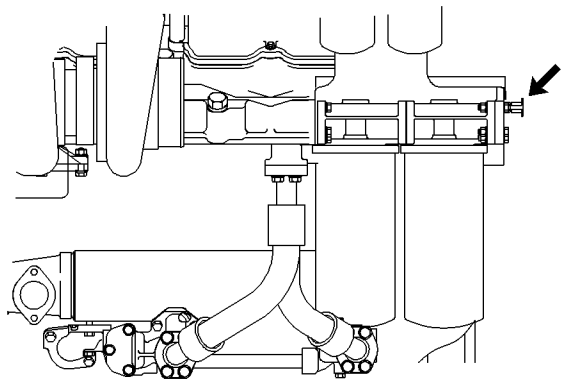


Illustration 137 g00936118

The sampling valve for the engine oil is located on the engine oil filter base on the right side of the machine.

Reference: Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for more information about obtaining an fluid sample.

i02433180

Engine Oil and Filter - Change

SMCS Code: 1318-510

Selection of the Oil Change Interval

NOTICE
This machine is equipped with an engine that meets EPA Tier 2, Euro Stage II, or MOC Step 2 emission regulations. A 500 hour engine oil change interval is available, provided that operating conditions and recommended multigrade oil types are met. When these requirements are not met, shorten the oil change interval to 250 hours, or use an S·O·S oil sampling and analysis program to determine an acceptable oil change interval.

If you select an interval for oil and filter change that is too long, you may damage the engine.

Caterpillar oil filters are recommended.

Recommended multigrade oil types are listed in Table 15 . Do not use single grade oils.

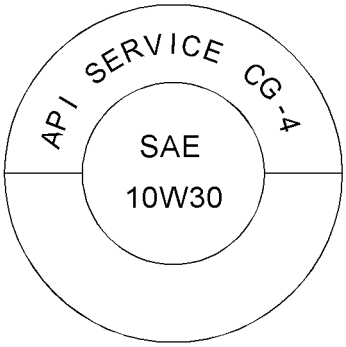


Illustration 138 g01126916

API Trademark

Commercial oils that are licensed by the American Petroleum Institute (API) bear this trademark. Commercial oils that do not bear this trademark are not licensed and these oils are not recommended. Oils that are not listed in Table 15 are not recommended.

Abnormally harsh operating cycles or harsh environments can shorten the service life of the engine oil. Arctic temperatures, corrosive environments, or extremely dusty conditions may require a reduction in engine oil change intervals from the recommendations in Table 15 . Also refer to Manual, SEBU5898, “Cold Weather Recommendations”. Poor maintenance of air filters or of fuel filters requires reduced oil change intervals. See your Caterpillar dealer for more information if this product will experience abnormally harsh operating cycles or harsh environments.

Table 15

990H Wheel Loader 844H Wheel Tractor Engine Oil Change Interval[1]				
Multigrade Oil Type	Operating Conditions			
	Normal[2]	High Load Factor[3] above 91 L (24 US gal) per hr of fuel	Severe	
			Fuel Sulfur from 0.3% to 0.5% [4]	Altitude above 1830 m (6000 ft)
Cat DEO Preferred	500 hr	500 hr	500 hr	250 hr[6]
ECF-1 11.0 minimum TBN[4] Preferred	500 hr	500 hr	500 hr	250 hr[6]
ECF-1 TBN[4] below 11.0	500 hr	500 hr	250 hr[5]	250 hr[6]
API CG-4	500 hr	250 hr[5]	250 hr[5]	250 hr[6]

(1) The traditional oil change interval for engines is 250 hours. The standard oil change interval in this machine is 500 hours, if the operating conditions and recommended oil types that are listed in this table are met. Improvements in the engine allow this engine oil change interval. This new standard interval is not permitted for other machines. Refer to the applicable Operation and Maintenance Manuals for the other machines.
(2) Normal conditions include these factors: Fuel sulfur below 0.3%, altitude below 1830 m (6000 ft) and good air filter and fuel filter maintenance. Normal conditions do not include high load factor, harsh operating cycles, or harsh environments.
(3) High load factors can shorten the service life of your engine oil. Continuous heavy load cycles and very little idle time result in increased fuel consumption and oil contamination. These factors deplete the oil additives more rapidly. If the average fuel consumption of your 990 Series II Wheel Loader or 844 Wheel Tractor exceeds 91 L (24 US gal) per hour, follow the “High Load Factor” recommendations in Table 15 . To determine average fuel consumption, measure average fuel consumption for a period of 50 to 100 hours. If the application of the machine is changed, the average fuel consumption may change.
(4) For sulfur content above 0.5%, refer to Operation and Maintenance Manual, SEBU6250, “Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines”.
(5) In order to verify an oil change interval of 500 hours, refer to “Program A” below.
(6) Use “Program B” below to determine an appropriate interval.

Adjustment of the Oil Change Interval

Note: Your Caterpillar dealer has additional information on these programs.

Program A

Verification for an Oil Change Interval of 500 Hours

This program consists of three oil change intervals of 500 hours. Oil sampling and analysis is done at 250 hours and 500 hours for each of the three intervals for a total of six oil samples. The analysis includes oil viscosity and infrared (IR) analysis of the oil. If all of the results are satisfactory, the 500 hour oil change interval is acceptable for the machine in that application. Repeat Program A if you change the application of the machine.

If a sample does not pass the oil analysis, take one of these actions:

- Shorten the oil change interval to 250 hours.
- Proceed to Program B.
- Change to a preferred oil type in Table 15 .

Program B

Optimizing Oil Change Intervals

Begin with a 250 hour oil change interval. The oil change intervals are adjusted by increments. Each increment is an additional 50 hours. Periodic oil sampling and analysis is done during each interval. The analysis includes oil viscosity and infrared (IR) analysis of the oil. Repeat Program B if you change the application of the machine.

If an oil sample does not pass the analysis, shorten the oil change interval, or change to a preferred multigrade oil type in the listing above.

References

Reference: Form, PEDP7035, “Optimizing Oil Change Intervals”

Reference: Form, PEDP7036, “S·O·S Fluid Analysis”

Reference: Form, PEDP7076, “Understanding the S·O·S Oil Analysis Tests”

Procedure for Changing the Engine Oil and Filter

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Open the engine access door on the right side of the machine.

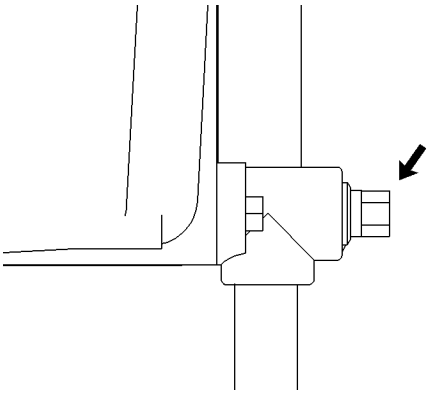


Illustration 139 g00950436

2. The crankcase drain valve is on the oil pan. Open the crankcase drain valve. Allow the oil to drain into a suitable container. Close the drain valve.

3. Open the engine access door on the left side of the machine.

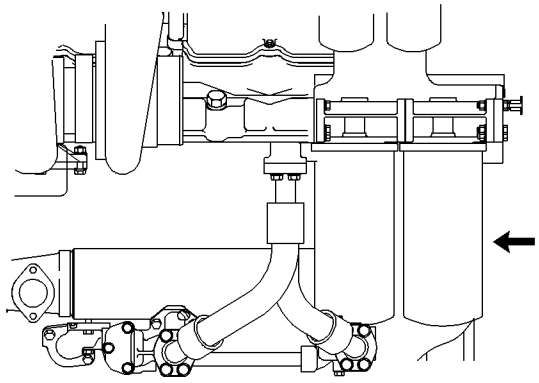


Illustration 140 g00950381

4. Remove the filter elements with a strap type wrench.

Reference: Refer to Operation and Maintenance Manual, “Oil Filter - Inspect” for information about inspecting used filter elements for metal and for other debris.

5. Clean the filter housing base. Make sure that the used filter gasket is completely removed.

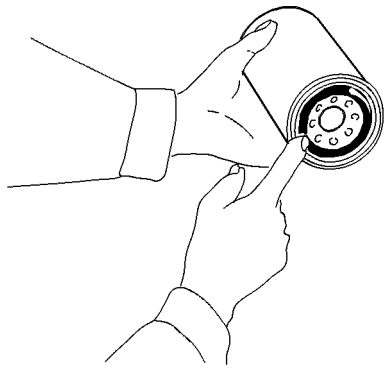


Illustration 141 g00101318

6. Apply a thin coat of oil to the seal on the new filters. Install each new engine oil filter hand tight until the seal of each engine oil filter contacts each base. Note the position of the index marks on each filter in relation to a fixed point on each filter base.

Note: There are rotation index marks on each engine oil filter that are spaced 90 degrees or 1/4 of a turn away from each other. When you tighten each engine oil filter, use the rotation marks as a guide.

7. Tighten the filters according to the instructions that are printed on the filters. Use the index marks as a guide. For non-Caterpillar filters, use the instructions that are provided with the filter.

Note: You may need to use a Caterpillar strap wrench, or another suitable tool, in order to turn the filter to the amount that is required for final installation. Make sure that the installation tool does not damage the filter.

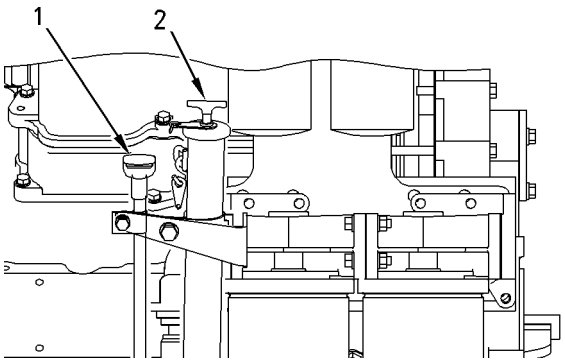


Illustration 142 g00950425

Note: The oil filler plug (2) and dipstick (1) are on the left side of the machine.

8. Remove the oil filler plug. Fill the crankcase with new oil. Clean the filler plug and install the filler plug.

Reference: Refer to Operation and Maintenance Manual, “Capacities (Refill)” in order to determine the correct amount of oil.

9. Start the engine and allow the oil to warm. Check the engine for leaks.

10. Turn off the engine and check the oil level on the dipstick. Maintain the oil between the “ADD” mark and the “FULL” mark. If necessary, add oil.

11. Close the engine access doors and stop the engine.

i04538255

Engine Valve Lash - Check

SMCS Code: 1105-535

In order to perform the valve lash adjustment, refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust”.

Note: A qualified mechanic should adjust the engine valve lash because special tools and training are required.

i01448018

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

Reference: Refer to Systems Operation/Testing and Adjusting, SENR6577, “3412C Engine For Caterpillar Built Machines” for the complete inspection procedure for the engine valve rotators. Consult your Caterpillar dealer for a proper inspection of the engine valve rotators.

i01394313

Engine Water Pump - Inspect

SMCS Code: 1361-040

Failure of the engine water pump may cause severe engine overheating problems such as cracks in the cylinder head or piston seizure.

Visually inspect the water pump for leaks. If you find leaks, all of the seals on the water pump must be replaced.

Note: For more information, refer to the appropriate Disassembly and Assembly manual for your machine's engine.

i01632017

Ether Starting Aid Cylinder - Replace
(If Equipped)

SMCS Code: 1456-510-CD

⚠ WARNING

Ether is poisonous and flammable.

Breathing ether vapors or repeated contact of ether with skin can cause personal injury.

Use ether only in well ventilated areas.

Do not smoke while changing ether cylinders.

Use ether with care to avoid fires.

Do not store replacement ether cylinders in living areas or in the operator's compartment.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard cylinders in a safe place. Do not puncture or burn cylinders.

Keep ether cylinders out of the reach of unauthorized personnel.

To avoid possible injury, be sure the brakes are applied and all controls are in HOLD or NEUTRAL when starting the engine.

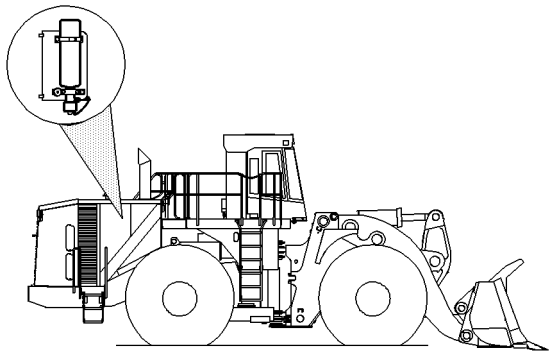


Illustration 143 g00845578

1. Open the engine access door on the right side of the machine. The ether starting aid cylinder is located in front of the air cleaner.
2. Loosen the cylinder retaining clamp. Unscrew the empty ether starting aid cylinder and remove the empty ether starting aid cylinder.
3. Remove the used gasket. Install the new gasket that is provided with each new ether starting aid cylinder.
4. Install the new ether starting aid cylinder. Tighten the ether starting aid cylinder and the cylinder retaining clamp hand tight.
5. Close the engine access door.

i03898359

Fuel Lines - Replace
(Low Pressure)

SMCS Code: 1274

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

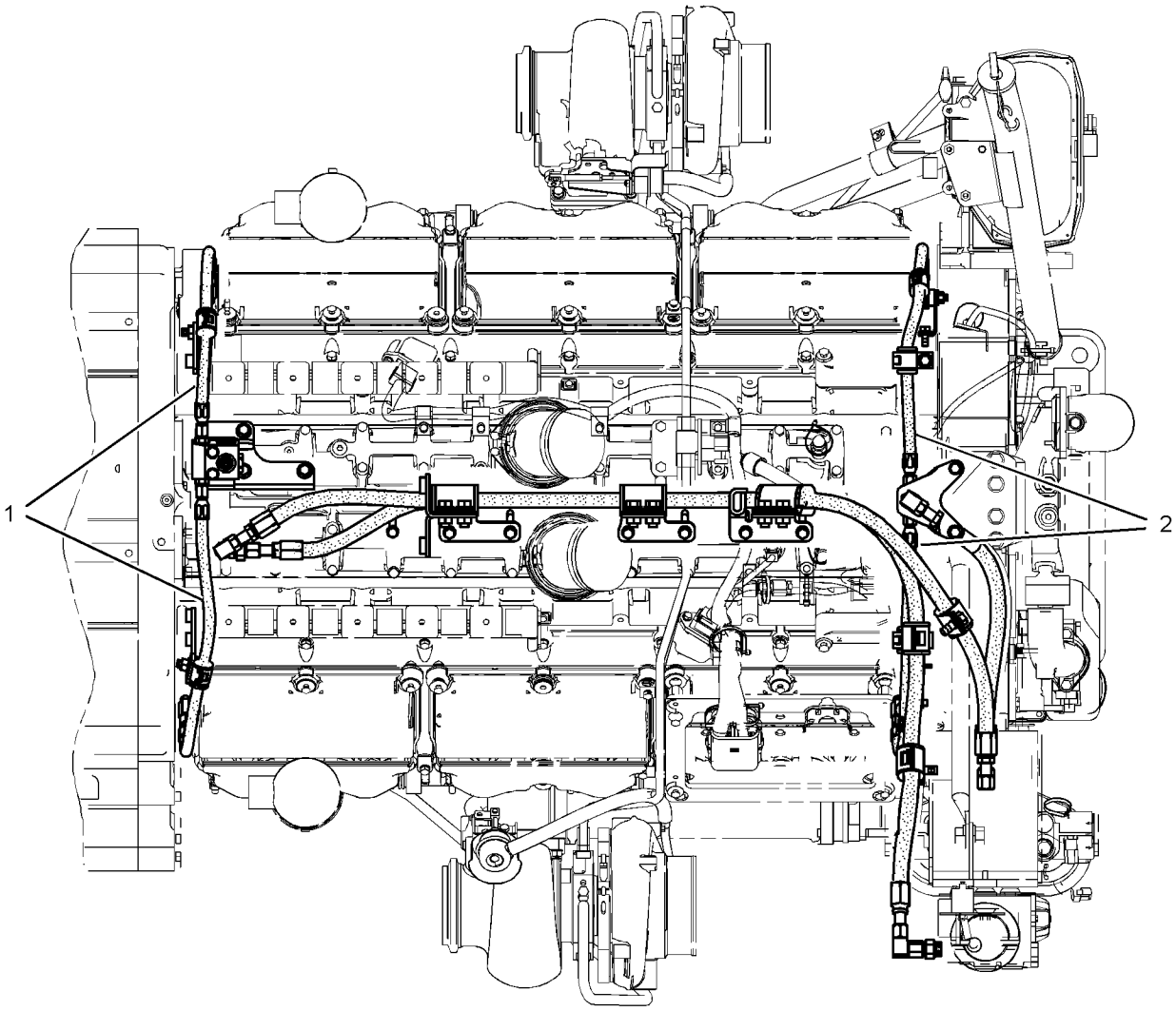
Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Cleanliness is an important factor. The exterior of the engine should be thoroughly cleaned before the removal procedure. Ensure the area around the Fuel Manifold and the Fuel Lines are thoroughly cleaned. This will prevent contaminants from entering the internal mechanism. Before replacing any Fuel Lines, follow the instructions that are listed below. Replace the Fuel Lines with the correct Fuel Lines Group.

Replace Nonmetallic Fuel Lines

Make sure that the nonmetallic fuel lines are replaced at the engine overhaul.



TOP VIEW OF ENGINE

Illustration 144 g02141035
Top view of engine

Note: The following procedures were written for only specific fuel lines that need replacing. Only remove the fuel lines and clamps that need replacement.

Removal Procedure

1. Turn the fuel supply to the OFF position.

2. Turn the battery disconnect switch to the OFF position.

3. Remove the rear two low-pressure fuel lines (1).

4. Remove the front two low-pressure fuel lines (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

1. Install the rear two low-pressure fuel lines (1) with new hoses.

2. Install the front two low-pressure fuel lines (2) with new hoses.

Note: Make sure that the hoses do not contact nearby components. Excessive contact with other surfaces will produce chafing that could lead to a leak.

3. Carefully inspect the engine for any spilled fuel. Make sure that no fuel remains on or close to the engine.

4. Turn the battery disconnect switch to the ON position.

5. Turn the fuel supply to the ON position.

Note: Fuel must be added to the fuel system ahead of the fuel filter.

6. Refill the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” for information about priming the engine with fuel.

7. Start the engine. Inspect the fuel system for leaks.

i02046075

Fuel System - Prime

SMCS Code: 1250-548

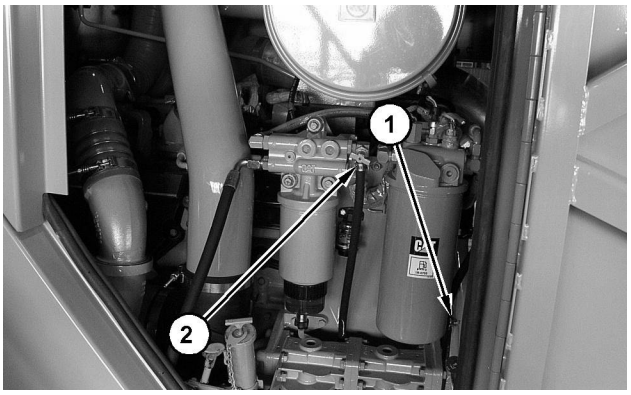


Illustration 145 g01050347

1. Open the engine access door on the left side of the machine.

2. Your machine is equipped with an electric fuel pump. The toggle switch (1) for the electric fuel pump is located above the primary fuel filter on the left side of the machine.

3. A plug (2) is located on the fuel manifold. The plug is used in order to purge air from the fuel lines.

4. Use the toggle switch in order to operate the electric fuel pump. Open the plug. Operate the fuel priming pump until no air bubbles are present from the plug.

5. Tighten the plug when air bubbles are no longer present. Turn off the fuel priming pump.

If the engine does not start or the engine misfires, further priming is necessary.

i02046487

Fuel System Primary Filter (Water Separator) - Drain

SMCS Code: 1263-543

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Do not fill fuel filters with fuel before installing them. Contaminated fuel will cause accelerated wear to fuel system parts. Fuel system should be primed prior to starting the engine.

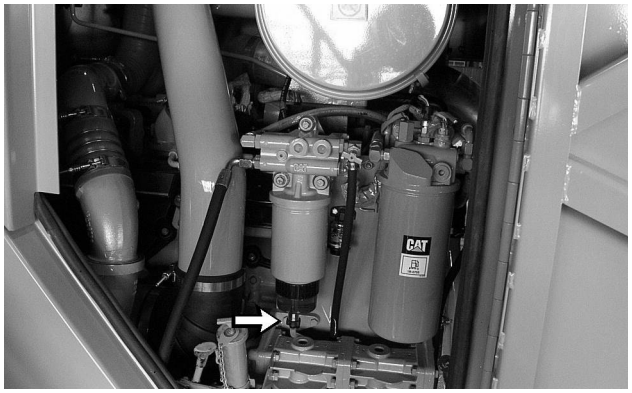


Illustration 146 g01050601

1. Open the engine access door on the left side of the machine. The water separator is located on the bottom of the primary fuel filter.

2. Attach a rubber tube to the bottom of the drain valve on the bottom of the water separator bowl. Open the drain valve. Allow the water and the fuel to drain into a suitable container.

3. Close the drain valve.

Note: The water separator is under suction during normal engine operation. Tighten the drain valve securely in order to prevent air leakage into the fuel system.

4. Close the access door.

i02046731

Fuel System Primary Filter (Water Separator) Element - Replace

SMCS Code: 1260-510; 1263-510-FQ

NOTICE
Do not fill fuel filters with fuel before installing them. Contaminated fuel will cause accelerated wear to fuel system parts.

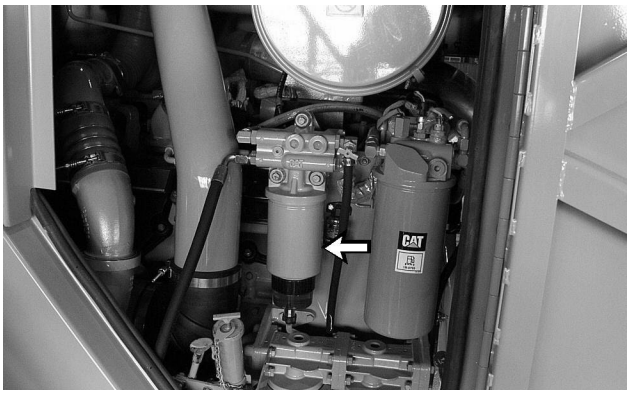


Illustration 147 g01050623

1. Open the engine access door on the left side of the machine.

2. Open the drain valve on the bottom of the water separator bowl. Allow the water and the fuel to drain into a suitable container.

3. Remove the primary fuel filter from the mounting base.

4. Remove the water separator bowl from the filter element. Clean the water separator bowl and the O-ring groove.

Note: The water separator bowl is reusable. Do not discard the water separator bowl.

5. Inspect the O-ring seal on the water separator bowl. Replace the O-ring seal, if necessary.

6. Lubricate the O-ring seal with clean diesel fuel or with engine oil. Place the O-ring seal in the water separator bowl.

7. Install the water separator bowl onto the new filter element by hand. Do not use tools to tighten the water separator bowl to the filter element.

8. Install the primary fuel filter.

9. Close the drain valve on the bottom of the water separator bowl.

Note: The water separator bowl is under suction during normal engine operation. Tighten the drain valve securely in order to prevent air leakage into the fuel system.

10. Prime the fuel system.

Reference: Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

11. Close the engine access door.

i01630296

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Do not fill fuel filters with fuel before installing them. Contaminated fuel will cause accelerated wear to fuel system parts. Fuel system should be primed prior to starting the engine.

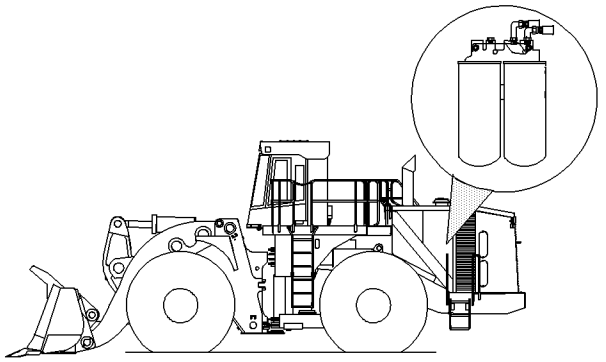


Illustration 148 g00845696

1. Open the engine access door on the left side of the machine.

2. Use a strap type wrench to remove both filter elements. Dispose of the used filter elements properly.

3. Clean the filter mounting base. Make sure that all of the used seal is completely removed.

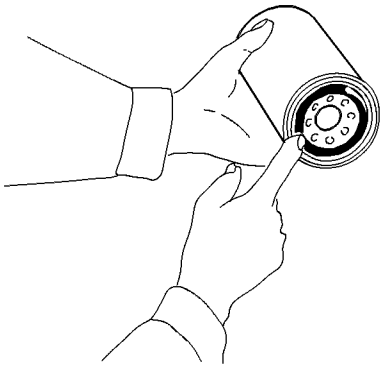


Illustration 149 g00101318

4. Lubricate the seal of the new filter elements with clean diesel fuel.

5. Install the new filter elements by hand. After the gasket contacts the filter mounting base, tighten the filter elements by an additional 3/4 turn.

6. Prime the fuel system.

Reference: Refer toOperation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

7. Close the engine access door.

i01864344

Fuel Tank Cap and Strainer - Clean

SMCS Code: 1273-070-Z2; 1273-070-STR

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

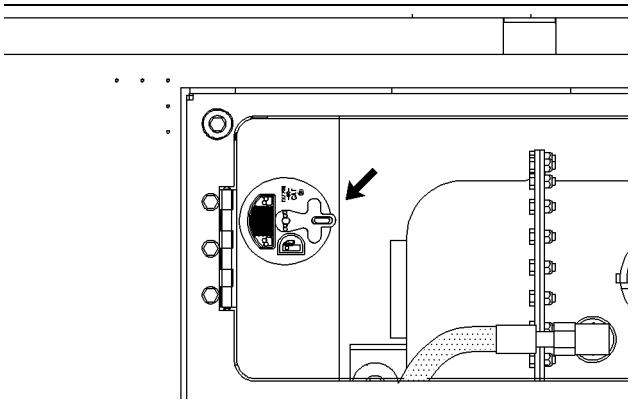


Illustration 150 g00950505

The fuel filler cap is located on the left side of the platform.

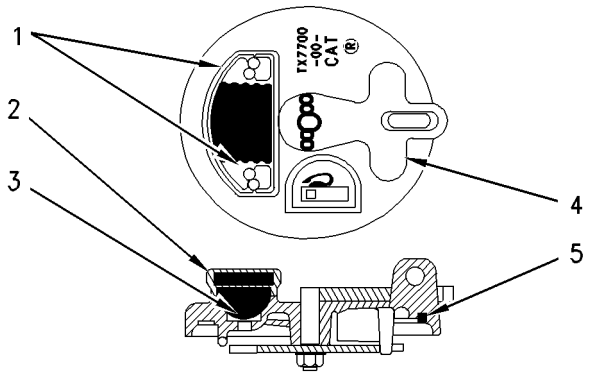


Illustration 151 g00848308

1. Lift lever (4) and turn the lever counterclockwise until the lever stops. Remove the fuel tank cap.
2. Inspect seal (5) for damage. If necessary, replace the seal.
3. Remove screws (1), filter assembly (2), valve (3) and the gaskets.
4. Remove the strainer from the filler opening.
5. Wash the fuel tank cap and the strainer in a clean, nonflammable solvent.
6. Install a new cap filter kit. Install the other components in reverse order.
7. Install the strainer and the fuel tank cap.

i01866057

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

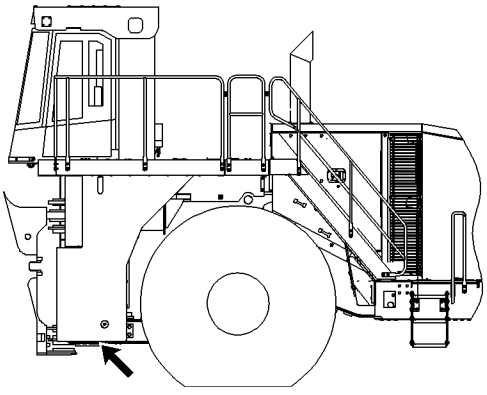


Illustration 152 g00951148

The drain valve is under the fuel tank on the left side of the machine.

1. Open the drain valve. Allow the water and the sediment to drain into a suitable container.
2. Close the drain valve.

i04819237

Fuses - Replace

SMCS Code: 1417-510

NOTICE
Replace the fuses with the same type and size only. Otherwise, electrical damage can result.

If it is necessary to replace fuses frequently, an electrical problem may exist. Contact your Caterpillar dealer

Type 1

The fuse panel is under the rear access door on the right side of the cab platform.

Transmission Control – 10 Amp

Air Filter Restriction Indicator – 10 amp

Product Link and Voltage Converter – 15 amp

Electronic Gauges – 10 amp

Rotating Beacon – 10 amp

Implement Electronic Control – 10 amp

Voltage Converter and Floodlight – 10 Amp

Blower Fan Motor – 20 Amp

Seat Heater and Air Compressor – 15 Amp

Side Window Wipers – 10 Amp

Front and Rear Window Wipers – 10 Amp

Horn – 10 Amp

Rear Floodlights – 10 Amp

Front Floodlights – 10 Amp

Tower Floodlights – 10 Amp

Type 2

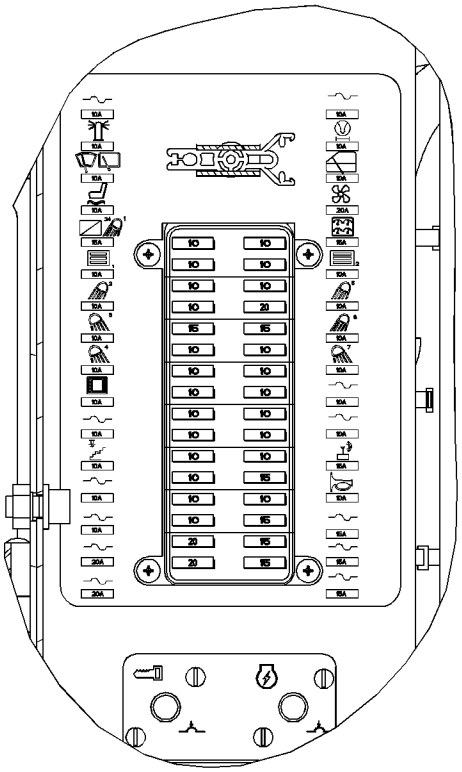


Illustration 153 g01317665

Spare (1) – 10 Amp

Spare (2) – 10 Amp

Beacon (3) – 10 Amp

Air Filter Restriction Indicator (4) – 10 amp

Front and Rear Window Wipers (5) – 10 Amp



Side Window Wipers (6) – 10 Amp



Seat Heater and Air Compressor (7) – 10 Amp



Blower Fan Motor (8) – 20 Amp





Voltage Converter and Floodlights (Bucket) (9) – 15 Amp



“VIMS” Monitor (ECM) (10) – 15 Amp



Implement Control (11) – 10 Amp



Power Train Control (12) – 10 Amp



Front ROPS floodlights (13) – 10 Amp



Front fender floodlights (14) – 10 Amp



Rear Floodlights (Radiator) (15) – 10 Amp



Front ROPS (HID) (16) – 10 Amp



Rear ROPS Floodlights (17) – 10 Amp



Rear ROPS (HID) (18) – 10 Amp



Rear Monitor (19) (Vision) – 10 Amp



Spare (20) – 10 Amp



Spare (21) – 10 Amp



Spare (22) – 10 Amp



Stairway Access Light (23) – 10 Amp



Product Link (24) – 15 Amp



Spare (25) – 10 Amp



Forward Horn (26) – 10 Amp



Spare (27) – 10 Amp



Spare (28) – 15 Amp



Spare (29) – 20 Amp



Spare (30) – 15 Amp



Spare (31) – 20 Amp



Spare (32) – 15 Amp

i07349182

High Intensity Discharge Lamp (HID) - Replace
(If Equipped)

SMCS Code: 1434-510

⚠ WARNING

HID lamps operate at very high voltages. To avoid electrical shock and personal injury, disconnect power before servicing HID lamps.

⚠ WARNING

HID bulbs become very hot during operation. Before servicing, remove power from lamp for at least five minutes to ensure lamp is cool.

NOTICE
Although HID bulb materials may change over time, HID bulbs produced at the time of the printing of this manual contain mercury. When disposing of this component, or any waste that contains mercury, please use caution and comply with any applicable laws.

1. Remove the electrical power from the high intensity discharge lamp (HID). The electrical power must be removed from the HID lamp for at least five minutes, in order to ensure that the bulb is cool.
2. Disassemble the housing for the HID lamp in order to have access to the bulb.

Note: On some HID lamps, the bulb is an integral part of the lens assembly. The bulb is not removed separately from the lens assembly. Replace the entire lens assembly on these HID lamps.

3. Remove the bulb from the HID lamp.
4. Install the replacement bulb in the HID lamp.

   If the bulb is an integral part of the lens assembly, install the replacement lens assembly in the HID lamp.

Note: In order to avoid failure to the bulb that is premature, avoid touching the bulb's surface with your bare hands. Clean any fingerprints from the bulb with alcohol prior to operation.

5. Reassemble the housing for the HID lamp. Ensure that any printing on the lens is oriented correctly with respect to the HID lamp's mounting position on the machine.
6. Reattach the electrical power to the HID lamp.
7. Check the HID lamp for proper operation.

Note: Consult your Cat dealer for additional information on HID lamps.

i03898378

Hoses and Clamps - Inspect/ Replace

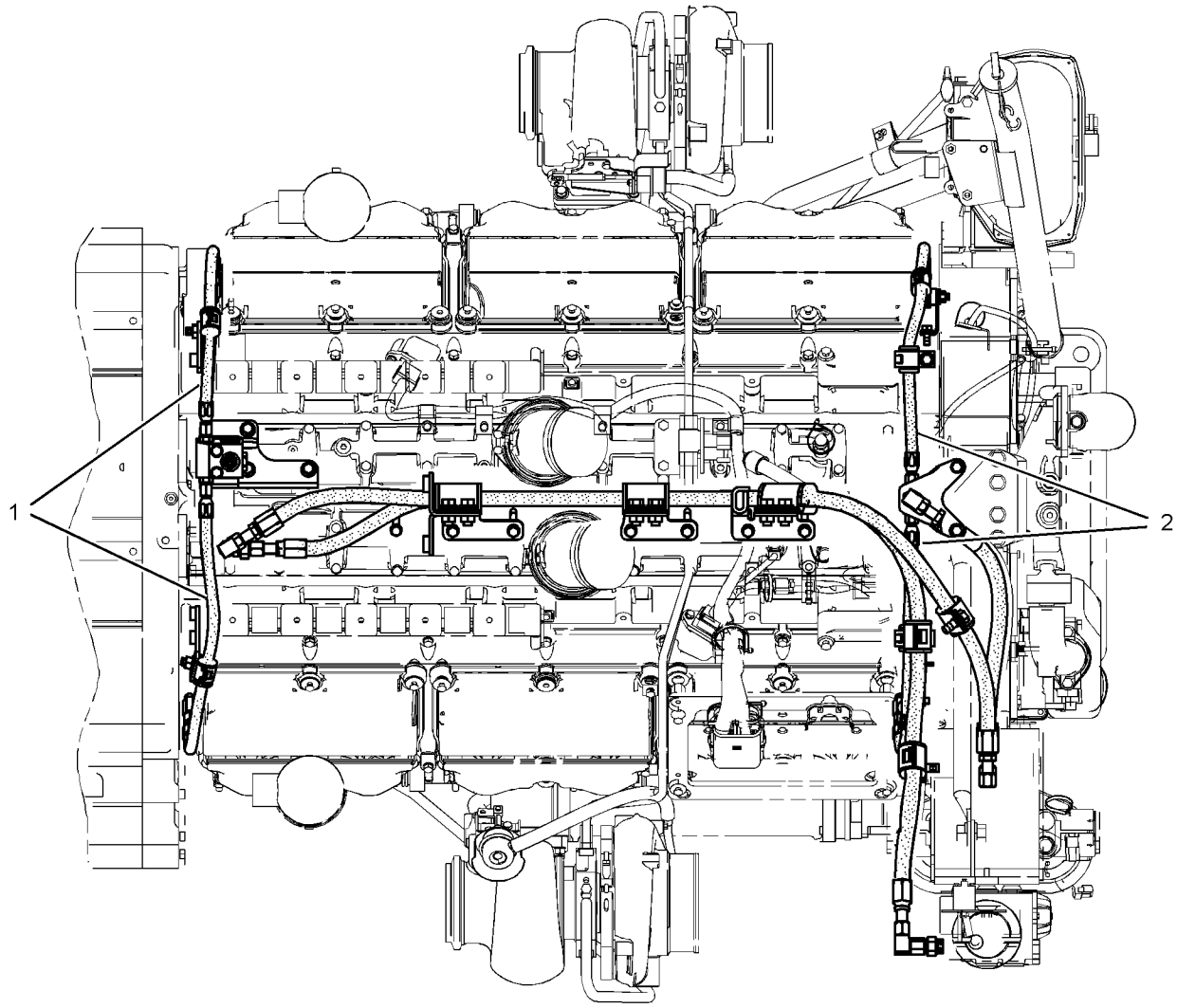
SMCS Code: 1000; 7554-510; 7554-040

Inspect the Hoses and the Clamps

The nonmetallic hoses and the clamps must be inspected periodically in order to ensure safe operation and continuous operation of the engine fuel system. Take proper safety precautions before inspecting or replacing hoses and clamps.

Note: Always use a board or cardboard when the engine components are checked for leaks. Leaking fluid that is under pressure can cause serious injury or possible death, including leaks that are the size of a pin hole. Refer to Operation and Maintenance Manual, “General Hazard Information” for more information.

Nonmetallic Fuel Lines



TOP VIEW OF ENGINE

Illustration 154 g02141367

(1) Rear low-pressure fuel lines (2) Front low-pressure fuel lines

Inspect hoses (1) and (2) of the engine fuel system for leaks that are caused by the following conditions.

Replace any non-metallic fuel line (hose) which exhibits any of the following conditions.

- Hoses which are cracked
- Hoses which are soft
- Outer covering that is chafed or cut
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed

- Hoses which exhibit signs of leakage which are not the result of loose couplings or clamps

Failure to replace a non-metallic fuel line (hose) which exhibits any of the above conditions may result in a hazardous situation.

Inspect all clamps for the following conditions. Replace any clamp which exhibits signs of any of the following conditions.

- Cracking
- Looseness
- Damage

Inspect all couplings for leaks. Replace any coupling which exhibits signs of leaks.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. The loose clamp can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Replace hoses that are cracked or soft. Replace hoses that show signs of leakage. Replace hoses that show signs of damage. Replace hose clamps that are cracked or damaged. Tighten or replace hose clamps which are loose.

Replace the Hoses and the Clamps

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Caterpillar Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Nonmetallic Fuel Lines

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

Replace the non-metallic fuel lines in a set.

1. Stop the engine and turn off the fuel supply.

2. Turn the battery disconnect switch to the OFF position.

3. Drain the fuel from the fuel system to a level that is below the hose that is being replaced.

4. Remove the hose clamps.

5. Disconnect the old hose. Refer to Illustration 154 .

6. Replace the old hose with a new hose.

7. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

8. Carefully inspect the engine for any spilled fuel. Make sure that no fuel remains on or close to the engine.

Note: Fuel must be added to the fuel system ahead of the fuel filter.

9. Refill the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” for information about priming the engine with fuel.

10. Start the engine. Inspect the fuel system for leaks.

i03650177

Hydraulic System Oil (Implement) (Braking) - Change

SMCS Code: 5056-044

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Operate the machine in order to warm the oil.

2. Park the machine on level ground. Lower the implement to the ground with a slight downward pressure. Engage the parking brake and stop the engine.

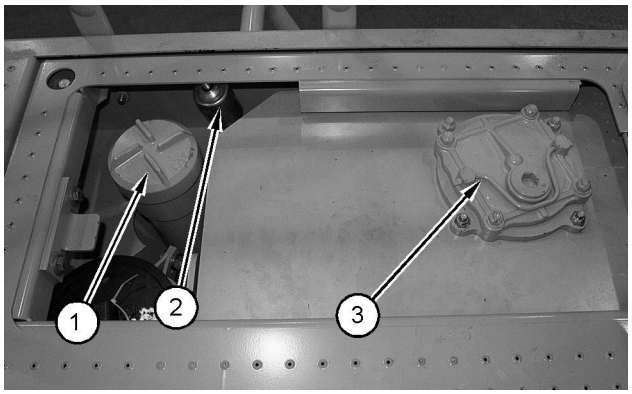


Illustration 155 g01050654

3. Open the access door on the right side of the platform.

4. Push the button on the top of breaker relief valve (2) in order to relieve any tank pressure.

5. Remove hydraulic tank filler cap (1). Remove the strainer from the tube.

6. Wash the strainer and the filler cap in a clean, nonflammable solvent.

7. Remove the oil drain plug from the bottom of the hydraulic tank.

8. Attach a hose to a suitable drain adapter. Install the adapter into the drain plug opening in order to open the internal drain valve. Allow the oil to drain into a suitable container.

NOTICE
Never start the engine while the hydraulic oil tank is being drained or while the hydraulic oil tank is empty. Excessive wear and damage to the hydraulic components can occur.

9. Remove the adapter in order to close the internal drain valve. Clean the drain plug and install the drain plug.

10. Remove filter cover (3) and replace the hydraulic oil filter.

Reference: Refer to Operation and Maintenance Manual, “Hydraulic System Oil Filter (Implement and Braking) - Replace” for the correct procedure.

11. Install the filler strainer.

12. Fill the hydraulic oil tank with clean oil. Make sure that the oil level is at the “FULL” mark on the sight gauge.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the correct type of oil and for the correct amount of oil.

13. Start the engine and run the engine for at least ten seconds. Then, stop the engine and add hydraulic oil to the tank until the oil level is at the “FULL” mark on the sight gauge.

14. Start the engine and run the engine at low idle. Cycle the implements so that all hydraulic systems are filled with oil.

Note: Make sure that the oil level is never below the suction ports in the hydraulic tank while the engine is running.

15. Stop the engine and top off the hydraulic tank so that the oil level is at the “FULL” mark on the sight gauge.

Note: The oil must be free of air bubbles. If air bubbles are present in the hydraulic oil, air is entering the hydraulic system. Inspect the hydraulic suction line and the hose clamps.

16. If necessary, tighten any loose clamps or any loose connections. Replace any damaged hoses.

17. Inspect the gasket on the hydraulic tank filler cap for damage. Replace the gasket, if necessary. Install the filler cap.

18. Stop the engine. Close the access door.

i03650242

Hydraulic System Oil (Steering) (Hydraulic Fan) - Change

SMCS Code: 5056-044

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Operate the machine in order to warm the oil.

2. Park the machine on level ground. Lower the blade to the ground with a slight downward pressure. Engage the parking brake and stop the engine.

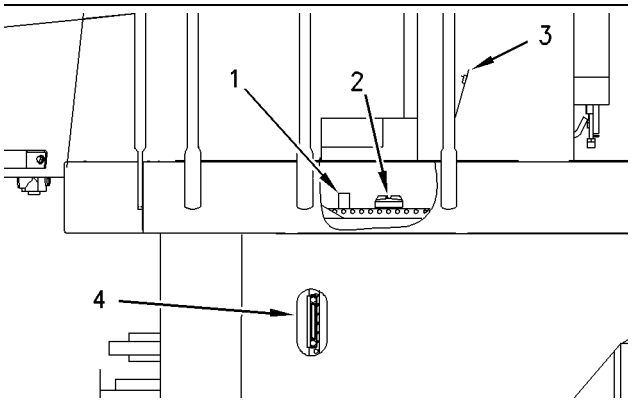


Illustration 156 g00951477

3. Open access panel (3) on the left side of the machine.

4. Push the button on the top of breaker relief valve (1) in order to relieve any tank pressure.

5. Remove hydraulic tank filler cap (2). Remove the strainer from the tube.

6. Wash the strainer and the filler cap in a clean, nonflammable solvent.

7. Remove the oil drain plug from the bottom of the hydraulic tank.

8. Attach a hose to a 126-7914 Oil Drain Coupling. Install the oil drain coupling into the drain plug opening in order to open the internal drain valve. Allow the oil to drain into a suitable container.

9. Remove the oil drain coupling in order to close the internal drain valve. Clean the drain plug and install the drain plug.

10. Replace the hydraulic oil filter.

Reference: Refer to Operation and Maintenance Manual, “Hydraulic System Oil Filter (Steering and Hydraulic Fan) - Replace” for the correct procedure.

11. Install the filler strainer.

12. Fill the hydraulic oil tank with clean oil. Make sure that the oil level is above the “ADD COLD” mark on sight gauge (4).

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the correct type of oil and for the correct amount of oil.

13. Start the engine and run the engine for at least ten seconds. Then, stop the engine and add hydraulic oil to the tank until the oil level is above the “ADD COLD” mark on the sight gauge.

14. Start the engine and run the engine at low idle. Cycle the STIC control so that the steering hydraulic oil lines are filled with oil.

Note: Make sure that the oil level is never below the suction ports in the hydraulic tank while the engine is running.

15. Stop the engine and top off the hydraulic tank so that the oil level is above the “ADD COLD” mark on the sight gauge.

Note: The oil must be free of air bubbles. If air bubbles are present in the hydraulic oil, air is entering the hydraulic system. Inspect the hydraulic suction line and the hose clamps.

16. If necessary, tighten any loose clamps or any loose connections. Replace any damaged hoses.

17. Inspect the gasket on the hydraulic tank filler cap for damage. Replace the gasket, if necessary. Install the filler cap.

18. Stop the engine. Close the access door.

i03650298

Hydraulic System Oil Filter (Implement) (Braking) - Replace

SMCS Code: 5068-510

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

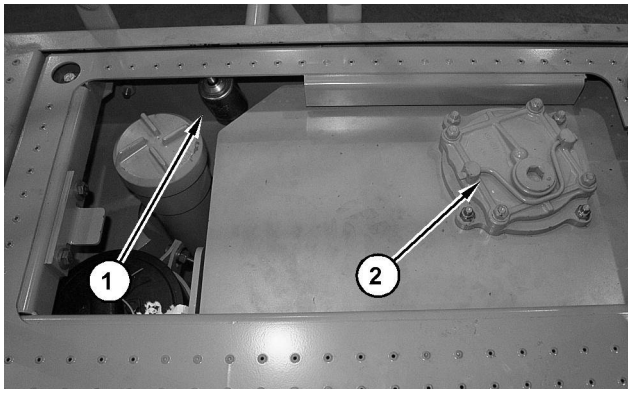


Illustration 157 g01050742

1. Open the access door on the right side of the cab platform.

2. Press the breaker relief valve (1) in order to relieve any tank pressure.

3. Remove the four bolts that hold filter cover (2) in place. Use the handle to pull the cover and the filter from the hydraulic tank.

4. Inspect the filter gasket and inspect the cover seal. Replace the gasket and replace the seal, if necessary.

5. Remove the filter element. Properly dispose of the filter element.

6. Remove the filter screen. Wash the screen in a clean nonflammable solvent.

7. Install the filter screen and install a new filter element.

8. Install the filter cover. Close the access door.

9. Start the engine. Run the engine at low idle and check for leaks in the hydraulic system.

10. Check the hydraulic oil level.

Reference: Refer to Operation and Maintenance Manual, “Hydraulic System Oil (Implement and Braking) - Check” for the correct procedure.

11. Stop the engine.

i03650327

Hydraulic System Oil Filter (Steering) (Hydraulic Fan) - Replace

SMCS Code: 5068-510

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

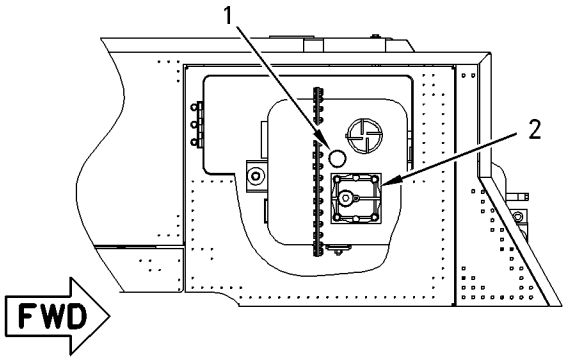


Illustration 158 g00951566

1. Open the access door on the left side of the cab platform.

2. Push the top of breaker relief valve (1) in order to relieve any tank pressure.

3. Remove the four bolts that hold filter cover (2) in place. Use the handle to pull the cover and the two filters from the hydraulic tank.

4. Inspect the filter gasket and inspect the cover seal. Replace the gasket and replace the seal, if necessary.

5. Install the new oil filters and install the filter cover. Install the four bolts.

6. Close the access door.

7. Check the hydraulic oil level.

Reference: Refer to Operation and Maintenance Manual, “Hydraulic System Oil Level (Steering and Hydraulic Fan) - Check” for the correct procedure.

i03650376

Hydraulic System Oil Level (Implement) (Braking) - Check

SMCS Code: 5056-535-FLV

The hydraulic tank for the implement and braking systems is located on the right side of the machine. Maintain the oil level above the “ADD COLD” mark in sight gauge (1) while the engine is running.

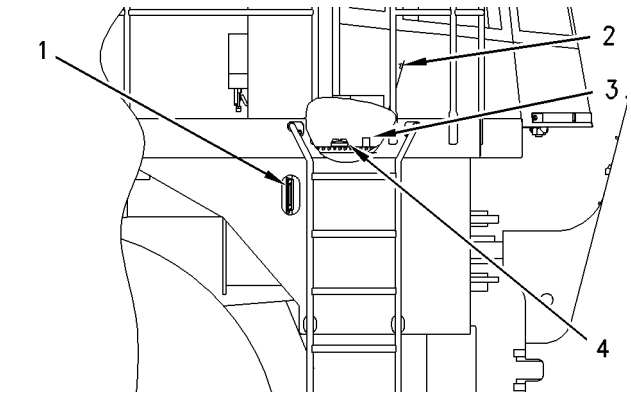


Illustration 159 g00946588

If necessary, add oil to the hydraulic tank.

1. Shut off the engine.

2. Open access door (2) on the right side of the cab platform.

3. Push the button on the top of breaker relief valve (3) in order to relieve any tank pressure.

4. Remove filler cap (4) and add the oil.

5. Install the filler cap and close the access door.

i03650410

Hydraulic System Oil Level (Steering) (Hydraulic Fan) - Check

SMCS Code: 5056-535-FLV

The hydraulic tank for the steering and hydraulic fan systems is located on the left side of the machine. Maintain the oil level above the “ADD COLD” mark in sight gauge (4) while the engine is running.

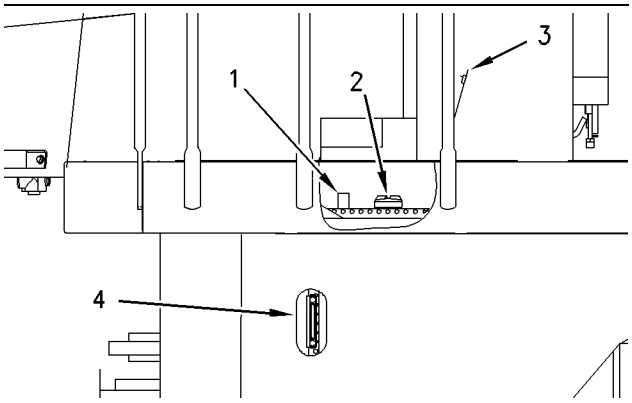


Illustration 160 g00951477

If necessary, add oil to the hydraulic tank.

1. Shut off the engine.

2. Open access door (3) on the left side of the cab platform.

3. Push the button on the top of breaker relief valve (1) in order to relieve any tank pressure.

4. Remove filler cap (2) and add the oil.

5. Install the filler cap and close the access door.

i03650431

Hydraulic System Oil Sample (Implement) (Braking) - Obtain

SMCS Code: 4250-008; 5050-008; 5056-008; 7542

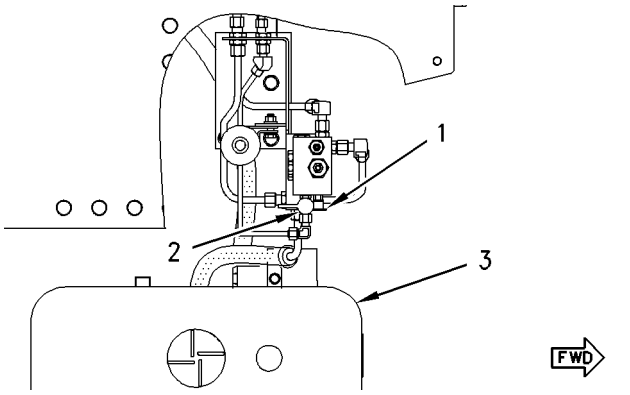


Illustration 161 g00936855

The sampling valve (1) for the hydraulic oil (implement and brakes) is located near hydraulic tank (3) under the right side cab platform. Do not use pressure tap (2).

Reference: Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for more information about obtaining an fluid sample.

i04291169

Hydraulic System Oil Sample (Steering) (Hydraulic Fan) - Obtain

SMCS Code: 4300-008; 5050-008; 5056-008; 7542

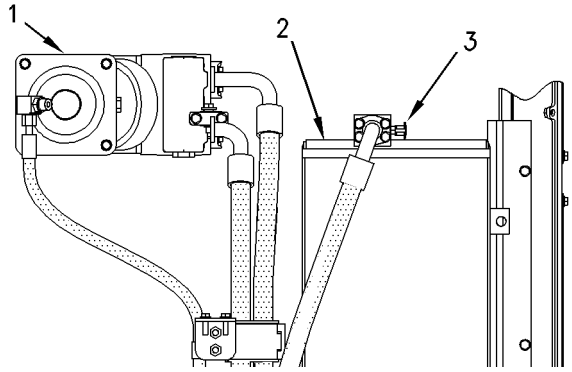


Illustration 162 g00936442

(1) Fan motor
(2) Cooler for the hydraulic fan
(3) Sampling valve

The sampling valve (3) for the hydraulic oil (steering and hydraulic fan motor) is located on the left side of the engine compartment behind the air inlet.

Reference: Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for more information about obtaining a fluid sample.

i01866105

Hydraulic Tank Breaker Relief Valve - Clean

SMCS Code: 5118-070

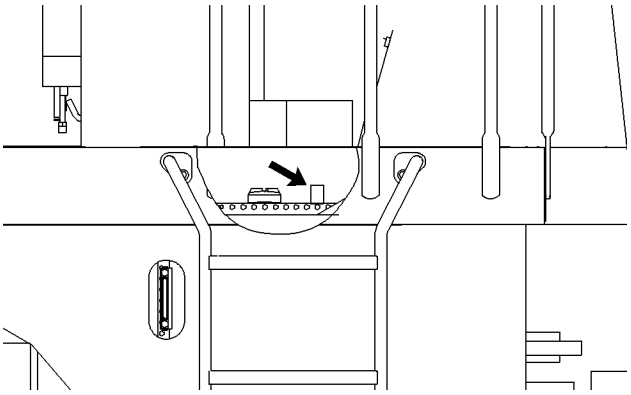


Illustration 163 g00951177

1. Open the access cover on the right side of the cab platform.
2. Remove the hydraulic tank breaker relief valve.
3. Clean the breaker relief valve in a clean nonflammable solvent. Dry the breaker relief valve thoroughly by shaking or by using compressed air.
4. Install the hydraulic tank breaker relief valve.
5. Close the access cover.
6. Repeat the procedure for the other hydraulic tank breaker relief valve on the left side of the machine.

i02068777

Lift Cylinder Yoke Bearings - Lubricate

SMCS Code: 5102-086-BD

Wipe off the fittings before any lubricant is applied.

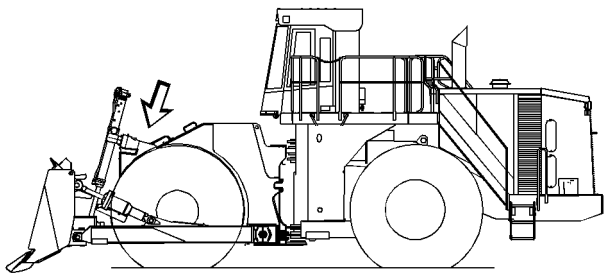


Illustration 164 g01059969

Apply lubricant through one fitting on the yoke for each lift cylinder.

There is a total of two fittings.

i02106227

Oil Filter - Inspect

SMCS Code: 1308-507; 3004-507; 3067-507; 5068-507

Inspect a Used Filter for Debris

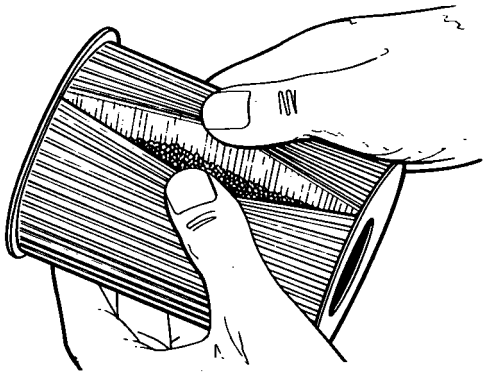


Illustration 165 g00100013

The element is shown with debris.

Use a filter cutter to cut the filter element open. Spread apart the pleats and inspect the element for metal and for other debris. An excessive amount of debris in the filter element can indicate a possible failure.

If metals are found in the filter element, a magnet can be used to differentiate between ferrous metals and nonferrous metals.

Ferrous metals can indicate wear on steel parts and on cast iron parts.

Nonferrous metals can indicate wear on the aluminum parts of the engine such as main bearings, rod bearings, or turbocharger bearings.

Small amounts of debris may be found in the filter element. This could be caused by friction and by normal wear. Consult your Caterpillar dealer in order to arrange for further analysis if an excessive amount of debris is found.

Using an oil filter element that is not recommended by Caterpillar can result in severe engine damage to engine bearings, to the crankshaft, and to other parts. This can result in larger particles in unfiltered oil. The particles could enter the lubricating system and the particles could cause damage.

i00057294

Radiator Core - Clean

SMCS Code: 1353-070-KO

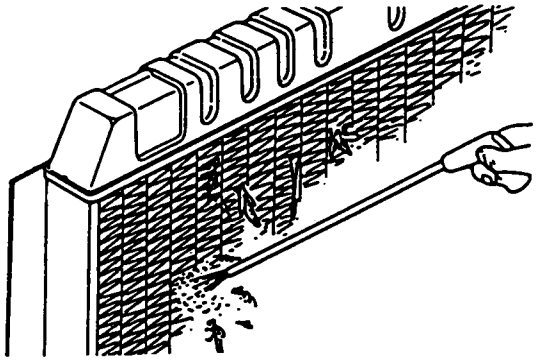


Illustration 166 g00100062

You can use compressed air, high pressure water, or steam to remove dust and other debris from the radiator core. However, the use of compressed air is preferred.

See Special Publication, SEBD0518, “Know Your Cooling System” for the complete procedure for cleaning the radiator core.

i05805860

Receiver Dryer (Refrigerant) - Replace

SMCS Code: 7322-510

⚠ WARNING

Personal injury can result from contact with refrigerant.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.

NOTICE
If the refrigerant system has been open to the outside air (without being plugged) for more than 30 minutes, the receiver-dryer must be replaced. Moisture will enter an open refrigerant system and cause corrosion which will lead to component failure.

Refer to Service Manual, “Air Conditioning and Heating R-134a for All Caterpillar Machines” for the proper procedure to change the receiver-dryer assembly and for the procedure to reclaim the refrigerant gas.

i01869155

Rollover Protective Structure (ROPS) - Inspect

SMCS Code: 7325-040

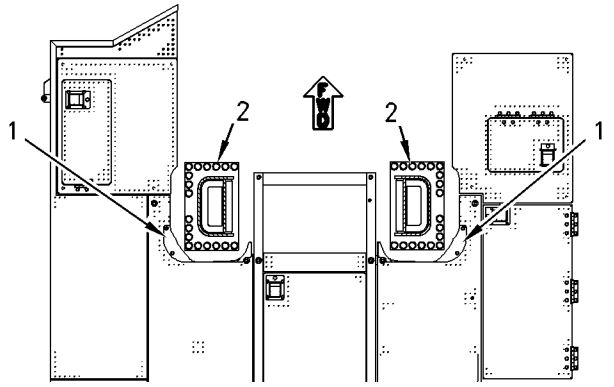


Illustration 167 g00952022
Typical example

1. Remove access covers (1) from both sides of the Rollover Protective Structure (ROPS).
2. Inspect the ROPS for bolts (2) that are loose or damaged. Replace the damaged bolts and missing bolts with original equipment parts only. Torque the bolts to 1600 ± 200 N·m (1200 ± 150 lb ft).

Note: Apply oil to all ROPS bolt threads before you install the bolts. Failure to apply oil can result in improper bolt torque.

3. Drive the machine on a rough surface. If the ROPS mounting supports rattle, replace the ROPS mounting supports.
4. Install the access covers.

Do not attempt to straighten the ROPS. Do not repair the ROPS by welding reinforcement plates to the structure.

Consult your Caterpillar dealer for repair of cracks in the weld, in the castings, or in any metal section of the ROPS.

i04423622

Seat Belt - Inspect

SMCS Code: 7327-040

Always inspect the condition of the seat belt and the condition of the seat belt mounting hardware before you operate the machine. Replace any parts that are damaged or worn before you operate the machine.

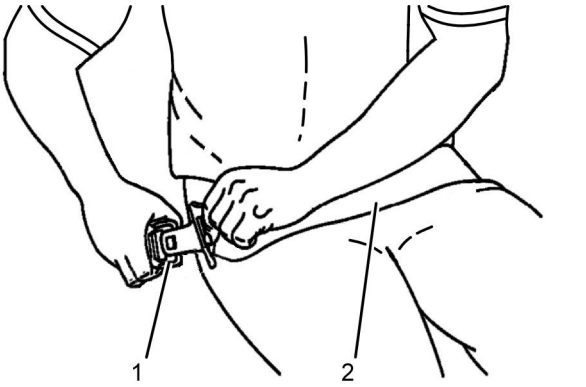


Illustration 168 g02620101

Typical example

Inspect buckle (1) for wear or for damage. If the buckle is worn or damaged, replace the seat belt.

Inspect seat belt (2) for webbing that is worn or frayed. Replace the seat belt if the webbing is worn or frayed.

Inspect all seat belt mounting hardware for wear or for damage. Replace any mounting hardware that is worn or damaged. Make sure that the mounting bolts are tight.

If your machine is equipped with a seat belt extension, also perform this inspection procedure for the seat belt extension.

Contact your Cat dealer for the replacement of the seat belt and the mounting hardware.

Note: The seat belt should be replaced within 3 years of the date of installation. A date of installation label is attached to the seat belt retractor and buckle. If the date of installation label is missing, replace belt within 3 years from the year of manufacture as indicated on belt webbing label, buckle housing, or installation tags (non-retractable belts).

i06891605

Seat Belt - Replace

SMCS Code: 7327-510

The seat belt should be replaced within 3 years of the date of installation. A date of installation label is attached to the seat belt retractor and buckle. If the date of installation label is missing, replace belt within 3 years from the year of manufacture as indicated on belt webbing label, buckle housing, or installation tags (non-retractable belts).

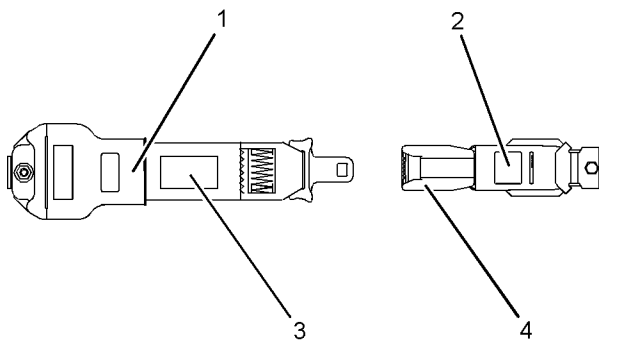


Illustration 169 g01152685

Typical Example

(1) Date of installation (retractor)
(2) Date of installation (buckle)
(3) Year of manufacture (tag) (fully extended web)
(4) Year of manufacture (underside) (buckle)

Consult your Cat dealer for the replacement of the seat belt and the mounting hardware.

Determine age of new seat belt before installing on seat. A manufacture label is on belt webbing and imprinted on belt buckle. Do not exceed install by date on label.

Complete seat belt system should be installed with new mounting hardware.

Date of installation labels should be marked and affixed to the seat belt retractor and buckle.

Note: Date of installation labels should be permanently marked by punch (retractable belt) or stamp (non-retractable belt).

If your machine is equipped with a seat belt extension, also perform this replacement procedure for the seat belt extension.

i01547608

Seat Side Rails - Adjust

SMCS Code: 7312-025

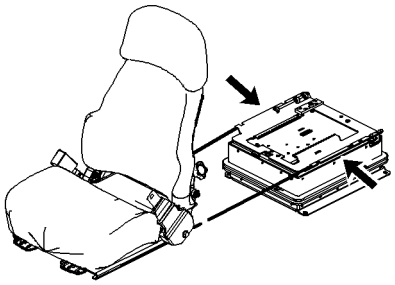


Illustration 170 g00804394

Caterpillar recommends adjusting the side rails after the initial 500 hours of machine operation. After the initial 500 service hours, perform this procedure when it is necessary.

Reference: Refer to Service Manual, SENR6615, “Contour Series Seat” for the adjustment procedure.

i03694709

Secondary Steering - Test

SMCS Code: 4300-081-SE; 4300-081-SST; 4324-081; 4324

⚠ WARNING

The service brake must be checked in order to ensure proper operation before you test the supplemental steering system.

Personal injury, death, or property damage could occur if the supplemental steering system is tested and the service brake is not operational.

Test the service brake before you test the supplemental steering system.

Perform the following procedure if your machine is equipped with a ground driven supplemental steering and if the procedure is required by local regulations.

Ensure that there are no hazards in the test area. The test area must be unobstructed and level. Operate the machine in second gear.

Ensure that all air tanks and accumulators are properly charged. Ensure that there is no load in the work tool. Position the machine with the bucket or the work tool in the CARRY position with the machine in neutral. Release the parking brake. Apply the service brakes and put the engine at low idle. Ensure that The area around the machine is clear of personnel. Shift the transmission to second gear forward and slowly release the service brakes. Moderately increase the engine speed to high idle. Shift the transmission to neutral. Turn the ignition to the OFF position. Allow the machine to coast.

While the machine is in motion, turn the machine to the left and to the right. If the machine responds to the steering input, the supplemental steering system is operating. Stop the machine with the service brakes. Apply the parking brake. The machine can then be returned to normal operation.

If there is no response to the steering input, the supplemental steering system is not operating. Stop the machine immediately. Repair the supplemental steering system before returning the machine to service.

i03689109

Service Brake Wear Indicator - Check

SMCS Code: 4255-535-IND

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

This procedure requires two people. One person must engage the service brakes and the other person must measure the disc wear. Care must be taken when you perform this procedure. Oil leakage from the brake system will occur. Keep all other personnel away from the machine or in sight of the operator.

1. Park the machine on a level surface away from other equipment and other personnel and lower the implement to the ground. Place the transmission in NEUTRAL. Engage the parking brake and turn off the engine.
2. Install the steering lock and chock the wheels.
3. Start the engine in order to build brake system pressure.

4. Stop the engine. Allow the axle oil to settle before proceeding to the next step.

Note: Keep the engine off when the brake wear is measured.

5. Place a suitable container below the plug in order to collect oil leakage from the brake system.

6. Press and hold the service brake pedal.

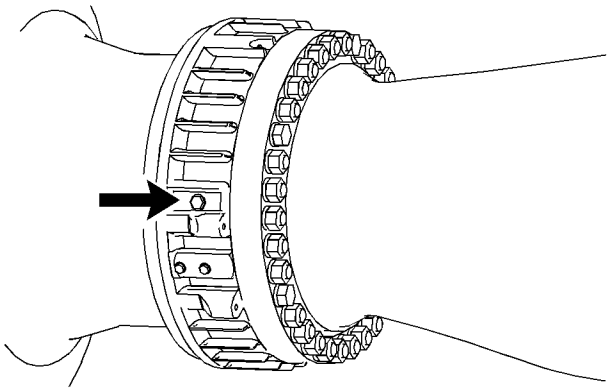


Illustration 171 g01446483

7. Remove the plug.

NOTICE
Do not allow the brake piston to retract while the pin is installed in the plug hole. This could cause the pin to break off when the brake piston retracts. It is possible for broken pieces of the tool to fall into the brake housing and cause damage.

8. Insert a FT3105 brake wear gauge into the inspection hole.

If the brake wear gauge does not drop all the way into the inspection hole, the brake wear is less than 50%. Proceed to step 11.

If the brake wear gauge drops all the way into the inspection hole, the brake wear is greater than 50%. Proceed to step 9.

9. Insert a FT3104 brake wear gauge into the inspection hole.

If the brake wear gauge does not drop all the way into the inspection hole, the brake wear is between 50% and 75%. Proceed to step 11.

If the brake wear gauge drops all the way into the inspection hole, the brake wear is greater than 75%. Proceed to step 10.

10. Insert a FT3103 brake wear gauge into the inspection hole.

If the brake wear gauge does not drop all the way into the inspection hole, the brake wear is between 75% and 100%. Brake service should be scheduled soon.

If the brake wear gauge drops all the way into the inspection hole, the brake wear is greater than 100%. Brake service should be scheduled immediately.

11. Remove the brake wear gauge.

12. Release the service brake pedal.

13. Install the plug.

14. Clean up spilled oil.

15. Repeat steps 1 through 14 for each service brake.

i00689198

Starting Motor - Inspect

SMCS Code: 1453-040

Caterpillar recommends a scheduled inspection of the starter. Inspect the starter for connections that are loose.

Check the starter for proper operation and check the battery charger for proper operation.

Keep the batteries fully charged.

Air temperature affects the cranking power of the batteries. Keep the batteries warm. The engine will not crank if the batteries are too cold. A warm engine will not crank if the batteries are too cold.

Refer to the Service Manual Module, SENR1018, “Engine Systems Operation Testing and Adjusting” for the procedure to inspect the starting motor.

i01448338

Steering Cylinder Bearings - Lubricate

SMCS Code: 4303-086-BD

Wipe the fittings before you apply any lubricant.

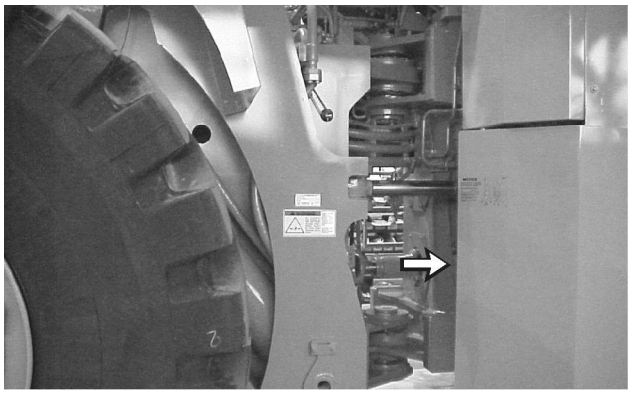


Illustration 172 g00761327

Two remote fittings are located near the articulation joint on the left side of the machine.



Illustration 173 g00304165

Typical Example

Apply lubricant through the two remote fittings for the head ends of the steering cylinders.

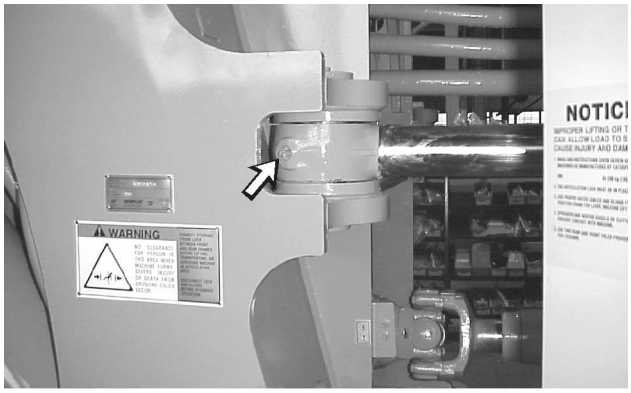


Illustration 174 g00761938

Apply lubricant through the fitting in the rod end of the left steering cylinder.

Apply lubricant through the fitting in the rod end of the right steering cylinder.

i02069257

Tilt Cylinder Bearings - Lubricate

SMCS Code: 5104-086-BD

Wipe off the fittings before any lubricant is applied.

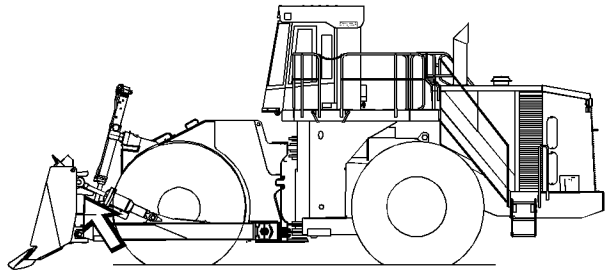


Illustration 175 g01060050

Apply lubricant through one fitting on each tilt cylinder.

There is a total of two fittings.

i02305841

Tire Inflation - Check

SMCS Code: 4203-535-AI

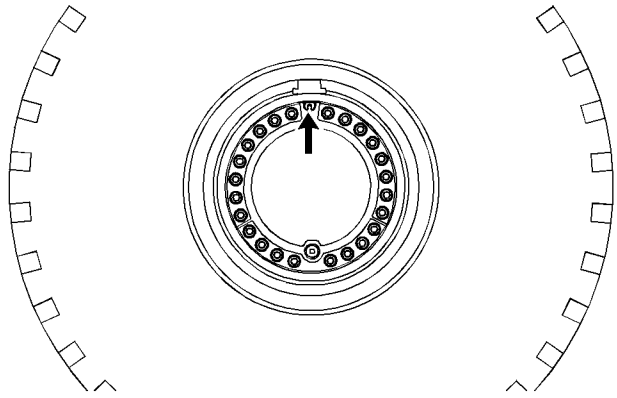


Illustration 176 g01160201

Always obtain proper tire inflation pressures and maintenance recommendations for the tires on your machine from your tire supplier. Measure the tire pressure on each tire.

Inflate the tires with nitrogen , if necessary.

Reference: Refer to the “Tire Inflation Information” section of the Operation and Maintenance Manual for more information.

i01868211

Transmission Magnetic Screen - Clean

SMCS Code: 3030-070-MGS

Clean the transmission magnetic screen if the transmission oil pump fails or the transmission is disassembled.

Drain the transmission oil before you remove the transmission magnetic screen. Refer to Operation and Maintenance Manual, “Transmission Oil - Change” for the procedure to drain the transmission oil.

1. Park the machine on level ground. Lower the blade to the ground and apply slight downward pressure. Engage the parking brake and stop the engine.

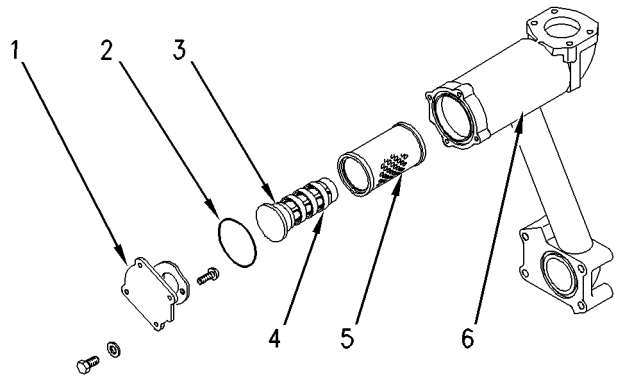


Illustration 177 g00849759

2. The transmission magnetic screen is located on the right side of the transmission. Remove cover (1) from transmission magnetic screen (5).

3. Remove magnets (4), screen (5) and tube (3) from housing (6).

4. Wash screen (5) and tube (3) in clean nonflammable solvent.

5. Clean magnets (4) with a cloth, with a stiff bristle brush or with pressure air.

6. Clean cover (1) and inspect seal (2). Replace the seal, if necessary.

7. Insert magnets (4) in screen (5). Then, insert screen (5), magnets (4) and tube (3) in housing (6).

8. Install cover (1) and tighten the cover bolts.

i02046957

Transmission Oil - Change

SMCS Code: 3030-044

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

1. Operate the machine in order to warm the oil.

2. Park the machine on level ground. Lower the implement to the ground and apply slight downward pressure. Engage the parking brake. Stop the engine.

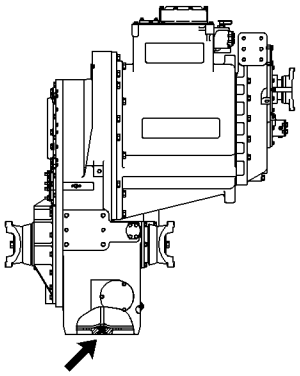


Illustration 178 g00951887

3. The transmission drain plug is located on the bottom of the transmission case at the center of the machine. Remove the transmission drain plug. Allow the oil to drain into a suitable container.

4. Change the transmission oil filter.

Reference: Refer to Operation and Maintenance Manual, “Transmission Oil Filter - Replace” for the correct procedure.

5. Clean the transmission magnetic screen.

Reference: Refer to Operation and Maintenance Manual, “Transmission Magnetic Screen - Clean” for the correct procedure.

6. Clean the transmission drain plug and install the transmission drain plug.

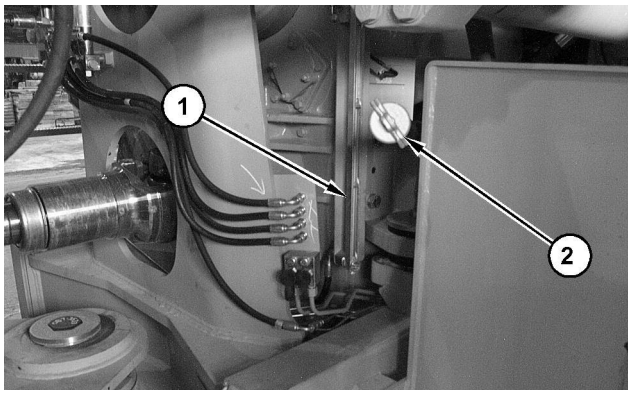


Illustration 179 g01050754

7. Remove transmission oil filler cap (2). Fill the transmission with oil.

Reference: Refer to Operation and Maintenance Manual, “Lubricant Viscosities and Refill Capacities” for the proper type of oil and for the proper amount of oil.

8. Clean the transmission oil filler cap and install the transmission oil filler cap.

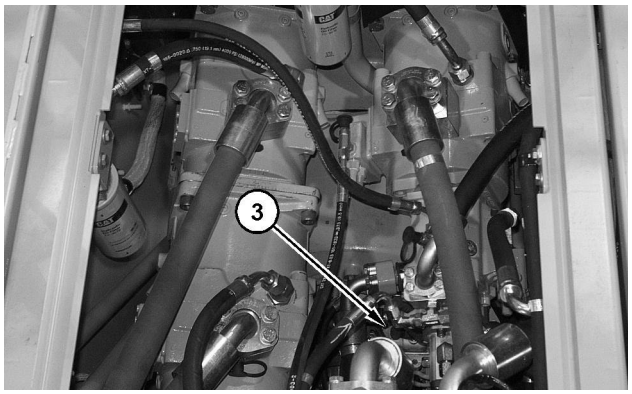


Illustration 180 g01050755

9. Open the access door in the platform behind the cab and remove transmission breather (3). Wash the breather in a clean nonflammable solvent. Allow the breather to dry or use air pressure to dry the breather. Install the transmission breather.

10. Remove the transfer gear housing breather. Wash the breather in a clean, nonflammable solvent. Allow the breather to dry or use air pressure to dry the breather. Install the transfer gear housing breather.

11. Start the engine and run the engine at low idle. Inspect the transmission for leaks.

12. Slowly operate the STIC steering control in order to circulate the oil.

13. Move the STIC transmission direction control switch to the NEUTRAL position. Engage the parking brake. Inspect the entire transmission system for leaks.

14. Check the oil level on the sight gauge (1).

Reference: Refer to Operation and Maintenance Manual, “Transmission Oil Level - Check” for the correct procedure.

15. Stop the engine.

i02047141

Transmission Oil Filter - Replace

SMCS Code: 3004-510; 3067-510

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

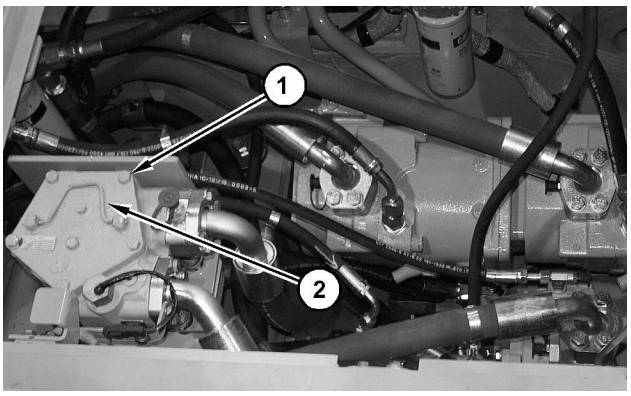


Illustration 181 g01050890

1. Open the access door in the center of the cab platform.

2. Remove mounting bolts (1) and pull up on handle (2) in order to remove the oil filter.

3. Remove the used filter element from the filter housing. Dispose of the used filter element properly.

4. Clean the filter housing and the filter housing base with a clean, nonflammable solvent.

5. Inspect the filter housing seal. Replace the seal if the seal is damaged.

6. Insert a new filter element into the filter housing.

7. Install the oil filter and the mounting bolts.

8. Start the engine and apply the right brake pedal only.

9. Slowly operate the transmission direction switch in order to circulate the oil.

10. Move the transmission direction switch to NEUTRAL. Engage the parking brake. Inspect the entire power train system for leaks.

11. Check the transmission oil level.

Reference: Refer to Operation and Maintenance Manual, “Transmission Oil Level - Check” for the correct procedure.

i02641020

Transmission Oil Level - Check

SMCS Code: 3030-535-FLV

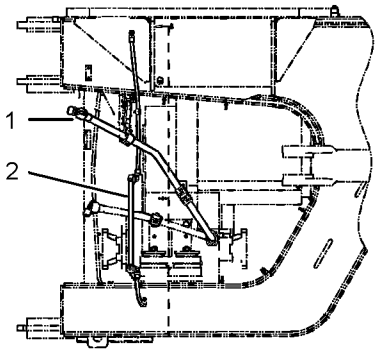


Illustration 182 g01325050

Transmission oil level gauge (2) and transmission oil filler cap (1) are located on the left side of the machine near the articulation joint.

1. Operate the machine for a few minutes in order to warm the oil.

2. Park the machine on firm, level ground. Put the transmission control into the NEUTRAL position. Lower the bucket to the ground with a slight downward pressure. Engage the parking brake.

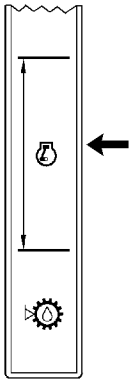


Illustration 183 g01326398

3. Check the oil level in sight gauge (2) while the engine is running at low idle. Maintain the oil level within the operating range while the engine is running.

Note: The oil level varies significantly when the engine is stopped. The oil level will be considerably higher than the operating range. The oil level should be above the middle of the gauge before the engine is started.

4. If necessary, remove filler cap (1) and add oil. Clean the filler cap and install the filler cap.

i02047417

Transmission Oil Sample - Obtain

SMCS Code: 3080-008; 7542

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Cat ® products.

Dispose of all fluids according to local regulations and mandates.

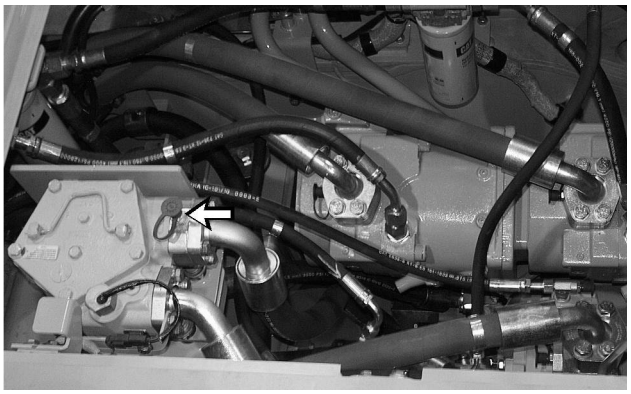


Illustration 184 g01051036

The sampling valve for the transmission is located in the center compartment on the cab platform right behind the cab.

Reference: Refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” for more information about obtaining an fluid sample.

i01394768

Turbocharger - Inspect

SMCS Code: 1052-040

If the turbocharger fails during engine operation, severe damage to the turbocharger compressor wheel and to the entire engine can result.

Turbocharger bearing failures can cause large quantities of oil to enter the intake system and the exhaust system. Loss of engine oil can result in serious engine damage.

Do not continue to operate the engine when a turbocharger bearing failure is accompanied by a significant loss of engine performance. Engine smoke and speeding up of the engine with no load are characteristics of a loss of engine performance.

Reference: For more information about inspecting the turbocharger, refer to the appropriate Service Manual for your machine's engine.

i01869115

Window Washer Reservoir - Fill

SMCS Code: 7306-544

NOTICE
When operating in freezing temperatures, use Caterpillar nonfreezing window washer solvent or equivalent. System damage can result from freezing.

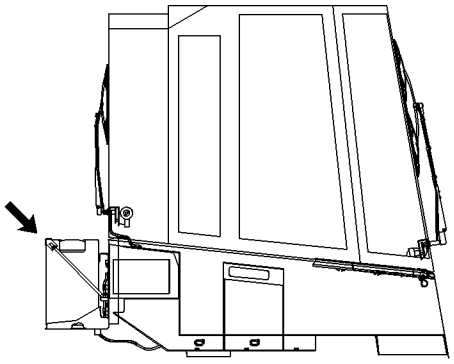


Illustration 185 g00952003

The window washer reservoir is located behind the cab.

As needed, fill the reservoir with window washer solvent.

i01869069

Window Wiper - Inspect/ Replace

SMCS Code: 7305-510; 7305-040

Inspect the condition of all of the wiper blades. Replace the wiper blades if the wiper blades are worn or damaged or if streaking occurs.

i04412316

Windows - Clean

SMCS Code: 7310-070

Clean the outside of the windows from the ground, unless handholds are available.

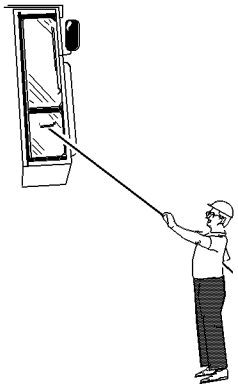


Illustration 186 g00566124
Typical example

Cleaning Methods

Commercial Window Cleaner

Apply the cleaner with a soft cloth. Rub the window with moderate pressure until all the dirt is removed. Allow the cleaner to dry. Wipe off the cleaner with a clean soft cloth.

Soap and Water

Use a clean sponge or a soft cloth. Wash the windows with a mild soap or with a mild detergent. Also use plenty of lukewarm water. Rinse the windows thoroughly. Dry the windows with a moist chamois or with a moist cellulose sponge.

Stubborn Dirt and Grease

Wash the windows with a good grade of naphtha, of isopropyl alcohol, or of Butyl Cellosolve. Then, wash the windows with soap and with water.

Polycarbonate Windows (If equipped)

Wash polycarbonate windows with a mild soap or detergent. Never use a cleaning solvent on polycarbonate windows.

Wash polycarbonate windows with warm water and a soft sponge, or damp cloth. Never use a dry cloth or paper towels on polycarbonate windows.

Rinse the windows with a sufficient amount of clean water.

Reference Information Section

Reference Materials

i02818556

Reference Material

SMCS Code: 1000; 7000

The following literature can be obtained from any Caterpillar dealer:

Caterpillar Reference Material

- Special Publication, PEHP6046, “Product Data Sheet for Caterpillar Diesel Engine Oils (DEO)”, CG-4 engine oil
- Special Publication, PEHP1021, “Product Data Sheet for Caterpillar Biodegradable Hydraulic Oil (BIO HYDO)”
- Special Publication, PEHP7508, “Product Data Sheet for Caterpillar Gear Oil (GO)”
- Special Publication, PEHP3050, “Product Data Sheet for Caterpillar Multipurpose Tractor Oil (MTO)”
- Special Publication, PEHP7506, “Product Data Sheet for Caterpillar Transmission/Drive Train Oil (TDTO)”
- Special Publication, NEHP5621, “How To Select The Right Grease For Any Job”
- Special Publication, PEHP0002, “Product Data Sheet for Multipurpose Lithium Complex Grease with Molybdenum (MPGM)”
- Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog”
- Special Publication, SEBD0640, “Oil and Your Engine”
- Special Publication, SEBD0717, “Diesel Fuels and Your Engine”
- Operation and Maintenance Manual, SEBU5898, “Cold Weather Recommendations for All Catepillar Machines”
- Special Publication, SEBD1587, “What ROPS/FOPS Certification Means”
- Special Publication, TEBJ1015, “Understanding the S·O·S Report”
- Special Publication, PEHP6001, “How to Take a Good Oil Sample”
- Special Publication, PEHP4036, “Product Data Sheet for Caterpillar ELC”
- Special Publication, PEHP5033, “S·O·S Coolant Analysis”
- Special Publication, SEBD0518, “Know Your Cooling System”
- Special Publication, SEBD0970, “Coolant and Your Engine”
- Special Publication, PMEP5027, “Label”
- Special Instruction, SEHS9031, “Storage Procedure for Caterpillar Products”
- Special Instruction, REHS0034, “Guideline for Repair of Non-metallic Fenders and Hoods”
- Special Instruction, SEHS6929, “Inspection, Maintenance and Repair of ROPS and Attachment Installation Guidelines”
- Special Instruction, REHS1642, “Operation of the Product Link System”
- Operation and Maintenance Manual, SEBU6310, “EMA Lubricating Oils Data Book For Engines”
- Operation and Maintenance Manual, SEBU6250, “Caterpillar Machine Fluids Recommendations”
- Operation and Maintenance Manual, SEBU6981, “Emissions Control Warranty Information for US, Canada, and California”
- Operation and Maintenance Manual (Supplement), SEBU8257, “The European Union Physical Agents (Vibration) Directive 2002/44/EC”
- Service Manual, SENR5664, “Air Conditioning and Heating R-134a for All Caterpillar Machines”
- Service Manual, RENR6245
- Service Manual, RENR6245
- Parts Manual, SEBP3340

Additional Reference Material

ASTM D2896, “TBN Measurements” This can normally be obtained from your local technological society, from your local library, or from your local college.

SAE J313, “Diesel Fuels” This can be found in the SAE handbook. Also, this publication can be obtained from your local technological society, from your local library, or from your local college.

SAE J754, “Nomenclature” This can normally be found in the SAE handbook.

SAE J183, “Classification” This can normally be found in the SAE handbook.

Engine Manufacturers Association Lubricating Oils Data Book

Engine Manufacturers Association
401 North Michigan Avenue
Chicago, Illinois, USA 60611
(312) 644-6610

i03989612

Decommissioning and Disposal

SMCS Code: 1000; 7000

When the product is removed from service, local regulations for the product decommissioning will vary. Disposal of the product will vary with local regulations. Consult the nearest Cat dealer for additional information.

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Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

	Dealer Contact	Phone Number	Hours
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____



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